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Impacts of nature imagery on people in severely nature-deprived environments

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An estimated 5.3 million Americans live or work in nature-deprived venues such as prisons, homeless shelters, and mental hospitals. Such removal from nature can result in an "extinction of experience" that can further lead to disinterest or disaffection toward natural settings, or even biophobia (fear of the natural environment). People who infrequently – or never – spend time in nature will be deprived of the numerous physical and emotional benefits that contact with nature affords. We report on the effects of vicarious nature experiences (nature videos) provided to maximum-security prison inmates for one year, and compared their emotions and behaviors to inmates who were not offered such videos. Inmates who watched nature videos reported feeling significantly calmer, less irritable, and more empathetic, and committed 26% fewer violent infractions as compared to those who did not watch the videos. Prison staff corroborated these findings. This research reinforces the value of nature exposure as a powerful tool not only for corrections administrators, but also for urban planners and policy makers, to promote socially desirable behaviors.

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The human race has been intimately connected with and dependent upon nature throughout its evolutionary history. Our species gains numerous physical, spiritual, and mental health benefits through contact with the natural world (Daily *et al.* 2009; Heerwagen 2009; Kahn and Hasbach 2013). Researchers have formulated multiple theories to explain this profoundly important, primal relationship including biophilia (an innate tendency to seek connections with nature and other forms of life; Wilson 1984), attention restoration theory (Kaplan 1995), and stress reduction theory (Ulrich *et al.* 1991).

In a nutshell:

- Within the US population, a growing segment (approximately 5.3 million people) has extremely limited access to the natural world and its many physical and emotional benefits
- Direct and indirect introduction of nature into human settings (eg parks and gardens) can improve mood and reduce violence, but little is known about how vicarious nature experiences affect those in severely nature-deprived environments such as prisons
- Providing nature imagery for one year to inmates in solitary confinement resulted in reduced stress and irritability, greater calmness, and significantly fewer (26%) violent incidents
- Vicarious nature video experiences, particularly for populations where contact with the outdoors is difficult or impossible, can serve as a valuable tool for corrections administrators, as well as urban planners and policy makers, to promote socially desirable behaviors and well-being

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Soga and Gaston (2016) raised an alert to ecologists about the perils of losing contact with natural environments. This phenomenon, known as the extinction of experience (Pyle 1993), has been attributed to many sources, including rapid urbanization; an increase in virtual over actual experiences; and less physically active, over-scheduled lifestyles, particularly among children. The repercussions of this removal from nature are far-reaching and are creating major health issues (Shanahan *et al.* 2015). Terms such as nature-deficit disorder are now common parlance (Louv 2005). Importantly, separation from the natural world is also weakening our ethical and empirical foundation for stewardship (Miller 2005).

Engaging with nature in a variety of ways could help reverse this disturbing trend. Kahn and Kellert (2002) categorized the broad range of nature-based contact or experience into three groups: direct contact, indirect contact, and vicarious experience. *Direct contact* involves physical contact with natural settings and non-human species, independent of human intervention and control (eg wilderness, open fields, bird-watching). *Indirect contact* is much the same except it occurs in a more controlled, restricted environment (eg aquaria, farms, pets). *Vicarious experience* occurs in the absence of physical contact with natural settings (eg by watching nature videos, reading *National Geographic* magazines, viewing photographs of cave art). All three types of contact with nature reduce stress, anxiety, irritability, and aggression to varying degrees in a wide range of human populations and venues, including hospitals, dementia care facilities, minimum- and medium-security prisons, and urban housing projects (Ulrich and Nadkarni 2009; Bratman *et al.* 2012; Kahn and Hasbach 2012; Gallegher 2013).

People who have direct and indirect experiences with nature tend to reap the greatest benefits (Townsend and

Weerasuriya 2010). Vicarious experiences with nature are less powerful (Kaplan 1993; Kahn *et al.* 2009), but can provide micro-restorative benefits. For example, in white- and blue-collar businesses, individuals with nature views from workspace windows report fewer ailments, lower stress, higher job satisfaction, and greater perseverance than those without such views (Kaplan 1993). Windows in minimum-security prison facilities that provide views of green space and nature can improve the physical health of inmates (Moore 1981).

A substantial portion of the US population is relegated to experiencing nature only vicariously. We estimated the size of this nature-deprived population by counting individuals living in what the US Census Bureau (2010, 2012) calls "group quarters", which are living arrangements that provide housing and/or custodial or medical care for residents (Table 1). Approximately 5.3 million people, comprising 1.7% of the US population, live in settings that fit this description.

Although many researchers have stated that all humans have a natural affinity for nature (eg Kahn and Kellert 2002; Soga and Gaston 2016), ample evidence suggests that some people who are disassociated from the natural world view nature as something to be feared, controlled, or dominated, rather than loved, respected, and preserved. For instance, inner-city children on field trips in wilderness areas report feeling uncomfortable or frightened instead of refreshed and restored (Orr 2004). These individuals are vulnerable to developing increased biophobia, which can range from disinterest, discomfort, and fear in natural places to a deep prejudice against nature and disgust for whatever is not manmade, managed, or air-conditioned (Ewert 1986; Ulrich 1993).

In this paper, we investigate whether vicarious nature experiences positively affect the moods, attitudes, and behaviors of people who are on the most extreme end of the nature deprivation spectrum – populations who are incarcerated in solitary confinement for extended periods of time and lack any access to nature. We were inspired by research in built environments that provide few or no natural elements, such as hospitals and dementia care facilities, where patients exposed to nature imagery exhibited reduced stress, anxiety, aggression, and violent outbursts (Ulrich 1984; Detweiler *et al.* 2012). Here, we explore whether prisoners in solitary confinement cellblocks might respond in similarly positive ways. Although some of the prison staff members we initially approached about this idea were interested in exploring nature imagery to potentially create a safer workplace, others viewed this undertaking as a waste of time. For the latter group, their experiences and viewpoints led them to believe that exposure to images of nature would have no effect on the moods, attitudes, or violent behaviors of these inmates (Oregon Youth Authority 2016).

Methods

Study site

This study took place at the Snake River Correctional Institution (SRCI) in Ontario, Oregon, a maximum-security prison and was part of the Initiative to Bring

Table 1. Estimates of populations that live in nature-deprived venues, as a subset of "group quarters populations" in the US (US Census Bureau 2010)

Category of group quarters type	*Number of individuals**	*Subtotals and total*	*Percent of US population*
Institutionalized populations		**3,993,700**	1.27
Correctional facilities for adults†	2,263,600		0.72
Correctional facilities for juveniles	151,300		0.05
Nursing facilities	1,502,300		0.48
Other institutional facilities‡	76,500		0.02
Non-institutionalized populations§		**1,303,900**	0.42
Military barracks and ships	338,200		0.11
Emergency and homeless shelters	209,300		0.07
Group homes for adults	304,700		0.10
Residential treatment centers	139,400		0.04
Maritime/merchant vessels	2300		0.001
Other non-institutionalized facilities	310,000		0.10
Total institutionalized and non-institutionalized populations		**5,297,600**	**1.69**

Notes: *To nearest 100 individuals. †Includes federal, state, local, municipal, and military disciplinary facilities. ‡Includes mental hospitals, psychiatric units, in-house hospice, military treatment facilities, and residential schools for people with disabilities. §Excludes college/university student housing and workers' group living quarters.

Science Programs to the Incarcerated (INSPIRE), which provides nature, science education, and conservation projects to the incarcerated across a wide variety of prisons, jails, and youth correctional centers (Figure 1; http://nalininadkarni.com/about/science-for-the-incarcerated).

Inmates in a general prison population (at minimum- and medium-security levels) are allowed time in outdoor recreation yards. However, prisoners in Intensive Management Units or IMUs (solitary confinement or segregated units) rarely – if ever – encounter plants, animals, fresh air, natural sounds, or even natural light. These inmates typically live in 8.3-m × 11.1-m cells, facing interior halls, for up to 23 hours per day. They can exercise alone between four and five times per week for 45–60 minutes in an enclosed exercise or recreation yard, which is typically a high-walled concrete enclosure (14.7 m × 14.7 m) (Mears 2005). Many IMU inmates become increasingly withdrawn, unruly, prone to self-harm, suicidal, or paranoid, which are all characteristics correlated with extreme sensory deprivation (Grassian and Friedman 1986; Haney 2003). IMUs are also considered more dangerous and stressful to staff, inducing anxiety, depression, and extreme hyper-vigilance, and resulting in more sick leave and reduced work performance relative to other prison workspaces (Finn 2000).

B Drummond

Figure 1. *The Stafford Creek Correctional Center, in Washington State, represents a venue of an extremely nature-deprived population.*

At the SRCI, we focused on one of five solitary confinement cellblocks (IMU-E), which houses 48 male inmates, split into two sides (E-A and E-B). Each side contains an exercise room and 24 individual cells, and is staffed by the same officers and other personnel. A majority (60%) of the inmates resided in the unit for intervals between 7 months and 3 years. The age ranges of inmates in E-A and E-B were not significantly different.

To control for differences in the risk of inmates engaging in violent behavior while in the IMU, we developed a risk model using Stochastic Gradient Boasting (SGB), which is a machine-learning algorithm. The participants for the development of the risk model included all inmates who were placed and spent at least 30 days in the IMU system at SRCI from 1 Jul 2009 through 20 Aug 2015 (n = 1486 unduplicated inmates randomly selected from 2500 unique unit episodes). The dependent target variable for the model was a person day rate of violent infractions, or disciplinary referrals (DRs). Person day rates were calculated by dividing the total number of DRs that were documented by officers in a particular cellblock unit during a pre- or post-period by the total number of days each and every inmate was in a particular cellblock unit during that period. For this variable, inmates were categorized as being in the top 20% (0 = not in the top 20% and 1 = in the top 20%). Listed in order of importance, the independent variables in the SGB model included: (1) prior DRs measured in person day rates, (2) mental health acuity (on a scale of 0 to 3), (3) developmental disability (0 = no disability present and 1 = disability present), and (4) at least one prior admission to the IMU (Oregon Youth Authority 2016). The predictive accuracy of the model was measured by the Area Under the Receiver Operator Characteristic Curve (AUC). For this model, AUC = 0.77, demonstrating a relatively strong predictive accuracy. The differences between E-A and E-B on risk scores were not statistically significant (t = 0.493, degrees of freedom = 250, P = 0.626), which indicates that the groups were equivalent in terms of risk and were appropriate for comparison (Oregon Youth Authority 2016).

The nature imagery intervention

Inmates in E-B had the opportunity to view nature videos in the indoor exercise room on their side of the cellblock once per day for 45 minutes, up to five times per week (Figure 2). For each viewing, inmates could either choose not to watch a video or select one of the 38 nature videos that had been retrieved by research staff from video archives and by prison staff from the internet. Videos were front-projected on the E-B indoor exercise room wall (3 m × 3 m) from an Epson EX7230 projector (Epson America Inc, Long Beach, CA) mounted 4 m above the floor. Video content included film footage and accompanying soundscapes of diverse biomes (eg ocean, forest, rivers, coral reefs), aquarium scenes, Earth viewed from space, clouds, and rain at night. Videos were silent, had ambient sounds, or were accompanied by music. On occasion throughout the study, officers offered extra time in the indoor exercise room to an E-B inmate whom they perceived

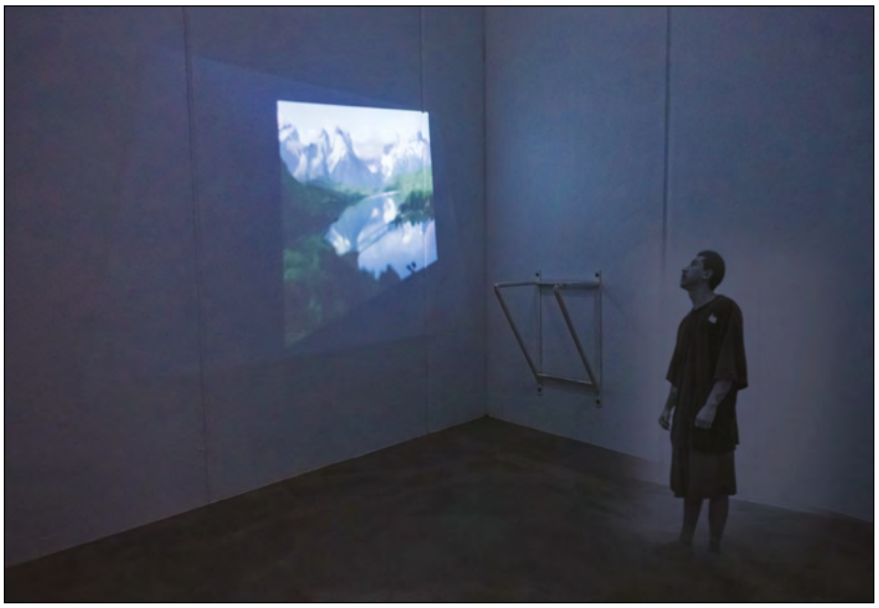

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Figure 2. *Inmate in solitary confinement cellblock IMU E-B viewing nature video imagery in an exercise room.*

as agitated or troubled, using a nature video as a calming intervention. Staff logged inmates' video choices between 28 Sep 2013 and 28 Mar 2014 (except for 22 days when the projector was broken).

Interviews and surveys

Individual, voluntary case study interviews were conducted with six E-B inmates and six SRCI officers and other staff who had worked in IMU-E for at least 3 months. Paper surveys were administered to all inmates on both sides of IMU-E (n = 13 for E-A; n = 14 for E-B) and online staff surveys were administered at the end of the one-year study. A random subset of staff respondents were invited to participate in surveys and case study interviews from the pool of all staff who worked in the five IMUs (for surveys, n = 17: 16 officers and one behavioral health staff member; for interviews, n = 6: 4 officers and 2 behavioral staff members). All of them had spent relatively long periods of time in corrections and the IMU (over 70% had spent more than 10 years in corrections, and over 50% had spent 4–10 years in the IMU).

Analysis of violent behavior

DRs are issued when a staff member has reason to believe that an inmate has broken a rule. The infractions range from showing disrespect (eg shouting at a staff member) to committing a physically violent act (eg assaulting staff or another inmate, throwing feces, uncontrolled yelling, punching an officer). Logging the number and kinds of DRs provides officers with a metric for measuring inmates' inappropriate behaviors. All DRs are reviewed by managing staff and documented in the corrections information system. Using data from the Oregon Department of Corrections information system data warehouse, we compared the number of DRs committed by inmates between the E-A and E-B cellblocks for the period prior to the intervention (7 Apr 2012 to 7 Apr 2013; hereafter, "pre-period") and the period during which the intervention was implemented (7 Apr 2013 to 7 Apr 2014; "post-period").

Inmates are intermittently moved by security staff into and out of the IMU, and in and out of individual cells within the IMU, due to changes in security levels and inmate behavior. To correct for the different lengths of time that individual inmates remained in their cells, we calculated the person day rates of disciplinary referrals (PDRDRs) for each inmate in E-A and E-B (n = 252 unduplicated inmates) for the pre- and post-periods; these PDRDRs served as the dependent variable for the analysis. This measure was calculated by totaling the number of DRs that were documented in a particular cellblock during the pre- or post-period, and dividing them by the total number of days each inmate was housed in a particular cellblock during a given period. For example, if there were 48 DRs documented in a cellblock during the pre-period, those 48 DRs were divided by 16,497 person days in the same cellblock during the pre-period, for a rate of 0.00291 PDRDRs. The percent differences in pre- and post-period rates of PDRDRs between E-A and E-B were used as the measure of the size and direction of pre- and post-intervention period infraction rates. We compared these differences with a chi-square goodness-of-fit test. Procedural details and statistics can be found in Oregon Youth Authority (2016).

Results

Effects on inmates participating in the imagery intervention

Surveys and interviews indicated that exposure to videos had a positive impact on inmates' emotional state, or mood. Nearly one-half of E-B inmate survey respondents (43%) agreed or strongly agreed that they felt calmer and less irritable after watching nature videos. They stated that these moods were sustained (ie they felt better for hours after exposure), and that they remembered the nature videos and felt more calm and less angry or agitated later (Figure 3). Of the inmate survey respondents, over 80% stated that exposure to nature videos made their time easier, 7% stated that it made their time

more difficult, and the remainder indicated no effect. All inmate survey respondents disagreed or strongly disagreed that watching nature videos made them feel more agitated, made them uninterested in learning more about what they saw, or affected their relationships with staff in negative ways. Over 60% of the surveyed inmates who viewed videos reported that the intervention had high or medium value for themselves, other inmates, and their families. For instance, one inmate wrote: "I still dislike SRCI but [the E-B side of the IMU-E] is easyer 2 cope with my time thanks 2 the blue room". For that subset of inmates, over 50% rated the intervention as having "high" or "medium" values for officers and support staff, and 95% rated it as having such values for behavioral health staff and upper administrators. Five interview participants reported positive physiological changes (eg slowed breathing, reduced tension), and four reported health benefits (eg improved sleep).

Comments on inmate surveys also documented expressions of pro-social and empathetic attitudes toward the staff, which is notable because typical attitudes of inmates toward staff are often suspicious and antagonistic. For example, one prisoner stated: "They [the staff] are learning. And trying to help us with all the hard time IMU brings to inmates. Understanding what IMU dose to the mind and giving us a way to get out of here". Many also articulated appreciation of nature. One inmate wrote: "The nature project help's me think clearer to know there is so much more beauty in this world then this prison"; "I have a long history of this so call life style since the age of 12 years old. When I first went into the Blue Room, I was like wow how beautiful this world is"; "It is temporary respite from a horrible environment".

Analysis of video selections from records (181 viewings matched to 33 specific videos) revealed that inmates preferred videos featuring beaches, mountains, ocean, jungles, and forests, and that they favored videos with a wide variety of nature scenes, animals, colors, and open spaces. Inmate interviews indicated that they liked "water, jungle and mountains, rainforest, places like where you'd go hiking and scenes of animals and places to daydream about, and nothing in particular – something other than four walls". Video selection records revealed that the most frequently viewed video (43% of all views) featured a diversity of landscapes from different countries, high-quality cinematography, uplifting music, a mix of animal life, minimal human presence, and scenes with blue skies, abundant light, and mainly wide-open scenery. Most inmates reported a preference for nature sounds (83%) over music (17%) or silence (0%).

Effects on staff participating in the imagery intervention

Interviews with staff members revealed that they and many of their peers were initially skeptical about offering nature imagery to inmates, but after observing the inmates

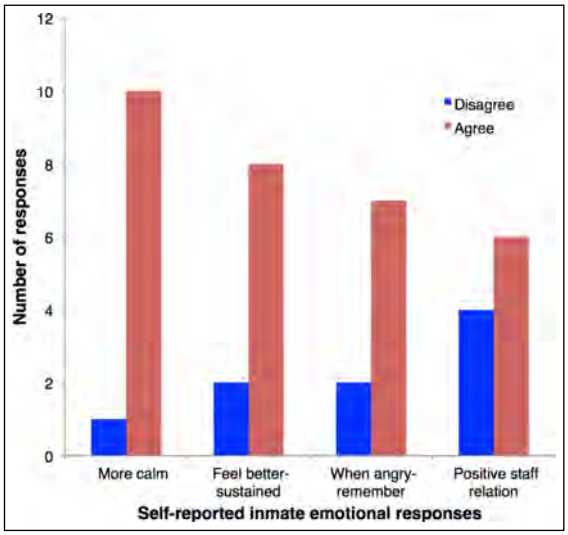

Figure 3. *Self-reported inmate mood and emotional self-regulation. "Feel better – sustained" = inmates agreed that positive emotions evoked during video-viewing were sustained for hours after exposure; "When angry – remember" = inmates agreed that when negative emotions such as anger emerged after video-viewing, they could evoke nature imagery to calm themselves. "Positive staff relation" = inmates agreed that the nature imagery project resulted in a more positive relationship between themselves and staff.*

for several months following initiation of the intervention, the majority of staff recognized it as potentially useful. All staff survey respondents agreed that the inmates became calmer after viewing the videos, and that these effects lasted for hours. All staff interviewees stated they observed less violent behavior, fewer incidents of cell extractions (forced subduing and removal of a prisoner from a cell by officers in protective gear, which often results in injury to inmates or officers), and fewer angry outbursts by inmates. Two stated that they observed less self-inflicted injury by inmates. By watching for precursor behaviors such as pacing or rocking, staff could offer an E-B inmate time in the nature imagery room to de-escalate behavior and avoid potential violent infractions. More than 60% of the surveyed staff reported that the intervention had a high to medium value for the officers, behavioral health staff, upper-level administration, and the inmates.

Staff surveys also revealed that they had empathy for the inmates. One staff member wrote: "When I heard about the concept it made a lot of sense to me. I like being in nature and I live in an area where I have a fantastic view of the valley. It is relaxing to me so I figure how much more calming would it be to those that are locked down 23 hours a day." Another reinforced the concept that presenting nature imagery was a proactive and effective practice: "I feel we are making strides to improve the environment we work in. Also to improve the mental health of some dangerous offenders."

Staff response to the intervention was not universally positive. Comments from officers at the end of the study period indicated skepticism, resistance, and a desire not to coddle (eg "mints on the pillows and tuck them in at night" or "right, let's give them more and their victims less"). However, these same officers stated that the intervention has "value" or "high value" for correctional counselors, upper administrators, and behavioral health staff.

Effects on violent behavior of inmates

Inmates who viewed nature videos (E-B) received fewer disciplinary reports for violent infractions (DRs) than those who did not view nature videos (E-A). Extrapolation of the quantitative results obtained during the study period (Table 2) indicates that if both sides of the IMU were at full capacity for the periods before and during the nature video intervention, E-A would have had 45 DRs prior to the intervention and 52 DRs in the year after the invention began (an increase of 7); by way of comparison, E-B would have had 57 DRs in the pre-period and 51 DRs in the post-period (a decrease of 6). This is equivalent to an overall difference of 26% fewer DRs for those who were exposed to nature videos. These numbers represent a substantial positive impact, given that many of these DRs result in violent interactions between inmates or between inmates and staff, with many outcomes resulting in injury and requiring hospitalization, damaged trust, and longer time spent in the IMU.

Discussion

The findings of this study suggest that inmates in solitary confinement respond positively to vicarious nature experiences. After viewing nature videos for up to 5 hours per week over the course of one year, inmates reported a reduction in negative emotions such as irritability and agitation, and stated that the nature imagery provided a calming effect that lasted beyond the viewing period, suggesting an enhancement of emotional self-regulation. Exposure to even this small amount of nature imagery also resulted in fewer DRs, less violent behavior, improvement in self-reported physiological and emotional states, and articulations of revived memories of experiences and connections to nature. This intervention influenced inmates' psychological well-being, empathy, and social contacts, as evidenced by inmate and staff reports of improved behavior and communication. Thus, access to vicarious nature experiences by inmates in their extremely nature-deprived environment produced positive emotions and behaviors, which were qualitatively similar to those reported for people in environments that were not nature-deprived (Townsend and Weerasuriya 2010).

Published articles describing negative responses of other nature-deprived populations to experiences of nature (eg Orr 2004) indicated the possibility that inmates might at best be disinterested in nature, and at worst exhibit evidence of biophobia. However, inmates living in an environment at the furthest extreme of nature deprivation articulated their capacity to appreciate and respond positively to nature, suggesting that this population had not become biophobic. Results suggest that inmates, who had been apart from any form of nature for weeks, months, or even years, gained some emotional and behavioral benefits from even short exposures to vicarious nature experiences. Furthermore, these findings bring into question the practice of removing inmates from nature as a form of corrections and support nature reconnection as a means of prison reform.

These results justify the promotion of research and public policies that address and devise ways to reduce the extinction of experience (Soga and Gaston 2016). Researchers and urban planners increasingly point to the value of integrating nature back into urban spaces (Miller 2005; Shanahan *et al.* 2015; Soga *et al.* 2015). Typically, recommendations for ways to mitigate the extinction of experience in urban settings include providing additional green infrastructure in the towns and cities where most people live or work, which gives urban dwellers opportunities not only to create memorable experiences but also to further experience nature (Bixler *et al.* 2002; Shanahan *et al.* 2015; Soga *et al.* 2015).

In interpreting these results, the potential influence of what is known as the Hawthorne effect should be considered. This denotes a situation in human studies where subjects modify behaviors in response to the

Table 2. Number of disciplinary referrals (DRs), the number of inmate person-days, calculated pre–post person-day-rates of disciplinary referrals (PDRDRs), the calculated number of DRs if the cellblock were filled to capacity, and the percent difference in DRs for E-A and E-B inmates before and during the nature imagery activities

Unit	DRs		Inmate person-days		PDRDRs		Calculated # of DRs		% difference	Chi square	P value
	before	during	before	during	before	during	before	during			
E-A	38	47	7450	7934	0.0051	0.0059	45	52	16.1	–2.71	<0.01
E-B	51	47	7879	8037	0.0065	0.0059	57	51	–9.7	2.21	<0.05

knowledge that they are being observed (Mayo 1993). This phenomenon can occur when the novelty of being research subjects and the resultant increased attention could lead to changes in the subjects' behaviors or productivity (McCarney *et al.* 2007). Behavioral changes in subjects can also result from trying to please the experimenter (Steele-Johnson *et al.* 2000), sabotaging the experiment if its purpose seems suspicious, or receiving feedback on their own behavior during the experiment (Parsons 1974).

Inmates in this study may have reacted to the additional sympathy, novelty, and interest presented by the outside researchers and/or the attention of corrections staff, who distributed the surveys. Inmates rarely receive any positive attention, and the mere presence of outsiders in the IMU is rare. The researcher who carried out case study interviews sat across from each inmate, and spoke through a glass pane (Figure 4). She treated the inmates with respect (addressing them by "Mr [last name]"), verified that their participation was voluntary, listened attentively and transcribed responses, and thanked them for their participation. Inmates were also free to choose which video they wanted to watch, which is atypical for their environment, where virtually no choices are their own. This added attention and their freedom to choose an activity may have influenced the results.

Figure 4. *Venue of case study interviews carried out in solitary confinement cellblock E-B (SRCI officer takes the place of the inmate, whom researchers could not photograph).*

Prison staff may also have been affected by the Hawthorne effect. Corrections officers receive little recognition from outsiders for the work they perform, which involves constant vigilance against violence and danger. Visits from researchers broke up staff routine and gave them opportunities to provide expertise. Researchers explained the scholarly background and purpose of the intervention, as well as the novel aspects of the study, and provided positive feedback during visits and in correspondence. Although some officers sustained a neutral or negative attitude about the study, others reported a sense of pride in contributing to this research, which they believed was innovative. Staff survey responses included such statements as: "It makes me proud to be recognized for something positive", "This shows that we are forward-thinking and looking for new ways to handle aggressive inmates", and "I like to think that we are trying many ways to help with the moods and behavior".

Although these potential interactions should be noted, a review of the Hawthorne effect by Clark and Sugrue (1991) concluded that uncontrolled novelty effects (the introduction of new people, objects, or actions in a venue, which may prompt spurious results) on average, decrease to a low level (<1% of the standard deviation) after 8 weeks. Because the duration of this study (1 year) far exceeded that period, Hawthorne effects may not have been consequential. Future research should develop ways to detect possible influences of this phenomenon in both inmates and staff.

The experimental design of the study left open the question of whether reductions in violence that resulted from this intervention were due to viewing videos of nature imagery, or to viewing any video. There were three reasons why an additional treatment of showing inmates videos of non-nature topics was not included in this study:

(1) Theoretical and applied literature has extensively documented the calming effects of viewing nature imagery (eg Kaplan 1993; Kahn *et al.* 2009).

(2) Research conditions in the IMU environment were tightly constrained by the high security conditions, the lack of precedents for researchers carrying out a nature intervention in solitary confinement cellblocks, and the limitations imposed by the Institutional Review Board for working with this vulnerable audience. The research team and the SRCI staff had limited logistical capacity to interact with IMU inmates. Surveys had to be given out by corrections staff, who had limited time for "extra" work. Case study interviews had to be administered by research staff, with constant surveillance by security officers. Thus, to ensure a large

enough sample size to test the impacts of the intervention, only one treatment (viewing nature videos) and one control (no videos) were feasible.

(3) Although previous studies have documented positive effects of nature imagery on emotions and behavior, no other studies investigated the impacts of nature imagery on the extremely nature-deprived population of inmates in solitary confinement, some of whom lack access to nature for more that 7 years. A logical first step (considering the constraints described above) was to first document whether any significant effects of their viewing nature imagery would occur. If this exploratory study did reveal any effects, further research could pursue questions about the impacts of other types of imagery, including non-nature imagery.

Insights from this research extend the growing body of research and mental health practices (eg ecotherapy) that connect or reconnect people, particularly children, with nature. Although focusing on solitary confinement cellblocks of prisons, our work reinforces other research suggesting that nature contact is a human right and necessity rather than a luxury (Kellert *et al.* 2008). These findings are applicable for any nature-deprived population and for settings characterized by isolation, low empathy due to hierarchical social structures, stress, and/or potential violence (eg mental health facilities, assisted living centers, military barracks, and people working in windowless offices, space stations, and tollbooth plazas). Our results support the growing awareness that elements of nature should be more fully incorporated not only into prisons, but also into urban planning and habitat design for our increasingly nature-deprived lifestyles.

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