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The Nature Contact Questionnaire: A measure of healthy workplace exposure

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Abstract. Understanding and promoting healthy workplaces is an important and growing area of interest in occupational health. Nature contact is a central component to the study of and promotion of healthy places. Previous findings suggest that nature contact influences health via stress appraisal process. Currently, there are no known comprehensive valid and reliable measures of nature contact, which presents obstacles to research and worksite health promotion.

Objective: This study was designed to develop and test an instrument to measure nature contact at work, entitled the *Nature Contact Questionnaire (NCQ)*, 16-item self-reported checklist to measure actual exposure.

Participants: A sample of 503 (30% response rate) office staff completed the questionnaire.

Methods: Office staff were sent an email with a link to the electronic survey twice, two weeks apart.

Results: Content and construct validity (KMO = 0.68), internal consistency (Alpha = 0.64), and test-retest reliability ($r = 0.85$, $p < 0.01$) were established.

Conclusions: The NCQ is the first known comprehensive, reliable and valid survey to measure nature contact, which allows research to compare forms of nature contact to best inform practice and design of healthy places.

Keywords: Employee stress, healthy places, work environment, nature contact, worksite health promotion

1. Introduction

The causal relationship between stress and the three leading causes of death in the US has been well documented [2,9,35]. The abundance of stress-health evidence points to two physiological mechanisms. First, perceived stress results in nervous and endocrine system arousal through neural and chemical pathways. Increased heart rate, respiratory changes, and overall physiological mobilization occur seconds after a threat is perceived [3,57]. Second, perceived stress has been shown to suppress the immune system [10] through both cellular and humeral immune responses such as

decreased natural killer (NK) cell activity [37] and secretory immunoglobulin A (S-IgA) levels [57]. The outcomes of chronic stress (and related co-morbidities) has societal impacts on health care costs and productivity [2,51].

Americans today are more stressed than in the past and work is attributed as a major cause [28,51]. Office staff, in particular, are a priority stress population according to the demand-control model and previous findings with high psychological demands and low resources [44,45]. In addition, office employees represent more than 70% of the American workforce [46]. Stress is a critical health issue among office staff.

1.1. Healthy workplaces

The study and promotion of healthy workplaces is important. An unhealthy workplace appears to cause

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poor employee health through biological and stress-related pathways. Biologically, building-related air pollutants and toxins can promote illnesses and respiratory conditions, such as Sick Building Syndrome [38, 58]. Office environments with “environmental psychological demands”, such as crowding and noise at work, increase the likelihood of perceived stress [7,29,42,49, 55].

Healthy workplaces, on the other hand, are free of these unhealthy biological and stress-related characteristics. In addition, healthy offices are places with health-promoting qualities such as the availability of healthy choices, safety, environmental sustainability and stewardship, and the opportunity for nature contact at work [17,19,20,23,24,32,62,67]. Understanding and promoting healthy workplaces is a critical aspect of effective worksite health promotion. “Environmental modifications are believed to be important additions to worksite health promotion programs (WHPPs)” [17, p. 61]. It is now widely believed that worksite health promotion should go beyond education and include environmental changes.

1.2. Nature contact at work

This study was designed to examine nature contact, one important component of a healthy place, at work. There is a vast literature that demonstrates the relationship between nature contact and human health outcomes [24]. Nature contact has been shown to be health-promoting in many settings, including office settings. In general, nature contact is achieved when an individual is exposed to natural elements. Nature contact has been defined as the interaction between humans and animals, plants, landscape views, and outdoors [21, 24].

Outdoor work breaks, a form of nature contact at work, has previously been studied. Researchers found that relaxing and enjoying nature was related to less work stress compared to active leisure such as challenging, exciting, and goal-driven activities. “Organizations, if they are committed to employee health and well-being, may now need to consider the benefits of providing recuperative-therapeutic opportunities in much the same way as they have considered and provided opportunities for employees to engage in social, sporting, and health-related activities” [66, p. 100].

Indoor plants in the office, a type of nature contact, have also been studied. In addition to serving as a “flexible and attractive biofiltration system. . . that can be used in any indoor space” [71, p. 7], indoor plants

may reduce stress among employees. Larsen and others [41] tested the effects of plants in an office space on health outcomes and found that participants in the high plant condition (22 plants in 140 square feet office space) reported greater well-being, greater perceived office attractiveness, and comfort than the other conditions [41].

Office windows provide the employee with the opportunity to look outdoors and have natural sunlight; both of which are examples of nature contact at work. Some researchers have commented that office windows are valued status symbols because people and societies intuitively understand the health benefits of windows [31,32]. Others proposed that windowless rooms in public places should be outlawed because they make occupants suffer [36]. Findings suggest that people prefer rooms with windows that cover about a quarter of the wall space [13].

Previous findings indicate that brief window viewings of natural elements at home and work were associated with wellbeing and stress reduction [31,32]. One of the first studies on the health-related importance of outdoor views took place in a prison. Moore [48] found that prisoners with an outside view from their cell window of rolling farmland and trees had 24% less sick visits than prisoners with a courtyard view from their cell window over the 11 year study. There were no other differences in cell design and prisoners were randomly assigned cells upon entry. Although an office is not a prison cell, these findings may inform healthy worksites because occupants of both spend day-time hours in the relative settings. In addition to the outdoor view, windows provide sunlight. Sunlight is a preferred, attractive, and practical source of light for work environments [6]. Beauchemin and Hays [4] examined the relationship between bright natural light rooms (direct sunlight from window) and dim natural light rooms (structure or position preventing direct sunlight from window) and found that health outcomes were significantly better for those in the bright room.

The health promoting mechanism of nature contact has been explained by natural scientists and theorists. E.O. Wilson’s evolutionary-based biophilia hypothesis contends that nature is innately relaxing, healing, and stress relieving for present-day humans because of the positive relationship related to survival between man and nature in primitive times [70]. Similarly, environmental restoration theories contend that nature contact is healthful because it restores cognitive resources necessary to cope with stress, thus reducing stress and protecting against stress-related health ailments [33,34, 68].

1.3. Significance

Nature contact at work is important to study. In contrast to other important factors that influence perceived stress, such as personality, problem solving ability, or job demands, enhancing nature contact at work is relatively easy, simple, and practical. Adding a plant or nature photography to one's office or going outside for a work break instead of the break room are simple ways to increase nature contact, which have implications for reducing stress and promoting stress-related health [24]. Cultivating a healthy workplace with purposeful opportunities of nature contact is an important and practical approach to reduce employee stress and promote health.

Although it is apparent that nature contact is an important aspect of a healthy workplace, there is a need for future research in measurement. Nature contact can take many forms and previous researchers have operationalized nature contact differently. For example, researchers have measured nature contact in the following ways: exercise on nature trails (e.g. [5]), plants in a workplace (e.g. [41]), fish tank in a dentist waiting room (e.g. [67]), windows and natural light in a classroom (e.g. [39]), nature CDs and photography in a hospital (e.g. [14]), and gardening (e.g. [8]). In addition, researchers have measured perceived restorative qualities of natural settings [26].

However, there is no instrument for measuring an individual's actual exposure to nature contact at work (or any setting). Currently, no published comprehensive nature contact measurements are available. Future research is needed in instrument development and testing. A comprehensive measure of nature contact would address an important gap in the literature and enable the research comparison of nature contact forms to inform practice recommendations. It is important to develop and test an instrument to enable future occupational health researchers to study the effects of the workplace on employee stress. A nature contact instrument would allow future researchers to answer important research questions.

First, a nature contact instrument would enable researchers to assess cross-sectional relationships between nature contact at work and stress and stress-related health outcomes. For example, researchers may examine the relationship between the amount of nature contact at work and employee stress. The following research question could be addressed: "Is nature contact at work associated with employee stress and or health outcomes?" These findings, including the significance

and the effect size of the relationship, would be especially important to worksite health promoters working to cultivate a healthy workplace.

Second, a nature contact instrument would allow researchers to assess the efficacy of a workplace-improvement intervention. The following research question, for example, could be addressed with a nature contact measurement taken pre and post a behavior change intervention: "Did an environmental education program result in healthier workplace exposures among employee participants?" These research findings would be especially important to health promoters working on workplace improvement efforts.

Third, a comprehensive nature contact instrument would allow researchers to make comparisons about workplace exposures. Kuo emphasized the need to develop a comprehensive measure of nature contact in order to study "which forms or doses of nature enhance effectiveness and which do not" [40, p. 9]. Researchers may examine the relationships among different forms of nature contact at work on employee stress and health. For example, the following research question could be addressed with a comprehensive measure of nature contact at work: "Which nature contact work exposure (outdoor work breaks, indoor plants, or nature photography) has the strongest correlation to employee stress?" This comparison would be especially important to health promoters trying to prioritize efforts by determining if one form of nature contact is more healthful than another.

1.4. Purpose

This study was designed to develop and test a comprehensive, reliable, and valid survey to measure actual nature contact experienced at work. The survey was designed to quantify and count the number of objective nature exposures, experiences, and features at work in a given week. We classified nature contact into three forms or categories to enable research comparisons and inform practice recommendations. *Outdoor nature contact* was defined as interaction with natural elements outdoors, such as gardening, spending time in an urban park [8,25]. *Indoor nature contact* was defined as contact with natural elements within a building, such as landscape view from window, natural light, live plants, fish tank [31,42]. *Indirect nature contact* was defined as interaction with abstract representations of natural elements within a building, such as photographs of a natural landscape and recorded nature sounds [14].

2. Methods

2.1. Sample

A census of office staff at a Southeastern University were invited to participate in the study ($N = 1,622$). Inclusion criteria required participants to be full-time, mostly desk-bound office staff. Thirteen job codes, such as secretary and office clerk, fit the criteria and were invited to participate. Desk bound office staff were chosen because they have stable work environments, which is important for reliable measurement. Electronic informed consent was obtained from all participants; participation was anonymous and voluntary.

2.2. Item development

The first step in item development was reviewing the multidisciplinary literature on the health benefits of nature contact among all populations. Most of nature contact's health benefits may be construed as stress-related such as clinical recovery, less incidences of illness, or restored cognitive abilities [24,33,68]. Therefore, the item development and selection literature review focused on nature contact that was related to stress and stress-related outcomes. Nature contact that has previously been shown to be health promoting or stress reducing was included. Each survey item was supported by direct or closely related previous findings supporting its health impact.

Devised and modified items were organized into one of the three categories of nature contact at work defined by the researchers. In this study, we classified nature contact at work into three categories for organization and comparison: outdoor (outdoor breaks, lunch, delivery); indoor (window view, natural light, fish tank, live plants); and indirect (artificial plants, nature sounds on CD, nature photography or art).

The literature was reviewed to determine how nature contact has previously been measured. Although there was no developed tool to measure everyday nature contact, researchers have developed individual question items to measure specific forms of nature contact such as availability of windows, quality of view, and number of indoor plants. Appropriate, previously used items that measured nature contact were adopted and modified [1,14,31,32,39,41,67,69]. Additional items were devised to measure actual nature contact previously shown to promote health.

2.3. Scaling responses

The survey was designed to quantify the actual and objective contact with nature features and experiences at work. Continuous response options were used because numerical data offers the most precise measurement to reduce possible measurement error [15]. "Zero, one, two, three, four, and five or more" were the response options for part one of the NCQ. Non-applicable ("N/A") was also used for the four outdoor nature contact items to represent no lunch anywhere, no breaks anywhere, and no delivery anywhere. The remaining response options for items related to exposure were ranges of percentages including "0, 1–20%, 21–40%, 41–60%, 61–80%, and 81–100%."

2.4. Scoring

The final instrument designed to quantify nature contact at work was titled Nature Contact Questionnaire (NCQ) (Appendix A). The NCQ was comprised of 16 items with six numerical response options. The NCQ assessed three forms of nature contact at work including indirect, indoor, and outdoor nature contact. The NCQ results in a total nature contact score and three subtotals for each of the forms of nature contact.

To calculate subtotals and totals, the participant's continuous responses were treated as ordinal data and assigned a value. "Zero" and "0%" categories of responses represent no nature contact and were assigned a value of 1. "One" and "1–20%" responses represent low nature contact and were assigned a value of 2 and so on. The "N/A" response option was available for the four outdoor nature contact items and was assigned a value of 0. The "N/A" suggested that the participant did not eat lunch at all in any environment, whereas the "zero" response option suggested that the participant did not eat lunch outside.

Four items, items a-d, represented outdoor nature contact; five items, items e, g-i, m-n, represented indoor nature contact; and five items, items f, j-l, o-p, represented indirect nature contact. The subtotals were calculated by adding the assigned ordinal response option value for each of the associated domain items. The summed scores represented the nature contact subtotal where higher numbers represent more nature contact in that form or domain. (Note: If future researchers plan to compare forms of nature contact, a conversion factor needs to be applied to outdoor nature contact because it has one less item than the other two subtotals [Conversion factor: $X*4 = 5 = 1.25$]). The outdoor

nature contact subtotal should be multiplied by the conversion factor in order to compare the subtotals). Total nature contact score was calculated by adding the three subtotals.

2.5. Data collection and analysis

Data were collected using a cross-sectional, web-based survey design. We sent an email invitation along with the web-link to access the online survey to the census [12,53,54]. The participants took approximately 10–15 minutes to complete the online survey. We repeated the data collection two weeks later to assess the *Nature Contact Questionnaire* test-retest reliability. Data analysis procedures were conducted using the Statistical Software for Social Sciences (SPSS) version 16. Content and face validity, internal consistency, test-retest reliability, and construct validity were assessed.

3. Results

3.1. Sample characteristics

The majority of the participants were women (92.9%) and whites (82.5%). The mean age of the participants was 42 years old with a standard deviation of 12 years. Approximately half of the participants attended some college or technical school (47.5%), reported earning between \$25,001–\$35,000 per year (49.5%), and reported being married (54.4%).

The response rate was about 30% ($N = 503$) for the first data collection. Of those responders, 83% participated in the second data collection for test-retest reliability analysis of the *Nature Contact Questionnaire* ($N = 401$, 25% of total census). There were no significant socio-demographic differences in second survey responders and non-responders.

3.2. NCQ profile

The instrument was designed to measure total nature contact and three subscales of nature contact, outdoor, indoor, and indirect. The sub-scores and overall total score were calculated by converting the continuous responses into ordinal responses and adding the responses. See Table 1 for a summary of the nature contact scores with higher numbers representing more nature contact at work.

The frequencies and percentages of each of the 16 nature contact items with the actual continuous response

Table 1
Nature contact questionnaire (NCQ) scores*

NCQ score	Minimum	Maximum	<i>M</i>	<i>sd</i>
Outdoor Nature Contact	0.0*	24.0	7.6	3.7
Indoor Nature Contact	6.0	26.0	12.0	5.6
Indirect Nature Contact	6.0	26.0	9.7	3.9
Total Nature Contact	14.0	63.0	29.3	8.6

*Expressed as M mean and sd standard deviation.

options are reported in Tables 2 through 4. The frequencies and percentages of outdoor nature contact response options, with responses ranging from 0–5 or more including non-applicable (N/A), are presented in Table 2. The N/A response option was designated for participants who did not have a break, lunch, or delivery task in any setting and was assigned a value of 0 for the ordinal conversion. The majority of the sample took breaks and ate lunch, but did not do so outside (59% and 67%, respectively). About a third of the participants took at least one weekly work break (35%) and ate lunch (30%) outdoors. A majority of the sample reported at least one outdoor delivery task (62%) and 18% exercised outdoors during their lunch break at least once over the last week.

Indoor and indirect nature contact item profiles are reported in Tables 3 and 4. Table 3 displays frequencies and percentages of items with response options ranging from 0–5 or more. Indoor nature contact items with the 0–5 or more response option were e, g, h, and i and indirect nature contact items with the 0–5 or more response option were f, j, k, and l (Table 3). About half of the participants reported having at least one of the following in their primary work space: live plant (53%), window that leads to the outdoors (53%), nature painting (50%), and professional or personal photograph of nature (52%).

Table 4 displays frequencies and percentages of items with response options ranging 0–100% of the time. Indoor nature contact items with the 0–100% response option were m and n and indirect nature contact items with the 0–100% response option were o and p (Table 4). Over half of the sample reported zero percentage of the day with sunlight (52%) and time with unobstructed view outside (54%). About 15% of the participants reported spending at least some time during the day watching nature images on a monitor or T.V. screen.

Three out of the 16 NCQ items were excluded from future analyses because over 95% of the responses fell in the zero response option. Fish tanks (h), animal/pets (i), and nature sounds (o) items were not included in the NCQ or future analyses. These items had very low

Table 2
Outdoor NCQ items

Items	N/A	0	1	2	3	4	5 or more
a. <i>Outdoor work breaks</i>							
N	28	234	37	30	19	13	38
Valid Percent*	7.0	58.6	9.3	7.5	4.8	3.3	9.5
b. <i>Outdoor lunch breaks</i>							
N	13	268	39	19	24	14	23
Valid Percent*	3.3	67.0	9.8	4.8	6.0	3.5	5.8
c. <i>Outdoor exercise during lunch</i>							
N	15	312	25	17	13	3	15
Valid Percent*	3.8	78.0	6.3	4.3	3.3	0.8	3.8
d. <i>Outdoor delivery</i>							
N	7	147	77	72	35	22	40
Valid Percent*	1.8	36.8	19.3	18.0	8.8	5.5	10.0

*Adjusted for missing data.

Table 3
Indoor (e,g-i) and indirect (f,j-l) NCQ items with response options 0 to 5 or more

Items	0	1	2	3	4	5 or more
e. <i>Live plants/flowers</i>						
N	186	76	52	35	16	35
Valid Percent*	46.5	19.0	13.0	8.8	4.0	8.8
f. <i>Artificial plants/flowers</i>						
N	279	63	34	7	8	9
Valid Percent*	69.8	15.8	8.5	1.8	2.0	2.3
g. <i>Windows that lead to outdoors</i>						
N	187	106	38	24	15	30
Valid Percent*	46.8	26.5	9.5	6.0	3.8	7.5
h. <i>Fish tank</i>						
N	389	10	–	1	–	–
Valid Percent*	97.3	2.5	–	0.3	–	–
i. <i>Animals/pets</i>						
N	392	4	2	–	1	1
Valid Percent*	98.0	1.0	0.5	–	0.3	0.3
j. <i>Realistic nature paintings/art</i>						
N	203	80	52	22	12	31
Valid Percent*	50.8	20.0	13.0	5.5	3.0	7.8
k. <i>Professional or personal nature photography</i>						
N	191	87	49	14	12	47
Valid Percent*	47.8	21.8	12.3	3.5	3.0	11.8
l. <i>Realistic nature carvings/sculptures</i>						
N	311	51	16	9	4	9
Valid Percent*	77.8	12.8	4.0	2.3	1.0	2.3

*Adjusted for missing data.

variability in response distribution and were excluded from the future analysis [43].

Outdoor nature contact items (Table 2) were items a, b, c, and d. Based on the acceptable distribution of these responses, all of the items were included in future analysis. Indoor nature contact items (Tables 3–4) were items e, g, h, i, m, and n. Two of the six indoor nature contact items, fish tank (h) and animal (i) exposures, were excluded from future analyses because of the low variability in response distribution. Over 95% of the participants reported the zero response option to these items. Indirect nature contact items (Tables 3–4) were items f, j, k, l, o, and p. One of the six indirect nature

contact items, time spent listening to nature sounds in the office (o), was excluded from future analyses because of the low variability in response distribution. Over 95% of the participants reported the zero percent response option to this item.

3.3. NCQ content and face validity

Content and face validity was assessed by an expert panel. A seven member expert panel reviewed the original items and conducted a second review of the revised items. Quantitative and qualitative responses were col-

Table 4
Indoor (m,n) and indirect (o,p) NCQ items with response options 0% to 100% of time

Items	0%	1–20%	21–40%	41–60%	61–80%	81–100%
m. <i>Time with sunlight</i>						
N	209	40	19	21	20	91
Valid Percent*	52.3	10.0	4.8	5.3	5.0	22.8
n. <i>Time with unobstructed view outside</i>						
N	217	34	10	13	15	111
Valid Percent*	54.3	8.5	2.5	3.3	3.8	27.8
o. <i>Time listening to nature sounds</i>						
N	382	10	7	1	–	–
Valid Percent*	95.5	2.5	1.8	0.3	–	–
p. <i>Time watching nature images on monitor</i>						
N	342	38	12	2	2	4
Valid Percent*	85.5	9.5	3.0	0.5	0.5	1.0

*Adjusted for missing data.

lected and analyzed to assess and improve NCQ's content and face validity.

Quantitative data was presented in the form of percentage of experts that agree that the *Nature Contact Questionnaire* was focused, brief, clear, readable, and assuring. Each item, direction, and response option was assessed. Any percentage less than 70% was considered problematic. The results indicated that most reviewers believed the preliminary *Nature Contact Questionnaire* was focused, brief, clear, readable, and assuring. However, there were concerns reflected in the lower percentages related to item and direction clarity and adequacy of response options.

Qualitative data were classified based on a phenomenological approach; statements were clustered or grouped based on commonality [65]. The comments were grouped based on their content in the following areas: time frame of the questionnaire, response options, wording and clarity, layout and formatting, content, and scoring and data analyses.

The panel's quantitative and qualitative feedback and suggestions were used to make modifications to the NCQ. Specifically, three of the nineteen items were eliminated, the response options were changed from a Likert-type scale to a continuous scale, the questionnaire's time-frame was changed from over the past month to the last week (Monday-Friday), and the directions and items were modified for improved clarity. A second review of the revised NCQ suggested there were concerns related to layout such as font size and color. Formatting and layout suggestions were used to make the final visual modifications. There were no expressed content concerns at the second review.

3.4. NCQ construct validity

Because outdoor, indoor, and indirect nature contact were sub-categories of nature contact conceptualized

by the researchers for this instrument and nature contact has never been previously measured comprehensively, it was important to establish construct validity. Principal component analysis (PCA) was used to collapse objective indicators of nature contact into a set of more parsimonious indices and to test if "outdoor, indoor, and indirect" were meaningful factors or indices within nature contact [56].

The Kaiser-Meyer-Olkin (KMO) measuring of sampling adequacy was 0.68 for NCQ items. Principal component analysis (PCA) with a varimax rotation method revealed three factors (Table 5). The factors were defined by a standard assignment rule including: a) inclusion criteria that items load at 0.6 or higher to the component, b) exclusion criteria that the item did not load more than 0.4 on any other component, and c) more than one loaded item is necessary for factor classification [18]. Highlighted items in Table 5 loaded on component.

Outdoor breaks, outdoor lunch, and outdoor exercise represent factor three. This factor closely reflects the hypothesized subtotal in this study titled outdoor nature contact. Number of windows, time spent with sunlight, and time with unobstructed view outdoors represent factor one. This factor closely reflects the hypothesized subtotal in this study titled indoor nature contact. Nature photography, nature paintings, and nature carvings represent factor two. This factor closely reflects the hypothesized subtotal in this study titled indirect nature contact. Component four was not a factor based on the standard assignment rule, specifically the criteria that more than one item is necessary for factor classification.

3.5. NCQ test-retest reliability

A bivariate Pearson Product correlation between total and subtotals at time I and time II were run to de-

Table 5
Results of NCQ item principal component analysis

NCQ Item	1	2	3	4
Frequency of outdoor Break	–	–	0.81	–
Frequency of outdoor lunch	–	–	0.69	–0.17
Frequency of outdoor exercise	–	0.14	0.68	0.20
Frequency of outdoor delivery	–	0.36	–	–0.50
Number of live life plants	0.29	0.26	0.11	0.35
Number of artificial plants	–	0.14	–	0.78
Number of windows leading outdoors	0.79	–	–	0.14
Number of nature paintings	–	0.71	–	0.29
Number of nature photography	–	0.75	–	–0.10
Number of nature carvings	0.12	0.62	–	–
Time with sunlight	0.90	–	–	–
Time with unobstructed view	0.86	–	–	–
Time viewing images on monitor	–	0.43	0.39	0.23

Table 6
Test-retest reliability coefficients (r) and associated R² for NCQ between time I (TI) and time II (TII)*

NCQ	Time I	Time II	r	R ²
	<i>M (sd)</i>	<i>M (sd)</i>	TI – TII	TI – TII
Outdoor Nature Contact Subtotal	7.6 (3.7)	7.9 (3.6)	0.75**	0.56
Indoor Nature Contact Subtotal	9.9 (5.6)	9.9 (5.7)	0.90**	0.81
Indirect Nature Contact Subtotal	8.6 (3.8)	8.7 (3.7)	0.79**	0.62
Total Nature Contact	26.2 (8.6)	26.5 (8.3)	0.84**	0.71

*Expressed as *M* mean, *sd* standard deviation.

***p* < 0.01 (two tailed).

termine the temporal stability of the survey items [52]. Because participants may remember their responses and try to emulate in order to appear consistent [16], we conducted the test-retest data collections two weeks apart to minimize this effect. See Table 6 for a summary of the NCQ's reliability coefficients.

3.6. Internal consistency

Internal consistency was measured for NCQ total and the three subscales with Cronbach's Alpha. See Table 4 for the NCQ's total, outdoor subtotal, indoor subtotal, and indirect subtotal respective Alpha levels. Table 7 reports the internal consistency for the NCQ total and subtotals as they were developed based on theoretical assumptions and previous findings. The frequencies of outdoor breaks, outdoor delivery, outdoor exercise, and outdoor lunch were included in the outdoor nature contact subtotal analysis. The number of live plants, the number of windows, time with sunlight, and time with unobstructed outdoor view were included in the indoor nature contact subtotal analysis. The number of artificial plants, nature photographs, paintings, carvings, and time spent watching nature images were included in the indirect nature contact subtotal analysis.

See Table 8 for the NCQ's total, outdoor subtotal, indoor subtotal, and indirect subtotal respective Alpha levels based on the PCA findings conducted in this study. Table 5 reports the internal consistency for the NCQ total and subtotals based on the data reduction findings of the PCA. Ten of the 13 NCQ items loaded on a factor and thus the 10 items were included in the internal consistency analyses reported in Table 8. Based on the loadings frequencies of outdoor breaks, outdoor exercise, and outdoor lunch were included in the outdoor nature contact subtotal analysis. The frequency of outdoor delivery did not load on the outdoor nature contact factor, or any factor, and was not included. The number of windows, time with sunlight, and time with unobstructed outdoor view were included in the indoor nature contact subtotal analysis. The number of live plants did not load on the indoor nature contact factor and was not included. The number of nature photographs, paintings, and carvings were included in the indirect nature contact subtotal analysis. The number of artificial plants and time spent watching nature images and listening to nature sounds did not load on the indirect nature contact factor, or any factor, and was not included.

Table 7
Cronbach's Alpha internal consistency based on theory*

NCQ	N Items	M	sd	Variance	Alpha
Outdoor Nature Contact Subtotal	4	8.0	3.8	14.5	0.47
Indoor Nature Contact Subtotal	4	9.8	5.6	31.4	0.73
Indirect Nature Contact Subtotal	5	8.8	3.9	15.2	0.56
Total Nature Contact	13	26.5	8.8	76.9	0.64

*Expressed as *M* mean, *sd* standard deviation.

Table 8
Cronbach's Alpha internal consistency based on factor analysis*

NCQ	N Items	M	sd	Variance	Alpha
Outdoor Nature Contact Subtotal	3	5.6	3.4	11.8	0.61
Indoor Nature Contact Subtotal	3	7.5	5.0	25.2	0.81
Indirect Nature Contact Subtotal	3	5.9	3.2	10.5	0.58
Total Nature Contact	10	22.5	8.3	68.8	0.65

*Expressed as *M* mean, *sd* standard deviation.

4. Discussion

Studying the workplace is a critical aspect of occupational health research. There is a growing recognition that cultivating healthy workplaces is an important aspect of worksite health promotion [17]. Previous findings suggest that nature contact is health-promoting in many settings, including work. Although nature contact at work is an essential aspect of healthy workplaces, there are research gaps that were addressed by this study. Until now, there was no comprehensive measure of actual nature contact experienced at work (or any setting). This study was designed to develop and test a comprehensive measure of nature contact at work. The Nature Contact Questionnaire (NCQ), developed and tested in this study, will enable future occupational health researchers to study the effects of the workplace environment on employee stress. These findings will inform practical efforts to increase the opportunity for nature contact at work, an important aspect of healthy workplaces [24,40].

The findings suggest that the instrument developed for this study, the Nature Contact Questionnaire (NCQ), is a valid and reliable instrument to quantify actual nature contact in an office setting. The Nature Contact Questionnaire is the first known comprehensive, reliable, and valid measure of nature contact. Because the NCQ is comprehensive with three subscales of nature contact, it also adds to applied and basic science by allowing researchers and practitioners to compare forms and doses of nature contact.

The NCQ's validity indicator (KMO = 0.68) was above the standard of 0.5 for scales that have evidence of construct validity [56]. The principle com-

ponent analysis (PCA) revealed three distinct factors that corresponded almost identically to our hypothesized subscale categories of outdoor, indoor, and indirect subtotals. These findings provided additional support for the proposed comprehensive nature contact construct validity as well as the hypothesized subcategories of nature contact. Although the PCA revealed three distinct factors congruent with our hypothesized subscales, there were several items that did not load on any of the factors as expected. It is not clear why these four items did not load on a NCQ factor. Future research could be conducted with special attention to the items that were expected to contribute based on previous findings, but did not load on any factor in this study. The wording of these items could be refined and further tested.

The NCQ's test-retest reliability coefficient ($r = 0.84$) was far above the standard of 0.5 [63] and the conservative standard of 0.6 [11] for stable survey instruments. Based on the findings, the NCQ can be considered stable over a two week time period.

The NCQ's internal consistency ($\alpha = 0.64$) was satisfactory based on standards for exploratory scales. Basic and applied research should reach an alpha between 0.7 and 0.9 [50]. There are two potential conclusions to these findings.

First, internal consistency may not be a relevant indicator of reliability for the NCQ. Internal consistency reliability (Alpha) is a measure of the similarity of instrument's items to each other as measured by average correlations. Internal consistency is not an appropriate measure "questionnaires that seek to obtain factual information about the occurrence of unrelated events or behaviors would not be theoretically amenable to

internal consistency reliability assessment" [64, p. 3]. Since the NCQ measures objective counts of nature contact rather than a subjective construct or concept of nature contact, internal consistency may not be a relevant measure [26]. The best alternative reliability indicator when internal consistency is inappropriate is test-retest reliability [64], which far exceeded standards for the NCQ.

The second conclusion is that NCQ is an exploratory scale and its internal consistency needs improvement and further testing. One strategy to increase internal reliability is to conduct a study with a larger number of participants. It has been suggested that there should be at least 5 participants for every item on the scale, and at least 200 participants for exploratory scales regardless of the number of items [18]. Although this study satisfied this requirement, increasing the number of participants over 500 may enhance internal consistency.

In addition, the response options may also be improved. Increasing the number of response options for each item has been shown to increase internal consistency. However, in this study, there were five to six response options for each item and the distribution of responses revealed that most participants reported low exposures to nature contact. Therefore, it may prove more beneficial to change the response options to a lower frequency scale [18,43,50,59]. Future studies may also convert the continuous response options to nominal response options. For example, the responses could be classified as either plants or no plants. This strategy may still pose a problem to internal consistency if over 70% of the responses fall into one of the nominal response options [43].

Internal consistency may also be enhanced by assessing office staff at other universities or other settings. All participants in this study were office staff at a southeastern university. Although there are many benefits to a well defined study population, a narrow population may pose range restriction limitations [50, 60]. Future studies could assess a more varied population to decrease this likelihood and to increase NCQ's internal consistency.

Criterion validity is another area of future research. Criterion validity is used to measure external validity by comparing the newly developed tool to a previously developed valid measure [47,61]. Because there are no other comprehensive nature contact instruments for comparison, criterion validity could be assessed by randomly visiting participant's office space to compare their responses to the researcher's evaluation of the space. The researcher's evaluation and the participant's

responses could be compared for an indication of the NCQ's criterion validity.

In addition, future research could also include modifications and application in other settings. First, items could be added to the NCQ based on new evidence. For example, open windows could be an item of indoor nature contact. Future studies could address if hearing outdoor sounds or feeling outdoor air and breezes are healthful and stress reducing. NCQ item development was based on previous direct or closely related (i.e. artificial plant) quantitative findings. Second, NCQ may be applied and tested in other settings beyond the workplace office. Environments such as classrooms, hospital rooms, and homes are examples of locations where the current NCQ could be applied and tested in future work.

5. Conclusions

The NCQ is an important contribution to occupational health research and worksite health promotion practice. The NCQ could be used by researchers to examine the relationship between NCQ and stress scores and or related health outcomes among employees. Researchers could also use the NCQ to statistically compare forms and doses of workplace exposures on stress outcomes. These research findings would help worksite health promoters increase the opportunity for nature contact at work, an important aspect of healthy workplaces. The NCQ met the a priori standards for validity and reliability of survey instruments. Based on the findings, it the NCQ is the first comprehensive, reliable, and valid measure for healthy nature contact exposure at work among office staff.

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Appendix

Nature Contact Questionnaire

Directions Part 1: The following questions are about your contact with the outside environment near your office. (Choose N/A if you did NOT have a work break or lunch break last week).

1. Last week (Monday-Friday), how many times did you . . .	0	1	2	3	4	5 or more	N/A
a. spend a morning or afternoon work break outside?							
b. eat your lunch outside?							
c. exercise outside during your lunch break?							
d. go outside for work related task such as delivery or errands?							

Directions Part 2–4: The following questions are about your indoor work environment (primary work space only). When completing the rest of this survey, please do not consider indoor spaces that you sometimes visit during your work day. Instead, only consider your primary work space, the one indoor space that you spend most of your day at work.

2. How would you describe your primary work space?

- Private office
- Shared office
- Reception area (faced to assist or greet visitors)
- Private cubicle
- Open design without offices or cubicle dividers between employees (non reception area)
- Other (specify)

3. Last week (Monday-Friday), how many ____ do you have in your primary work space?	0	1	2	3	4	5 or more
e. live plants or flower arrangements						
f. artificial plants or flower arrangements						
g. windows (including those on doors) that lead directly to the outdoors						
h. fish aquariums with live fish						
i. animals or pets						
j. paintings or drawings that represent realistic natural scenes or animals (such as open fields, trees, flowers, rain drop, ocean, cats, etc)						
k. personal or professional photographs of natural scenes or animals						
l. realistic sculptures or carvings of animals or natural elements (such as a bird or sunset)						

4. In your primary work space last (Monday-Friday), what percentage of the time did you . . .	0%	1–20%	21–40%	41–60%	61–80%	81–100%
m. have sunlight lighting your space?						
n. have an unobstructed view outside (blinds open and not drawn)?						
o. listen to recorded nature sounds (such as ocean waves)?						
p. watch images of natural places or animals on a T.V. or monitor?						

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