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Are nature lovers more innovative? The relationship between connectedness with nature and cognitive styles

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ABSTRACT

This paper tests whether people's sense of connectedness with the natural environment is related to cognitive styles such as Kirton's adaption–innovation (KAI), and analytic-holistic thinking (AHT). We conducted two studies with Singaporean secondary students as participants. Study 1 ($N = 138$), using an online survey, established the significant positive relationship between the nature relatedness self subscale and both the KAI and the AHT cognitive styles. Study 2 ($N = 185$), using pen and paper surveys, replicated Study 1's findings and found that connectedness with nature was significantly related to both the KAI and the AHT cognitive styles beyond alternative explanations (demographic and well-being status). Students who were more connected with nature preferred innovative and holistic cognitive styles, while controlling for their general emotional status and well-being. These findings are the first to establish the link between connectedness with nature and cognitive styles. Future research and implications are discussed.

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1. Introduction

Does being connected with the natural environment influence us, particularly in the way we think? According to Atchley, Strayer, and Atchley (2012), the environment plays an important role in the way people think, feel and behave. Creativity has been shown to be related to both the natural environment (Ma, 2009) and participation in nature-related activities (Atchley et al., 2012). Until now, however, no research has investigated the relationship between connectedness with nature and cognitive styles. Generally, studies on connectedness with nature have focussed on its effects in two key areas, namely environmental behaviour (Mayer & Frantz, 2004; Nisbet, Zelenski, & Murphy, 2009) and the ways we feel, such as our positive affect (Nisbet & Zelenski, 2011; Nisbet, Zelenski, & Murphy, 2011) and our level of vitality (Cervinka, Röderer, & Hefler, 2012; Nisbet et al., 2011). Extending this line of research, we test whether connectedness with nature is associated with cognitive variables, specifically thinking styles. While tests have been carried out for participants from Western cultures, neither connectedness to nature nor nature relatedness scales have been examined, to the best of our knowledge, in any study within Asia. This paper is the first study to (1) examine the connectedness with nature measures among Singaporean students and (2) examine the relationship between connectedness with nature and thinking styles; in particular, adaption–innovation and analytic-holistic thinking styles.

1.1. Connectedness with nature

The renowned ecologist Leopold (1949) advocated the idea of a relationship between humans and the land they inhabited. The biophilia hypothesis (Wilson, 1984) similarly proposed that humans have an intrinsic need to be connected to the natural environment and may benefit from this exposure to nature. Building on this theoretical idea of connection with nature, Mayer and Frantz (2004) developed a one-dimensional scale named the connectedness to nature scale (CNS). This scale is supposed to measure an individual's trait level of affective connectedness with the natural environment. Mayer and Frantz (2004) found that individuals who felt a greater connection with nature were more likely to feel satisfied with their lives. A recent study, however, suggested that CNS does not measure the affective aspect of connectedness with nature but is rather a measurement of cognitive beliefs (Perrin & Benassi, 2009). Clarifying the distinction between the affective and cognitive aspects of CNS is beyond the scope of this paper, so CNS will be employed as the measurement of one's general connectedness with nature. Additionally, although

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CNS was reported by Mayer and Frantz (2004) to be a reliable scale, it lacks a comprehensive approach to measurement of a holistic connection to nature; failing, for example, to describe people's physical connection to nature (Nisbet et al., 2009).

To enable a more comprehensive understanding of people's connection with the natural world, Nisbet et al. (2009) developed a new construct, nature relatedness (NR), as an inclusive measure of the individual's level of connection to nature. There are three aspects of the nature-related attribute: (1) NR-self is supposed to capture the affective connection to nature through thoughts and feelings; (2) NR-perspective represents the cognitive connection relating to the impact of human actions on the natural world; and (3) NR-experience denotes a physical connection to nature via people's comfort and familiarity level and their physical desire to be in the natural world. This scale was found to correlate with environmental behaviours such as spending more time in nature, and personality measures such as openness to experience (Nisbet et al., 2009). In order to provide a more complete insight into the effects of connectedness with nature, this paper examines both connectedness to nature and nature relatedness scales.

1.2. Connectedness with nature and cognitive styles

Are cognitive styles – e.g. innovative and holistic thinking – associated with connectedness with nature? Previous research has established the link between cognitions like creativity and personality traits such as openness to experience (George & Zhou, 2001), with the trait of openness to experience associated in turn with connectedness with nature (Nisbet et al., 2009). These findings suggest that cognitive styles may be related to connectedness to nature. To date, however, little research has studied the effects of connectedness with nature on cognitive functioning in general or cognitive styles in particular. Atchley et al. (2012) found that after three days of hiking in nature, Outward Bound participants scored 50% better in creative performance than a control group of participants assessed before they embarked on a similar hike. This was the first study to establish the effects of nature exposure on creative performance, and supports Wilson's (1984) proposition of beneficial effects when exposed to the natural environment. Because exposure to nature is associated with connectedness with nature (Mayer, Frantz, Bruehlman-Senecal, & Dolliver, 2009) and boosts cognitive benefits as well, we propose that connectedness with nature may also be related to our cognitive styles. We test this idea therefore by systematically studying the relationship between cognitive styles and measures of connectedness with nature.

1.3. Connectedness with nature and adaption–innovation thinking

On the basis of Atchley et al.'s (2012) findings, we propose that creative thinking style may be related to connectedness with nature. According to Csikszentmihalyi (1996), nature experiences commonly serve to nurture creativity. For example, engaging in outdoor activities has been used in Singapore as a potential intervention to foster innovative and creative thinking skills thought to be lacking in students (Gassner & Russell, 2008; Lim, 2012). As increased creativity is often associated with innovative thinking (Isaksen & Puccio, 1988), Kirton's (1976, 1993) Adaption–Innovation Inventory (KAI) is commonly used to examine creative thinking styles. It captures a continuum where individuals with adaptive thinking preferences are placed at one end and those with innovative preferences at the other. The adaptors prefer to work within a framework of systems and aim to do things more efficiently. The innovators, by contrast, prefer to break out of the norm and do things differently. The KAI assesses whether a person's thinking tendency is geared towards adaptive or innovative thinking. Previous research reported links between KAI on the one hand, and creative behaviour and openness to experience on the other (Ee, Seng, & Kwang, 2007). Openness to new experiences is also a trait commonly found in nature lovers (Nisbet et al., 2009). Therefore, KAI is a relevant cognitive style for investigation, as it may be linked to connectedness with nature.

The first aim of our paper is to investigate the relationship between creativity as measured by the KAI and connectedness with nature. Innovative thinkers employ divergent thinking to generate as many ideas as possible in order to create an innovative idea/product (Baer, 1993). Likewise, nature lovers try to feel or think of all possible ways to be connected with the natural environment. Mayer and Frantz (2004) argued that connectedness with nature is similar to establishing a close relationship with other people. According to the self-expansion model (Aron, Aron, Tudor, & Nelson, 1991), relationship closeness involves the inclusion of others in the self, which leads to greater perspective taking (Davis, Conklin, Smith, & Luce, 1996). As nature lovers are concerned about nature, they often consider divergent nature-related issues and may engage in more perspective taking. Therefore, Mayer and Frantz (2004) considered nature as one potential focus of self-expansion.

Additionally, innovative thinkers and nature lovers share similar characteristics, i.e. openness to new experiences (Ee et al., 2007; Nisbet et al., 2009). According to Mortlock (1984), activities in nature may be regarded as outdoor adventure which symbolises a sense of adventure in the natural world. This association with adventure arises from the fact that nature may be unpredictable and challenge people's comfort zones. Venturing into the natural environment often involves physically demanding activity (e.g. trekking), risks (e.g. getting lost) as well as opportunities for uplifting experiences (e.g., viewing a beautiful sunrise from a mountain summit). To be connected with nature, therefore, people need to be open and to embrace this sense of adventure. Similarly, innovative thinkers need to be open-minded in order to generate innovative ideas (Ee et al., 2007). On the basis of these two different lines of argument, we propose that having a sense of connectedness with nature increases people's innovative thinking style.

1.4. Connectedness with nature and analytic-holistic thinking

Our second aim is to examine whether connectedness with nature relates to an analytic-holistic thinking style. Traditionally, collectivistic cultures (stereotypically East Asians) are considered to be holistic whereas an individualistic culture such as that of the United States is said to be more analytical (Nisbett, Peng, Choi, & Norenzayan, 2001). To examine this culturally influenced cognition, Choi, Koo, and Choi (2007) proposed the analytic-holistic thinking (AHT) dimension, which consists of four domains (locus of attention, causal theory, perception of change and the attitude toward contradictions) and places analytic and holistic thinking on a continuum. Analytic thinking refers to a linear analysis of an object which is in isolation from any related factors. Holistic thinking, on the other hand, refers to an emphasis on the interconnectedness of interactions between objects/people and their surroundings. Choi et al. (2007) demonstrated that AHT styles differ *between* cultures (Korean versus American) and *within* cultures (students of Oriental medicine versus others). They also found that holistic thinkers displayed more holistic performance trends (considering larger amounts of information, for example) during cognitive tasks like categorisation and causal reasoning. Our proposition is that connectedness with nature also has a positive relationship with AHT.

Interconnectedness within nature and knowledge of nature are very similar to core aspects of holistic thinking. These components focus on the interactions within the natural world, such as

attention to the ecosystem, relationships within the ecosystem, and a cyclic approach to food webs and life cycles. In the life cycle of a butterfly, for example, there are four separate stages which are distinct in appearance and functions but interrelated to form a complete cycle. The butterfly also serves another function in a larger system (i.e., an ecosystem), in that it cannot function or survive in isolation from other living things within that system. Understanding nature in its complexity requires a more holistic consideration of seemingly independent events and facts. We speculate that individuals who are connected to nature will also be more likely to consider issues in a holistic manner. The two concepts share a common foundation whereby issues are felt and thought about in a more holistic and systemic way.

2. Study 1

Although exposure to nature is closely linked to connectedness with nature (Mayer et al., 2009) and found to enhance cognitive skills such as creativity (Atchley et al., 2012), this is the first study to explore the relationships between connectedness with nature and cognitive styles. By investigating the relation between the two sets of constructs, we wanted to address this research gap and gain theoretical insights to set a basis for future applied research. We hypothesised that connectedness with nature would be positively correlated with both innovative and holistic cognitive styles.

2.1. Method

2.1.1. Participants and procedure

Adolescents ($N = 138$, 75 males, 63 females) voluntarily participated in the online survey conducted through snowball sampling. Ages ranged from 13 to 17 years ($M = 14.56$ years, $SD = 1.03$). All participants were secondary school students in Singapore; 9.4% were studying in Secondary One, 60.9% in Secondary Two, 13.7% in Secondary Three, 14.4% in Secondary Four and 1.4% in Secondary Five. The proportion of participants studying in the express stream was 80.4%, whereas 19.6% were in the normal stream.[1]

2.1.2. Measures

The *connectedness to nature scale* (CNS) is a 14-item scale developed by Mayer and Frantz (2004) to measure the trait level of one's connectedness with nature. Example items include "*I often feel a sense of oneness with the natural world around me*" and "*I often feel disconnected from nature*" (reverse scored). Participants rated how strongly they agreed or disagreed with each item on a 5-point Likert-type scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The Cronbach's alpha was .83.

Nature relatedness constitutes three subscales – nature relatedness self (NR-self), nature relatedness perspective (NR-perspective) and nature relatedness experience (NR-experience) – which measure, respectively, the affective, cognitive and experiential aspects of people's relatedness with nature (Nisbet et al., 2009). There are 21 items which may be positively or negatively worded: an NR-self item, for example, is "*I am very aware of environmental issues*", while an example item of NR-perspective reads "*Some species are just meant to die out or become extinct*". An NR-experience example item is "*I take notice of wildlife wherever I am*". Participants scored how strongly they agreed or disagreed with each item on a 5-point Likert-type scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The reliabilities were .78 for NR-self, .72 for NR-perspective and .54 for NR-experience.

Table 1
Descriptive statistics and correlations between connection to nature and cognitive styles.

Variable	*M*	*SD*	1	2	3	4	5
1. CNS	3.61	.52	–				
2. NR-self	3.63	.55	.72**	–			
3. NR-perspective	2.86	.79	.41**	.17	–		
4. NR-experience	3.22	.60	.45**	.56**	.03	–	
5. KAI	110.63	18.00	.68**	.63**	.38**	.35**	–
6. AHS	5.08	.49	.32**	.47**	.00	.18	.45**

Note. CNS: Connectedness to Nature Scale; NR-self: Nature Relatedness Self subscale; NR-perspective: Nature Relatedness Perspective subscale; NR-experience: Nature Relatedness Experience subscale; KAI: Kirton's Adaption–Innovation Inventory; AHS: Analysis-Holism Scale.
*$p < .05$, **$p < .01$.

The *Analysis-Holism Scale* (AHS) is employed to measure analytic versus holistic thinking preference. This is a 23-item scale adapted from Choi et al. (2007). Example items include "*The whole is greater than the sum of its parts*" and "*Everything that happens in the world is predictable*" (reverse scored). Participants indicated how strongly they agreed or disagreed with each item on a 7-point Likert-type scale, ranging from 1 (strongly disagree) to 7 (strongly agree). A higher AHS score indicates people's preference for a holistic thinking style and a lower AHS score indicates a more analytic cognitive tendency. The overall scale was shown to be reliable ($\alpha = .71$).

The *Kirton's Adaption–Innovation Inventory* (KAI), a 32-item scale, assessed whether participants' preferred creative style was more innovative or adaptive oriented (Kirton, 1976, 1993). An example item from the innovative creative end is "*is always full of ideas*" and an adaptive item example is "*conforms*". Participants scored how well each item described them on a 5-point Likert-type scale ranging from 1(not at all like me) to 5 (just like me), which gave a possible range of 32–160 KAI scores. A higher KAI score indicates a more innovative preference while a lower KAI score suggests a more adaptive preference. The KAI scale was found to be reliable ($\alpha = .94$).

2.2. Results

Table 1[2] shows all the statistically significant correlations between the two cognitive styles and connectedness to nature. KAI correlated significantly with CNS and all nature relatedness (NR) subscales whereas AHS only correlated significantly with the affective connectedness with nature, CNS and NR-self.

Two hierarchical multiple regression analyses were used for KAI and AHS scores. Both KAI and AHS were regressed on CNS and three NR subscales, after controlling demographics. At Step 1, we added age, gender, and educational status (both level and stream). At Step 2, we entered CNS and NR subscales.

The nature predictors in Step 2 explained an additional 47.6% of the variance over and above demographic variables ($\Delta R^2 = .48$, $\Delta F(4, 111) = 28.94$, $p < .01$). Of the four scales, NR-self (standardised $\beta = .31$, $p < .01$), NR-perspective (standardised $\beta = .17$, $p < .05$), and CNS (standardised $\beta = .37$, $p < .01$) were significant predictors of KAI. All predictors together accounted for 54.4% of the variance ($R^2 = .54$, $F(8, 111) = 16.52$, $p < .01$) in scores for KAI.

[1] Singaporean students are streamed during their secondary school education according to their performance at the national primary school leaving examinations. Generally, low achieving students will study five years in the normal stream, whereas the majority will spend four years in the express stream during their secondary school education.

[2] Refer to Table 1.

Table 2
Descriptive statistics and correlations between connection to nature, cognitive styles and well-being.

Variable	α	*M*	*SD*	1	2	3	4	5	6	7	8	9
1. CNS	.85	3.42	.46	–								
2. NR-self	.79	3.49	.60	.72**	–							
3. NR-perspective	.38	3.51	.57	.23**	.24**	–						
4. NR-experience	.65	3.23	.72	.44**	.42**	.12	–					
5. KAI	.91	110.83	15.82	.49**	.37**	.12	.22**	–				
6. AHS	.85	4.67	.54	.53**	.43**	.31**	.21**	.45**	–			
7. GHQ	.83	12.03	5.48	−.19**	−.08	.06	−.16*	−.18*	−.07	–		
8. WEMWBS	.91	49.67	9.48	.36**	.22**	.01	.26**	.58**	.40**	−.53**	–	
9. Positive mood	.76	3.62	.72	.38**	.28**	.08	.32**	.52**	.34**	−.32**	.68**	–
10. Negative mood	.86	2.50	.93	−.02	.07	−.12	−.06	.02	−.04	.35**	−.23**	−.12

Note. CNS: Connectedness to Nature Scale; NR-self: Nature Relatedness Self subscale; NR-perspective: Nature Relatedness Perspective subscale; NR-experience: Nature Relatedness Experience subscale; KAI: Kirton's Adaption–Innovation Inventory; AHS: Analysis-Holism Scale; GHQ: General Health Questionnaire; WEMWBS: Warwick–Edinburgh Mental Well-being Scale.
$^{*}p < .05$, $^{**}p < .01$.

For AHS, the nature scales together accounted for 21.0% of the variance in AHS scores ($\Delta R^2 = .21$, $\Delta F(4, 113) = 8.82$, $p < .01$), after controlling the demographics. NR-self (standardised $\beta = .42$, $p < .01$) was the only significant predictor for AHS. All predictors together explained 32.7% of the variance ($R^2 = .33$, $F(8, 113) = 6.86$, $p < .01$).

2.3. Discussion

Study 1 revealed significant correlations between connectedness with nature and both innovative thinking as measured by the KAI and holistic thinking as measured by the AHS. This is the first study to establish a relationship between connectedness with nature and cognitive styles. Both the connectedness to nature scale and nature relatedness subscales (self and perspective) were significant predictors of KAI beyond demographic effects. In other words, innovative thinkers feel more connected with nature and have a higher sense of agency regarding the impact of humans on the natural world. The nature relatedness self subscale also emerged as a significant predictor of AHS beyond demographic effects; holistic thinkers report being more connected with nature. In sum, the nature relatedness self subscale emerged as a significant predictor for both thinking styles.

3. Study 2

This second study addressed two objectives. We wanted, first, to replicate our Study 1 findings, using this time a different survey mode (pen and paper). Second, we aimed to address the question of whether connectedness with nature would predict cognitive styles beyond alternative explanations such as well-being effects. Study 1 showed that connectedness with nature was the most significant correlate and predictor of both innovative and holistic thinking styles. Previous research reported robust links between connectedness with nature and well-being (Cervinka et al., 2012; Nisbet & Zelenski, 2011; Nisbet et al., 2011) and Zhang (2008) also found significant relationships between emotions and cognitive styles. This second study therefore explores the predictive validity of connectedness with nature for cognitive styles after controlling for well-being and demographics. In other words, is there an effect of nature on cognitive styles once affective processes induced by nature are accounted for?

3.1. Method

3.1.1. Participants and procedure

Singapore secondary school students (98 male and 87 female) voluntarily participated in this pen and paper survey. Their ages ranged from 13 to 16 years ($M = 13.45$ years, $SD = 2.15$). 48.1% of the participants were studying in Secondary One, 40.5% in Secondary Two, and 11.4% in Secondary Three. The proportion of the participants studying in the express stream was 62.7% compared with 36.8% in the normal stream (see Footnote 1).

3.1.2. Measures

As in Study 1, we employed the connectedness to nature scale (Mayer & Frantz, 2004) and nature relatedness scale (Nisbet et al., 2009) to assess connectedness with nature. For cognitive styles, we again used Kirton's (1976) Adaption–Innovation Inventory and adapted Choi et al.'s (2007) Analysis-Holism Scale. The respective reliabilities are shown in Table 2.[3]

Mood was measured adapting the Positive and Negative Affect Scale for children (Laurent et al., 1999). There were six items like "*active*" and "*happy*" for positive affect and six items like "*nervous*" and "*fright*" for negative affect. Participants were to rate how well the word described their mood over the past few weeks on a 5-point Likert scale, ranging from 1 (very slightly or not at all) to 5 (extremely). Their reliabilities were .76 for positive mood and .86 for negative mood.

Well-being was measured by the General Health Questionnaire (GHQ) (Goldberg & Williams, 1988) and the Warwick–Edinburgh Mental Well-being Scale (WEMWBS) (Tennant et al., 2007). The GHQ measures an individual's psychological well-being by using a 4-point Likert-type scale to rate his/her feelings over the preceding few weeks with 12 items, e.g. "*Lost much sleep over worry*". The GHQ scale showed good internal reliability ($\alpha = .83$). A lower GHQ score indicates greater psychological well-being.

WEMWBS is a 14-item scale that assesses the positive aspects of mental health. Participants rated statements that best described their thoughts or feelings over the previous few weeks on a 5-point Likert-type scale ranging from 1 (none of the time) to 5 (all of the time). Example items include "*I've been feeling relaxed*" and "*I've been thinking clearly*". A higher WEMWBS score indicates more positive well-being. The scale had good internal reliability ($\alpha = .91$).

3.2. Results

Descriptive statistics and correlational coefficients for all variables are shown in Table 2.[3] Three of the nature variables, namely connectedness to nature scale (CNS), nature relatedness self (NR-self), and nature relatedness experience (NR-experience), correlated significantly with the two cognitive style variables: Kirton's Adaption–Innovation Inventory (KAI) and Analysis-Holism Scale

[3] Refer to Table 2.

Table 3
Hierarchical multiple regression analyses predicting cognitive thinking styles.

	Variables	KAI	AHS
Step 1	Gender	.02	−.05
	Age	.13	.05
	Education level	−.06	−.03
	Education stream	.00	−.23**
		$R^2 = .02$	$R^2 = .07$
		$\Delta R^2 = .02$	$\Delta R^2 = .07$
		$\Delta F(4, 175) = .72$	$\Delta F(4, 175) = 3.09^*$
Step 2	GHQ	.15*	.20*
	WEMWBS	.59**	.42**
	Positive mood	.18*	.12
	Negative mood	.12	.03
		$R^2 = .44$	$R^2 = .26$
		$\Delta R^2 = .42$	$\Delta R^2 = .19$
		$\Delta F(4, 171) = 31.66^{**}$	$\Delta F(4, 171) = 11.05^{**}$
Step 3	NR-self	.09	.09
	NR-perspective	.08	.11
	NR-experience	−.08	−.08
	CNS	.25**	.38**
		$R^2 = .52$	$R^2 = .44$
		$\Delta R^2 = .09$	$\Delta R^2 = .18$
		$\Delta F(4, 167) = 7.79^{**}$	$\Delta F(4, 167) = 13.47^{**}$

Note. CNS: Connectedness to Nature Scale; NR-self: Nature Relatedness Self subscale; NR-perspective: Nature Relatedness Perspective subscale; NR-experience: Nature Relatedness Experience subscale; KAI: Kirton's Adaption–Innovation Inventory; AHS: Analysis-Holism Scale; GHQ: General Health Questionnaire; WEMWBS: Warwick–Edinburgh Mental Well-being Scale.
$^*p < .05$, $^{**}p < .01$.

(AHS). The cognitive nature variable, nature relatedness perspective (NR-perspective), correlated significantly with only AHS. Both CNS and NR-experience correlated significantly with three well-being scales, i.e., General Health Questionnaire (GHQ), Warwick–Edinburgh Mental Well-being Scale (WEMWBS) and positive mood. NR-self correlated significantly with positive well-being scales (WEMWBS and positive mood).

No multicollinearity problems were found (*VIF* = 1.62 for GHQ, 2.38 for WEMWBS, 1.96 for positive mood, 1.24 for negative mood, 2.22 for NR-self, 1.26 for NR-perspective, 1.40 for NR-experience and 2.44 for CNS). Two hierarchical multiple regression analyses were used for KAI and AHS scores respectively (see Table 3[4]). To investigate the role of connectedness with nature in the prediction of cognitive styles, both KAI and AHS were regressed on CNS and three nature relatedness (NR) subscales, after controlling for demographics and well-being. At Step 1, we added age, gender, and educational status (both level and stream). At Step 2, we entered four well-being indicators (GHQ, WEMWBS, positive and negative mood). Finally at Step 3, we entered CNS and NR subscales.

For KAI, results indicated that all predictors accounted for 52.4% of the variance ($R^2 = .52$, $F(12, 167) = 15.30$, $p < .01$) at Step 3 of the regression. Well-being variables explained 41.9%, and connectedness with nature explained an additional 8.9% of the variance in KAI scores. CNS (standardised $\beta = .25$, $p < .01$) was the only significant nature predictor of KAI, $\Delta F(4, 167) = 7.79$, $p < .01$.

For AHS, all predictors accounted for 43.9% of the variance ($R^2 = .44$, $F(12, 167) = 10.88$, $p < .01$) at Step 3 of the regression. In particular, demographics explained 6.6%, well-being variables explained 19.2% and connectedness with nature explained another 18.1% of the variance. Only CNS (standardised $\beta = .38$, $p < .01$) significantly predicted AHS scores, $\Delta F(4, 167) = 13.47$, $p < .01$.

[4] Refer to Table 3.

3.3. Discussion

Results for Study 2 replicated those of Study 1. Furthermore, the relationships between connectedness with nature and both KAI and AHS remained significant after controlling for well-being and affect variables. In particular, CNS emerged as the significant predictor for both cognitive styles, after controlling for demographic and well-being effects. In other words, higher degrees of nature connectedness were associated with a higher holistic thinking tendency and a greater innovative thinking style, as expected.

4. General discussion

As predicted, Kirton's adaption–innovation (KAI) and analytic-holistic thinking (AHT) cognitive styles were both found in the present studies to be significantly correlated with connectedness with nature. Individuals who have a closer connection with nature are more innovative-orientated and have higher holistic perspectives. In the online study (Study 1), the nature relatedness self subscale was a significant predictor for both cognitive styles, regardless of demographic status. For the pen and paper study (Study 2), the connectedness to nature scale significantly predicted both cognitive styles, despite adding both demographic and well-being status as additional control variables. Overall, innovators and holistic thinkers are more connected with nature than adaptors or analytic thinkers, thus supporting our hypotheses.

These results show that connectedness with nature is significantly related to both KAI and AHT cognitive styles, a finding consistent with previous research into the benefits of nature exposure and creativity (Atchley et al., 2012). It supports our assumption that connectedness with nature relates to innovative thinking because of the similar characteristics shared by both innovative thinkers and nature lovers. In addition, connectedness with nature is linked to AHT because of the parallel fundamentals between holistic thinking and knowledge of nature. These studies are the first to demonstrate the relationship between connectedness with nature and key cognitive styles, expanding beyond previous research on connectedness with nature/well-being effects.

Our findings show that connectedness with nature emerged as an influential variable contributing to KAI and AHT cognitive styles. In other words, the more connected people are with nature, the greater their preference for innovative and holistic thinking styles. Moreover, Study 2 showed that these effects held even when controlling for general affect and well-being. Although previous research has found that connectedness with nature is related to well-being (Cervinka et al., 2012; Nisbet & Zelenski, 2011; Nisbet et al., 2011), our studies have shown that connectedness to nature scale (CNS) differs from the general affect and well-being measures.

According to Perrin and Benassi (2009), CNS measures cognitive beliefs rather than emotional connectedness with nature, which may explain why it predicts cognitive styles. Our data provides some indirect data that is relevant to this debate. The CNS correlated quite highly with the three affect-related variables (positive mood, psychological well-being and positive aspects of mental health) and somewhat higher than with nature relatedness. Among the nature relatedness items, the supposedly affective nature relatedness self subscale and the more experiential nature relatedness experience subscale are also positively correlated with positive mood and well-being. Perrin and Benassi (2009) make valid points about the phrasing of the items of the CNS, yet individuals who score higher on this scale also report more positive mood and higher well-being, suggesting that the scale is associated with affective processes. Consistent with our findings, some researchers (Beery, 2012) argued that beliefs tap into affective

responses even though they are more formally characterized as cognitive responses (Perrin & Benassi, 2009). By relating the CNS to both cognitive and affective process variables, our research provides a novel avenue for addressing the conceptual status of these and other variables and it is our hope that future research will explore possible mechanisms further.

Our study is significant for two main reasons. One of these is that this is the first paper to highlight the role of connectedness with nature in cognitive styles beyond the effects of the physical aspect of nature. Current research (Atchley et al., 2012; Ma, 2009) into the effects of nature exposure on creativity has focused on the physical properties of the environment, neglecting potential psychological explanations. In our studies, connectedness with nature was the most consistent correlate and predictor for both the KAI and AHT cognitive styles. The concept of connectedness with nature is based on Leopold's (1949) vision of the connection of human beings with the natural environment. These findings, therefore, affirmed the importance of our connectedness with nature; a connectedness extending beyond well-being, and confirming the beneficial cognitive effects such a link has for humans (Wilson, 1984). This finding suggests that in future research, connectedness with nature may be a potential mediator in establishing the effects of nature on creativity.

Second, our studies have obtained initial evidence for connectedness with nature scales among a sample of secondary school students in Singapore. It has been mentioned already that while previous studies of connectedness with nature have been carried out with participants from Western cultures, this is the first time both connectedness to nature and nature relatedness scales have been examined within Asia. We found moderate to high reliabilities for both scales. We also reported high correlations between the subscale nature relatedness self (the supposed emotional aspect) and CNS. If CNS measures cognitive beliefs (Perrin & Benassi, 2009), further investigation into the reliability and validity of the nature relatedness scale is recommended. Our studies show several new findings linking connectedness with nature and cognitive styles such as innovation and holistic thinking. These findings await further research; in particular investigations of the process mechanisms linking these constructs, and clarification of the components of connectedness with nature that underpin these correlations.

This paper has two limitations; the first being that the research sample might be biased because the participants were students from a single national culture (Singapore). The results may not therefore apply to students from other countries, or to adults. Second, our studies are arguably limited by the methodological approach used, which encompassed online and pen and paper questionnaire methods. Current research lacks the ability to determine if the effects are due to other factors associated with connectedness with nature; exposure to nature, for example. An experimental design to investigate the impact of exposure to nature on connectedness with nature and cognitive styles would provide additional insight (as in Mayer et al., 2009). These studies provide the basis for future field studies to investigate the role of connectedness with nature as a potential mediator for the relation between nature and cognitive styles.

Such limitations notwithstanding, our research highlights practical implications for educators and parents in Singapore who are developing students' cognitive styles. Singapore's national and economic development requires the country's young people to be educated and to develop their capabilities so that, when confronting the challenges of the twenty-first century, they are able to make meaningful, efficient contributions (Ananiadou & Claro, 2009). Cognitive styles such as innovation are instrumental in maintaining the competitiveness of the twenty-first century workforce (APEC Human Resources Development Working Group, 2011). In line with previous research showing that training and exposure to nature enhance connectedness with nature, we speculate that such exposure, and education platforms linking to the environment and outdoor education, may foster students' connectedness with nature and in turn enhance people's cognitive styles.

It is likely that authentic, repeated interactions with nature are crucial in developing a sense of connectedness to nature, and these nature-related experiences could be integrated into students' lifestyles, both at school and at home. When reviewing the school curriculum and teaching pedagogies, schools and educators should consider incorporating ways to foster students' connectedness with nature. As some nature-related experiences are resource intensive for urban dwellers and may be cancelled due to inclement weather (the onset of a thunderstorm, for instance), it is becoming more common for schools to conduct outdoor lessons in synthetic environments: using artificial turf for soccer games, for example, as well as indoor sports halls and urbanised campsites. Restricting so-called nature experiences to this synthetic type may, however, hinder opportunities to cultivate students' connectedness with nature. Opportunities might be realised through different platforms; from formal academic lessons to learning trips at natural places in order to encourage authentic engagement with the natural environment. Moreover, parents should encourage their children's love of nature by integrating nature experiences within their home lifestyle; although additional indoor tuition typically fills up the after-school schedule of a Singapore student. Parents should therefore consider engaging in activities such as gardening or hiking in nature reserves with their children over the weekends, because connecting with nature may be good for our thoughts. This is no less true of adults than of children. In sum, we have reported significant associations between connectedness with nature and both KAI and AHT cognitive styles. Beyond demographic and well-being status, connectedness with nature was the most significant predictor for both cognitive styles. Because of its significant association with cognitive styles, connectedness with nature should be promoted in schools and workplaces and during leisure time. Going outdoors to connect with nature is both beneficial for our well-being and for our capacity to innovate and refresh our thinking.

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