

Original Research

Nature Connection, Mindfulness, and Wellbeing: A Network Analysis

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doi:10.21926/obm.icm.2304050**Received:** September 15, 2022**Accepted:** October 30, 2023**Published:** November 06, 2023**Abstract**

Relationships between nature connection, mindfulness and wellbeing have been observed through nature based therapeutic interventions, where mindfulness and nature appear to reciprocally influence each other in relation to wellbeing and is potentially consistent with attention restoration theory. However, previous studies have relied on examining nature based interventions rather than the role of nature connection in everyday lives. This investigation explored the relationship between nature connection, mindfulness, and wellbeing within a general population sample in Auckland, New Zealand during the COVID-19 pandemic. Participants (n = 472) completed a survey questionnaire measuring nature connectedness (CNS), hedonic and eudemonic wellbeing (PANAS and MLQ), stress (PSS), and mindfulness (FFMQ). Given mindfulness consists of interrelated practices and the relationship between mindfulness and nature connection is thought to be reciprocal, an EBIC GLASSO network was constructed to investigate the pathways between nature connection, mindfulness, and wellbeing. The FFMQ subscale of Observing was central to the network in terms of closeness and betweenness and had a strong correlation with CNS where it bridged CNS and wellbeing scales. This study demonstrates that individuals in their daily lives show relationships between nature connection, mindfulness, and wellbeing, and indicates that the



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Observing aspect of mindfulness might be useful for harnessing nature connection and wellbeing effects.

Keywords

Nature; mindfulness; wellbeing; nature connection; network analysis

1. Introduction

The environment we live in will not be the same in fifteen, twenty, or thirty years and beyond. History has taught us that we are constantly evolving. In many cases our evolution has drawn us away from the forests, open landscapes, mountains, beaches and so on. Our lifestyles have shifted to significantly decrease the time we spend outside in nature. Swan [1] found that the average Western person typically spends around 95% of their time indoors with an average of roughly 8 hours of screen time per day. Many of our health hazards are related to this type of sedentary lifestyle, including lack of physical activity, chronic psychological stress, and growing numbers who stay indoors [2]. Increasing exposure to nature may mitigate these negative effects and improve wellbeing.

1.1 Nature Connection and Wellbeing

Two theories connect human wellbeing with experience of nature. The first is Wilson's [3] biophilia hypothesis whose fundamental tenet suggests that humans have an innate tendency to seek an affiliation with nature and other forms of life. According to biophilia it is inconceivable that nature has not played a monumental role in forming our emotional and cognitive mechanisms. Given our extensive history of gathering, hunting, and farming, the ability to affiliate with the natural environment unequivocally enhanced the fitness of our predecessors [4]. Consequentially, humans today have inherited a brain shaped by an evolutionary process which tailored its function towards extracting, processing and critically examining information within the natural environment [3]. The evolution of biophilia has been proposed as biocultural where learning principles are spread throughout a particular culture causing the genes which facilitate biophilic tendencies to spread through the culture via natural selection. Thus, making behaviours associated with nature connection more frequent. Adaptive behaviours that had been learned are thought to consist of both avoidance (biophobia) and approach (biophilia) responses to environmental stimuli [5]. Individuals who learnt such behaviours were then able to adapt to the dangers and rewards that nature presents.

A more specific hypothesis is Kaplan & Kaplan's [6] attention restoration theory that posits natural environments can help to restore a depleted capacity for focused attention after individuals are worn out from dealing with a significant amount of demanding information and competitive stimuli. The central foci of this theory is that there are two categories of attention: directed attention, which is demanding and fascination which is rather effortless. Attention restoration theory posits that humans can efficiently restore and recover when we are exposed to environments which encourage fascination opposed to directed attention. Soft fascination of nature has been argued to encourage individuals to become attentive to the natural environment which

facilitates rest, calm and contemplation [7]. This is a welcoming experience providing an antidote to the demanding directive attention that is associated with many tasks in modern day society [8]. Kaplan & Kaplan [6] hypothesise that nature experiences have the capacity to renew attention after exerting mental energy. As a result, our ability to focus and concentrate is largely improved [9].

In recent years there has been an increase in research assessing nature's ability to positively influence our wellbeing. Both Sadowski et al [10] and Nisbet et al [11] found that individuals high in nature relatedness were much more likely to have greater levels of both positive affect and life satisfaction. Additionally, higher levels of nature relatedness were negatively associated with negative affect. These effects were consistent across three experiments examining nature's influence on hedonic wellbeing with each incorporating a variety of study populations from students to full time workers [12].

Spending time within the natural environment, even when in an unspectacular urban green space, appears to bolster subjective nature connectedness as well as enhance positive emotions [11, 13]. White et al's [14] research which examined data from over 10,000 residents in the United Kingdom found that living in a green area was associated with having more satisfaction with life than those in a more urban setting, indicating that simply having green spaces around us can produce a positive effect hedonically. Similarly, Nisbet et al [12] found those who live in greener environments tend to report fewer physical symptoms and have better physical and mental health than those who are deprived of nature exposure.

However, there are some inconsistencies in the research literature when it comes to the extent of contact with nature that is required to see positive benefits. The location of nature contact had a significant impact on the relationship between nature exposure and both positive mood and subjective wellbeing in Hamann and Ivztan's [8] research. The increase in positive mood and subjective wellbeing was far more significant when participants were exposed to wild areas such as mountains or forests opposed to urban green spaces. Participants only experienced these significant increases when spending 30 minutes or more each day within these settings. The benefits were not present in those that spent 15-30 minutes per day in nature, illustrating that there may be a buffering point in which the effects upscale as time in nature increases and the setting becomes wilder. However, only three participants had spent 15-30 minutes in nature therefore significantly limiting the strength of data in this category. Whereas Nisbet et al [11] found that benefits to hedonic wellbeing were most pronounced during direct exposure to nature even if the exposure was brief. Van Gordon et al [7] highlight that direct exposure to nature in the form of touching wood from a tree or viewing images of flowers for just three minutes can induce beneficial psychological responses.

Two of the dominant researchers in the field of nature connection have developed measurement scales assessing one's connection to the natural world that are widely used among the community [15, 16]. Both inherently encompass hedonic and eudemonic aspects attributable to wellbeing. The connectedness to nature scale [15] and nature relatedness scale [16] consist of affective responses towards an individual's subjective connection that align with hedonic wellbeing. For example, participants are asked to rank an affective experience such as "I enjoy being outdoors, even in unpleasant weather" [16] on a scale from disagree strongly to agree strongly. Eudemonic aspects of wellbeing however appear to be the dominant theme. Mayer and Frantz's [15] connectedness to nature scale (CNS) attempts to evaluate an individual's experiential sense of oneness with nature. Items include the degree to which subjects feel they share a common life force with all others that

inhabit earth, or the degree to which one feels they are part of a larger cyclical process of living. Comparatively in the nature relatedness scale (NRS) participants are asked how much they feel that their relationship with nature is an integral part of their identity. Clearly these techniques are targeting something deep and meaningful that appears to consistently manifest in our relationship with nature.

This connection goes beyond experiencing positive or negative affect. It is common for humans to experience a profound connection that encompasses a sense of union with the universe [8]. Having a strong connection with nature is associated with more meaningfulness, happiness, pro social behaviours as well as pro nature behaviours [17]. Nature appears to support the balance of our emotion regulation system, evidenced by lowering levels of depression [8], anxiety and increasing vitality [7]. Howell et al [18] suggest that aspects of wellbeing that have a strong emphasis on 'functioning well' are more reliably related to nature connection. Both social and psychological wellbeing were more strongly correlated to nature connection in all three experiments ($r = 0.230$ & $r = 0.270$) whereas emotional wellbeing, which focuses on 'feeling good' was less associated with nature connection in two of three of their experiments ($r = 0.170$). Those who have a strong connection with nature derive a sense of meaningful co-existence from this relationship and this meaningful attachment may in turn boost wellbeing. Nisbet et al [12] describe a positive feedback loop where those high in nature connection are more likely to exhibit pro environmental behaviours as well as be exposed to natural settings which in turn increases wellbeing and their connection to nature. Eudemonic benefits included increased autonomy and meaning or purpose in life.

Having a subjective sense of meaning has been increasingly associated with nature exposure and connectedness. Passmore and Howell [19] found that meaning mediated the relationship between wellbeing and nature connectedness. Additionally, after spending several days in the wilderness, participants experienced a stronger sense of meaning in life [20]. Exposure to wild settings appears to produce the most significant increase in meaning [8]. Those who are in frequent contact with nature tend to evolve from casual observers into developing a deep connection which incorporates awe, fascination and meaning, particularly in wild landscapes [21]. While wild settings appear to provide the most significant benefits, urban greenspaces are more effective than artificial spaces at increasing wellbeing [8]. Therefore, suggesting that any nature is better than none. It is however important to note that Herzog and Rector [22] found that when individuals experienced perceived danger while in nature, they did not experience the restorative effects that a wild environment tends to provide. Highlighting that not every experience in nature is entirely beneficial.

Nature connection has garnered popular attention for its ability to reduce stress and provide a relaxing and restorative effect which is largely influenced by a Japanese practice called Shinrin Yoku, or Forest Bathing. Shinrin Yoku is the practice of bathing in the forest's atmosphere while encouraging mindful awareness of all five senses. As a result, the three stress hormones (cortisol, adrenaline and noradrenaline) are reduced, blood pressure decreases, individuals experience a preventative effect on hypertension, immune functioning improves as well as sleep quality [23]. While this aligns with Van Gordon et al's [7] findings that nature brings balance to both our nervous system and emotion regulation system, producing an energising yet calming experience when spending time in nature, we cannot be sure of the relative contributions from being in nature versus the mindful sensory activities, or how they may mediate one another.

1.2 Nature Connectedness, Mindfulness, and Wellbeing

Mindfulness (based on a Buddhist practice) is often described using Kabat-Zinn's definition that "mindfulness is the awareness that arises from paying attention on purpose, in the present moment, and non judgmentally" ([24], p. 145), with two key components operationally defined as self-regulation of attention and an orientation of curiosity, openness, and acceptance [25]. Mindfulness and nature have a historic connection dating back thousands of years. Indian Buddhist Shantideva in the eighth century shared two famous quotes in his *Guide to Bodhisattva Way of Life*; "Until one is hoisted by four men and mourned by the world, one should retire to the forest"; "When shall I dwell in unclaimed and naturally spacious regions, wandering as I please and without a residence" [26]. Likewise, Kempton [27] shows that interconnection is observed through nature in both Buddhist and secular mindfulness related poetry. Interconnectedness is a common concept in mindfulness and meditation literature which proclaims that "any given phenomenon is connected to all other phenomena" ([7], p. 1). An effective method in developing an understanding of how interconnectedness relates to us is to explore our connection with nature, as per forest bathing.

There are a multitude of ways nature can be utilised to enhance mindful awareness. It can guide the direction and content of mindfulness meditation. One technique involves contemplating and observing certain properties of the environment. For example, while sitting in meditation next to a river practitioners can ask complex questions such as: 'if I look away from the river for a short period and then return my gaze, is it then the same river?' Questions such as these facilitate understanding of the natural law of impermanence: the first of the three marks of existence in Buddhist doctrine which proclaims that everything in material existence is impermanent [7]. Contemplative meditation is a practice which highlights our interconnectedness with nature as we too come into being and then dissolve as evidenced by the ageing process. From the Buddhist perspective individuals should resist attachment as it is thought to cause suffering due to the inevitable finitude of that which one is attached to. Thus, through understanding impermanence one can begin to walk the path of spiritual enlightenment.

Developing an awareness of the different aspects that are a part of nature and how these influence our emotions can strengthen our connectedness through intensifying our understanding for the natural world and its processes [7]. Interestingly, attending an MBSR programme in a natural environment versus an indoor or built outdoor environment resulted in more reflective attitudes and less rumination, both of which are aspects of eudemonic wellbeing [28]. There was no difference in hedonic aspects of wellbeing between the three MBSR groups however those in the natural environment experienced more positive effects on stress relief. The positive effects from the MBSR programme also lasted far longer for those in the natural environment which may be explained by its eudemonic promoting facets of nature connection [29].

Mindfulness at the trait level is conducive to the positive outcomes that come from exposure to nature [30]. Therefore, producing a reciprocal effect in which mindfulness enhances nature experience, resulting in an increase in nature connection and enhancing the wide variety of wellbeing outcomes from nature experiences.

The amplified sensory impact of nature experiences facilitated by mindfulness techniques strengthens nature connectedness [18, 30]. Mindfulness partially mediates the relationship between wellbeing and nature connectedness [7]. The benefits of mindfulness practice seem to be derived from increased information processing and attention regulation leading to greater self-

reflection. Nisbet et al [11] suggest that through these mechanisms being mindful in natural environments increases one's ability to connect with nature and experience its benefits more efficiently. Even when exposure is short lived these mindful techniques can be utilised to maximise the benefits within a smaller window.

Hamann & Ivtzan [8] found that those higher in trait mindfulness were more likely to engage in environmentally friendly behaviours and to feel connected to nature. State mindfulness also increased in their experiment through nature exposure however this was only significant in wild environments. Such landscapes are much less accessible and therefore reinforce the utility in maximising nature's benefits through mindfulness practice. Howell et al [18] reported that mindfulness correlated in measurement scales which emphasised the awareness dimensions of mindfulness opposed to acceptance. Indicating that the enhanced awareness of nature experiences, rather than non judgmental acceptance of these experiences, may be the associating factor fostering nature connection. Thus, in order to optimise positive experiences within nature an attentive mind may be more important than an accepting mind [18].

Contact with natural landscapes can aid in the restoration of attention capability and ease the challenge of becoming present. Consistent with Kaplan & Kaplan's Attention Restoration Theory where attentional fascination with nature can restore attentional capacity that has been depleted by focused attention [31]. This cyclical interaction between mindfulness and nature likely displays an association between dimensions of mindfulness and nature connectedness. This is evidenced by a variety of mindfulness measures capturing a relationship with connectedness which varies in its strength depending on the focus of the dimensions of the mindfulness scale [32]. For example, Sadowski et al [10] found that the non reactivity, observing and describing facets of mindfulness were significantly related to nature relatedness, life satisfaction, subjective wellbeing and positive affect. Contrarily the acting with awareness and non judging facets of mindfulness were not significantly related to nature connectedness or negative affect. These findings suggest that when exploring nature connection, it is important to consider the role of observing, non reactivity and describing aspects of mindfulness. Non-reactivity and observing had the most profound associations with both wellbeing and connection as they partially mediated the relationship between positive affect and nature connection as well as fully mediating the relationship between life satisfaction and connectedness [10]. Furthermore, the relationship between negative affect and nature connection was completely negatively mediated by non reactivity. Consistent with Barbaro and Picket's [33] findings, greater levels of connectedness led to less negative affect through decreasing reactivity to experience. In addition, increased connectedness leads to more positive affect, greater subjective wellbeing and life satisfaction through observing and non reactivity facets of mindfulness. Sadowski et al [10] suggest that the ability to focus and appreciate the occurrence of the present moment allows individuals to attend to environmental stimuli in a more complete manner. Therefore strengthening the connection one feels with nature, consequentially increasing its beneficial effects on wellbeing.

Mindful meditation in a natural setting has been shown to strengthen our connection to nature [30]. The non judgemental awareness and presence that mindful meditation centralises on may be an effective facilitator in increasing one's sense of connection [32]. Adventure-Heart and Proeve [34] compared the effects of mindfulness meditation and loving kindness meditation on both social and nature connectedness. Both were found to show significantly higher scores on social and nature connection than the control group who focused on progressive muscle relaxation techniques.

Additionally, both social and nature connectedness were positively associated with positive affect yet there was no relationship with negative affect. Nisbet et al [11] also produced a similar result. In their mindful walk in nature experiment participants increased state mindfulness (particularly decentering aspects compared to curiosity), experienced greater connectedness to nature and virtually eradicated their negative moods. Interestingly, these benefits were present regardless of the level of expertise in mindfulness practice prior to the experiment, suggesting that even those with little to no experience in mindfulness training can with guidance receive benefits from practising in nature.

The current literature has predominantly focused on examining the immediate effects of mindfulness-based programs or nature exposure practices within the environment and/or with restricted samples, such as university students. Consequently, little is known as to whether similar effects are present within the general population as they encounter nature in their everyday lives. Hence, this research aimed to evaluate the relationships between nature connection, wellbeing, and mindfulness amongst Aucklanders as they went about their daily lives during the ongoing COVID-19 pandemic where Auckland experienced a number of lockdowns of various durations whilst affording individual's the experience of walking (exercising) in nature in their neighbourhood. This gave the opportunity to evaluate the relationships between nature connection, wellbeing, and mindfulness at a time when stress and isolation were potentially high, but nature was accessible. The research was conducted via online questionnaire designed to target the local population and measure the network (EBIC GLASSO) of relationships between participants' level of nature connection (Connection to Nature Scale), hedonic and eudemonic wellbeing (Positive and Negative Affect Scale and Meaningfulness in Life Questionnaire), stress (Perceived Stress Scale) and mindfulness (Five Facet Mindfulness Questionnaire). Network analysis was selected as the preferred method given the likely reciprocal relationships between mindfulness and nature connection in relation to wellbeing (i.e., mindfulness increases nature connection, and nature connection increases mindfulness) that is consistent with the attention restoration hypothesis, while also acknowledging that mindfulness scales consist of interrelated practices, rather than mindfulness being a single outcome [35].

2. Method

2.1 Research Design

To test the hypotheses regarding nature connection, mindfulness and wellbeing, participants were recruited to take part in an online survey questionnaire. Participation entailed responding to five measurement scales benchmarking eudemonic wellbeing, hedonic wellbeing, perceived stress, and mindfulness. In addition, respondents were required to detail a variety of demographics as well as their average amount of time spent in nature. The survey questionnaire was administered as a singular response, capturing the respondent's average scores on each of the respective measurement scales/subscales. Correlational analyses and an EPIC GLASSO network were utilised to measure the relationship between variables.

Note that this research is based on the Capizzi's Masters thesis which was supervised by Kempton. In terms of reflexivity, Capizzi approached the research with an open curiosity towards the project and his own experiences of practicing mindfulness and experiencing nature connection. Kempton helped to evolve the research by critiquing what could have been a simple unidirectional

analysis and encouraging a deeper analysis based on mindfulness being a network of practices. Therefore, both authors came with a background that expected to see relationships (based on the research literature and their own experiences) but chose to widen the boundaries of the quantitative analysis by exploring reciprocal relationships.

2.2 Participants

Participants were recruited via popular social media platform Facebook. A wide range of local community groups and pages across the greater Auckland area were requested to be joined to get a strong representation of rural, suburban and urban communities given previous research has identified that access to green environments is associated with better physical and mental health [12]. Sampling consisted of targeting an even number of local communities between Auckland Central, North Shore, South Auckland and eastern suburbs, Pukekohe, West Auckland, and Rodney. Communities from each category were then selected by a random name generator which randomly selected an even amount of towns in each district. A brief overview of the purpose of this research was provided in the group application to outline the motivation behind getting in contact with the local community members. An estimated 25% of attempted applications resulted in failure to join as many community groups require members to be living locally. Following a successful application, a brief mission statement outlining the purpose of this research project was posted on each of the community groups along with a link which took participants directly to the online survey questionnaire. The link opened an information page detailing particulars such as what the study was about, who is doing the research, who can participate, the rights of participants, what is involved in the process and contact information of the researchers.

To take part in the research participants were required to be 18 years or over. All members within the Facebook community groups had access to the survey provided they were over the required age. Participants were informed that they would remain anonymous throughout the entirety of the research. Furthermore, participants had the option to request access to the final write up of the project. After a few weeks of recovering survey data it became clear that increasing the amount of male participants was desirable. Therefore, a second post on each of the community groups repeating the exact message as the first, accompanied by a request for male participants was completed. All processes and procedures had been evaluated by peer review and judged to be low risk. Informed consent was completed prior to the participants beginning the survey questions.

As Epskamp et al. [36] recommended, we aimed for three participants per parameter. For an 11-node network (Total scores for CNS, PSS, MLQ Presence, MLQ Search, PANAS-, PANAS+, and the five scores for each facet of the FFMQ) there are 71.5 possible parameters to estimate (11 threshold parameters and $11 \times 10/2 = 55$ pairwise association parameters), and hence selection aimed to recruit at least 215 participants.

A total number of 746 participants registered to take part in the online survey questionnaire. Of which 231 failed to achieve 90% completion of the entire questionnaire, 4 were identified as duplicate responses and 3 reported a high fraud score. Those unable to participate included 4 who live outside of New Zealand, 4 under the age of 18 and 6 who did not give consent. A further 22 participants failed to achieve 90% completion on at least one of the five measurement scales. Resulting in a total of 274 participants who met the exclusion criteria. Providing a final sample group of $n = 472$.

Within the final sample group ($n = 472$) 17.4% identified as male, 81.1% as female, 1.1% as gender diverse and 0.4% preferred not to say. Those between the ages of 18-25 = 7.4%, 26-35 = 16.7%, 36-45 = 21.2, 46-55 = 25.8%, 56-65 = 17.6% and 65+ = 11.2%. Participants of this Auckland sample were over represented by NZ European/European participants (80%), with 7% being Maori, compared to 2018 census statistics of Europeans (53.5%) and Maori (11.5%) (StatsNZ). The majority of the group resided in a suburban area (59.5%), followed by rural (30.9%) and then urban (9.3%). Typically, the participants spent a large amount of time in nature, with 10+ visits in nature a month, and visits of 60+ minutes being the both the median and mode.

Overall, the participants showed a mid to high connection to nature ($M = 3.93$, $SD = 0.62$), while total scores on the FFMQ ($M = 135.67$, $SD = 18.82$). Scores on the PSS indicated that stress was not high, despite the COVID-19 pandemic lockdowns ($M = 17.32$, $SD = 6.61$). Participants generally experienced positive feelings as indicated by the PANAS positive affect items ($M = 33.82$, $SD = 6.75$), and low negative feelings as indicated by the PANAS negative affect items ($M = 19.66$, $SD = 7.63$). However, reliability was low and the PANAS was excluded from further analyses. Participants scores on the Presence scale of the MLQ indicate that participants appraised their lives as having meaning and valued meaning ($M = 25.67$, $SD = 6.16$), while having a reasonable level of exploring meaning and purpose in their lives ($M = 20.84$, $SD = 7.53$), with a small negative correlation between the two ($r = -0.25$, $P < 0.01$).

2.3 Procedure

All participants were sent a link to the online survey questionnaire via their respective community groups on Facebook. Once the participants had read through the information page they were required to give consent via ticking a confirmation box on the following page. Participants were then required to provide demographic information pertaining their age, sex and location of residence (rural/urban/suburban). They could then move on to the questionnaire containing the five core measurement scales assessing nature connection, hedonic wellbeing, eudemonic wellbeing, stress and mindfulness. Lastly participants were asked to provide information regarding their average visits/time spent in nature. The questionnaire remained open for two months. Following the completion of the survey participants were thanked for their contributions and given the opportunity to request access to the final publication of research.

2.4 Questionnaire Measures

The survey questionnaire consisted of a variety of measurement scales outlining connection to nature, hedonic wellbeing, eudemonic wellbeing, stress, and mindfulness. The measurement tools used were the Connectedness to Nature Scale (CNS), Perceived Stress Scale (PSS), Positive and Negative Affect Schedule (PANAS), Meaning in Life Questionnaire (MLQ) and the Five Facet Mindfulness Questionnaire (FFMQ). Additional questions were included to establish demographics and detail participants' level of exposure to the natural environment. Demographic information was extracted with questions regarding age, gender (optional) and housing location (urban, suburban and rural). Participants' level of exposure to nature was quantified via two Likert scale questions: "on average, how often do you spend time in nature?" (1-6 scale), and "how long are these experiences typically?" (1-4 scale). Lastly an optional question was posed for participants to briefly describe what these nature experiences were like. Prior to these questions context was provided

outlining what a 'nature experience' might entail. Examples were given such as: "*a simple walk in the park, gardening, spending time in a forest, hiking in the mountains or swimming in the ocean etc.*". At the end of the survey respondents were given a thank you message as well as an email address to contact should they desire to read the final writings of this research.

2.4.1 Connectedness to Nature Scale

Mayer and Frantz' [15] Connectedness to Nature Scale (CNS) is designed to measure an individual's affective and experiential sense of oneness with nature. The CNS consists of 14 statements which target specific aspects of the relationship humans share with the environment. Participants are required to respond on a five point likert scale ranging from strongly disagree (1) to strongly agree (5) based on how they generally feel towards each of the 14 statements. Scoring is completed via calculating the mean response, producing a total number between 1 and 5. Scores from 1-2 represent low levels of nature connection while 4-5 indicate high levels of nature connection. Results from the CNS positively correlate with similar measures of nature connection and environmental attitudes. Additionally, it has high internal consistency ($\alpha = 0.84$) and high test-retest reliability [15], and in this study was $\alpha = 0.85$.

2.4.2 Perceived Stress Scale

Cohen et al's [37] Perceived Stress Scale measures the significance to which situations in life are subjectively appraised as stressful. The PSS conceptualises psychological stress to occur when demands exceed resources, impacting the individual's ability to cope. Structured by a 10 item inventory, participants are asked to respond on a five point likert scale ranging from 0 (never) to 4 (very often). Each item addresses the frequency to which specific thoughts and feelings occurred during the last month. Total scores are then calculated via summation, with several of the items requiring reverse coding. Higher scores represent higher levels of perceived stress, contrarily lower scores represent less perceived stress. Roberti et al [38] demonstrated a high reliability coefficient for the PSS ($\alpha = 0.89$) and in this study it was $\alpha = 0.87$.

2.4.3 Positive and Negative Affect Schedule

The Positive and Negative Affect Schedule is a measurement scale consisting of a variety of words that describe different feelings and emotions distinct to either positive or negative affect. Developed by Watson, Clark and Tellegen [39] the PANAS measures both positive and negative affect: the tendency to subjectively experience either positive or negative emotions, and is used here as a measure related to hedonic meaning. The schedule consists of two sets of 10 items. Each dimension respectively describes positive or negative emotions such as 'enthusiastic', 'excited', 'irritable' and 'guilty'. Participants are required to produce a score ranging from 1 (very slightly or not at all) to 5 (extremely). Indicating the extent to which they generally feel this way, that is, how they tend to feel on average towards each specific item. Total scores range from 10-50 on both the positive and negative sub scales. Higher scores represent greater levels of either positive or negative affect. Watson et al [39] consider positive and negative affect to be distinct categories of emotion and should therefore be evaluated individually. The PANAS is designed for the researcher to select a time frame to be targeted ranging from present moment to in general. Given the focus of this

research the time frame of 'in general' was selected and has demonstrated acceptably high reliability scores ($\alpha = 0.88$ for positive affect and 0.87 for negative affect), but in this study was low for both positive and negative affect ($\alpha = 0.53$ for positive affect and 0.40 for negative affect). Due to the low reliability the PANAS scores were removed from further analysis.

2.4.4 Meaning in Life Questionnaire

The Meaning in Life Questionnaire is a 10 item schedule which evaluates the level of presence and search for meaning in life. Steger et al [40] developed the measurement to assist individuals in building an understanding of their perceptions of their lives. The items are split into two subscales - presence and search, with some items relating to eudemonic meaning. The presence of meaning subscale is made up of five items specifically tailored to assess how full participants feel their lives are with meaning. The search subscale is made up of five items evaluating how motivated and engaged participants are in efforts to find meaning and deepen their understanding of meaning as it relates to them. For each item respondents are required to produce a score on a seven-point likert scale ranging from absolutely untrue to absolutely true. Scores are then summed to provide a total for each subscale, ranging from 5 to 35. Scores above 24 on the presence subscale indicate that the respondent appraises their life to have purpose and valued meaning. Scores above 24 on the search subscale suggest that they are persistently exploring this purpose and meaning. Steger et al [40] report good internal consistency for both the presence ($\alpha = 0.86$) and search ($\alpha = 0.92$) subscales as well as good convergent and discriminant validity. In this study alphas were similar for both presence ($\alpha = 0.88$) and search ($\alpha = 0.92$).

2.4.5 Five Facet Mindfulness Questionnaire

Baer et al's [41] Five Facet Mindfulness Questionnaire is a self scorable and self help measurement tool designed to examine an individual's level of overall mindfulness. More specifically, the FFMQ provides insight into each of the five facets inherently present within mindfulness: observing, describing, acting with awareness, non judgement and non reactivity. Describing relates to the way we use words to express our experiences to ourselves and others. Acting with awareness evaluates the actions taken after attending to current stimuli. Identifying the ability to act from fast judgement and steer away from mindless autopilot when responding to a situation. Non judging measures the degree to which an individual's inner critic affects their positive state of mind. Highlighting the importance of unconditional empathy towards the self and others as well as self acceptance. Lastly, non reactivity measures the ability to actively detach from unwanted thoughts and emotions. Therefore, fortifying emotional wellbeing and facilitating mental balance. The FFMQ is a valuable tool for measuring the mediating effects of mindfulness in mental health and mindful interventions. The scale is made up of 39 items that relate to experiences, thoughts and actions that occur in everyday life. Each item is tailored to measure one of the five facets of mindfulness. Respondents are required to provide a score that reflects what is 'generally true' for each item on a five point likert scale ranging from never or very rarely true, to very often or always true. Although mindfulness is viewed as a skill that can be developed, the FFMQ measures trait mindfulness which is more stable across time. Summation of the reverse and direct scored items are then calculated for each of the five facets to provide a total score on the respective categories. A total summation is then calculated to provide an overall score, outlining an individual's level of

complete mindfulness. Baer et al [41] report that repeated administration of the FFMQ has demonstrated high test-retest reliability and adequate to good internal consistency for each of the five facets ($\alpha = 0.75$ non reactivity, 0.83 observing, 0.87 acting with awareness, 0.91 describing and 0.87 non judging). In this study there was excellent internal consistency for the FFMQ, with all FFMQ items $\alpha > 0.90$.

2.5 Data Analysis

Given the theoretical predictions that there would be a reciprocal relationship between the CNS and the FFMQ, and that mindfulness can be considered a process (of connected nodes) as opposed to an outcome or predictor (e.g., [35, 42, 43]), after initial inspection of correlations and ANOVAs, a network analysis was performed. In network analysis models, items become nodes in the network, while the statistical relations (e.g., correlations) between nodes become the edges, with the thickness of the edge indicating the strength of the relationship (i.e., the thicker the edge, the stronger the correlation). Those nodes that are strongly associated are placed at the center of the network, with weakly associated nodes placed peripherally. Given the number of nodes (i.e. scales and sub-scales) that were included in this research, it was important to reduce the number of false-positive edges, and so the Least Absolute Shrinkage and Selection Operator (LASSO) was applied. LASSO produces a conservative model as it estimates small or unstable correlations as zero. This has the two-fold benefit of removing network edges that are less likely to be genuine, while making the network easier to interpret [44]. Extended Bayesian Information Criterion (EBIC) [45] was used to optimize fit and increase the probability of revealing the true network structure with a tuning parameter of 0.5 [44, 46, 47].

To quantify the importance of each node in the network, betweenness, closeness, and strength centrality indices were calculated. The betweenness denotes the number of times a specific node acts as a bridge along the shortest path between two nodes, while the closeness measures the number of direct and indirect links between each node and the others; the strength of these inter-node connections is expressed as the degree [44]. Each of these indices were normalized (mean = 0, and standard deviation (SD) = 1), so that an index value of >1 indicates that it is >1 SD from the mean.

Descriptive and network analyses were performed using JASP version 0.16.3 statistical software (Department of Psychological Methods University of Amsterdam, Amsterdam, The Netherlands, <https://jasp-stats.org/>).

3. Results

Previous research has shown that mindfulness partially mediates the relationship between wellbeing and nature connectedness, with awareness facets (e.g., non-reactivity, observing, and describing) accounting for mindfulness effects involving connection to nature and wellbeing [10, 18]. However, these studies produced linear results that do not allow mindfulness facets to be seen as a network of practices nor does it present reciprocal relationships between mindfulness facets, nature connection, and wellbeing. Hence, this study provides a network analysis of these relationships in the everyday lives of participants.

3.1 Demographics

An examination of correlations revealed significant relationships between age and all measures, with younger adults (18-25) showing lower scores on scales measuring beneficial factors (e.g., FFMQ, CNS, MLQ), and higher on negative scales measuring detrimental factors (e.g., PSS). One-way ANOVAs revealed a significant effect of gender on the CNS, with females reporting higher scores than males, and there were significant effects of the participants' environment, with participants in rural environments reporting less negative scores (PSS) than suburban participants.

There were two questions on the amount of time participants spent in nature. In the first analysis participants were divided into six groups based on the 6 categories of response options for visits per month (group 1: 0-1 times per month; group 2: 2-3 times per month; group 3: 4-5 times per month; group 4: 6-7 times per month; group 5: 8-9 times per month; group 6: 10 plus times per month). The One-Way ANOVA results suggest that CNS scores of the groups differed significantly ($F_{5, 466} = 9.829$, $p < 0.01$). To check for individual differences between groups post hoc comparisons were adjusted for multiple correlations using Bonferroni corrections. The tests indicated that the mean score in group 1 ($M = 3.07$, $SD = 0.719$) was significantly lower than group 2 ($M = 3.73$, $SD = 0.648$), group 3 ($M = 3.77$, $SD = 0.545$), group 4 ($M = 3.80$, $SD = 0.653$), group 5 ($M = 3.76$, $SD = 0.560$) and group 6 ($M = 4.03$, $SD = 0.587$). The mean differences were significant at the 0.05 level. However, there were no significant differences between groups 2-6.

In the second analysis participants were divided into four groups based on the four categories of response options for amount of time per visit (group 1: 5-15 minutes; group 2: 15-30 minutes; group 3: 30-60 minutes; group 4: 60 plus minutes). The One-Way ANOVA results suggest that the CNS scores of the groups differed significantly ($F_{3, 468} = 8.586$, $p < 0.01$). To check for individual differences between groups post hoc comparisons were adjusted for multiple correlations using Bonferroni corrections. The test indicated that the mean score in group 1 ($M = 3.34$, $SD = 0.788$) was significantly lower than group 2 ($M = 3.79$, $SD = 0.578$), group 3 ($M = 3.96$, $SD = 0.587$) and group 4 ($M = 4.02$, $SD = 0.630$) - refer to figure 8. The mean differences were significant at the 0.05 level. Additionally, group 2 scores were significantly lower than group 4 ($p < 0.05$).

3.2 CNS Correlations and Network Analysis

Removal of false-positive edges was performed by LASSO treating weak/unstable edges as zero.

In general, the expected relationships between CNS and the other measures were observed with significant positive correlations found between CNS and MLQ Presence ($p < 0.01$, $r = 0.268$, $r^2 = 0.072$), total FFMQ ($p < 0.01$, $r = 0.301$, $r^2 = 0.091$), and the FFMQ subscales of Observing ($p < 0.01$, $r = 0.456$, $r^2 = 0.208$), Non-reactivity ($p < 0.01$, $r = 0.207$, $r^2 = 0.043$), Describing ($p < 0.01$, $r = 0.205$, $r^2 = 0.042$), and Non-judging ($p < 0.05$, $r = 0.117$, $r^2 = 0.014$), while the PSS showed a significant negative correlation with CNS ($p < 0.01$, $r = -1.29$, $r^2 = 0.017$). MLQ Search, and FFMQ subscale Awareness did not show a significant relationship with CNS.

Figure 1 shows the participants regularised (GLASSO) network, with Figure 2 detailing the centrality analysis. Nonjudging (FFMQ subscale) and Observing (FFMQ subscale) had the highest betweenness (directly connecting more items with each other). Nonreacting (FFMQ subscale) and PSS had the highest closeness (direct and indirect connections with other items), and Nonjudging (FFMQ subscale) and PSS had the highest degree (stronger links with other items). Observing (FFMQ subscale) and Describing (FFMQ subscale) has the highest expected influence.

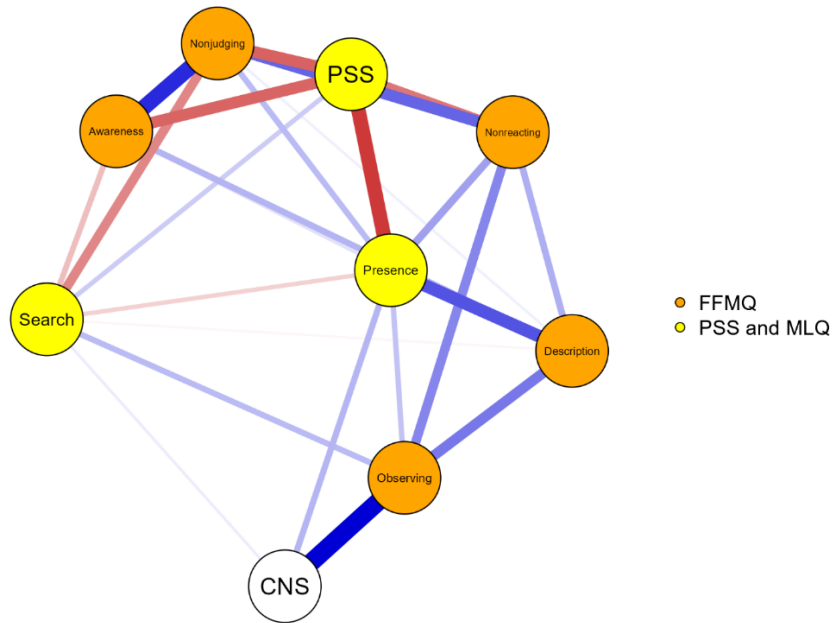


Figure 1 GLASSO network for CNS, FFMQ subscales, PSS, and MLQ Presence and Search subscales. Each node represents a scale/subscale. Each pathway represents the regularised covariance between two components. Thicker pathways signify stronger associations. Orange denotes FFMQ subscales, yellow denotes PSS and MLQ subscales, and white CNS.

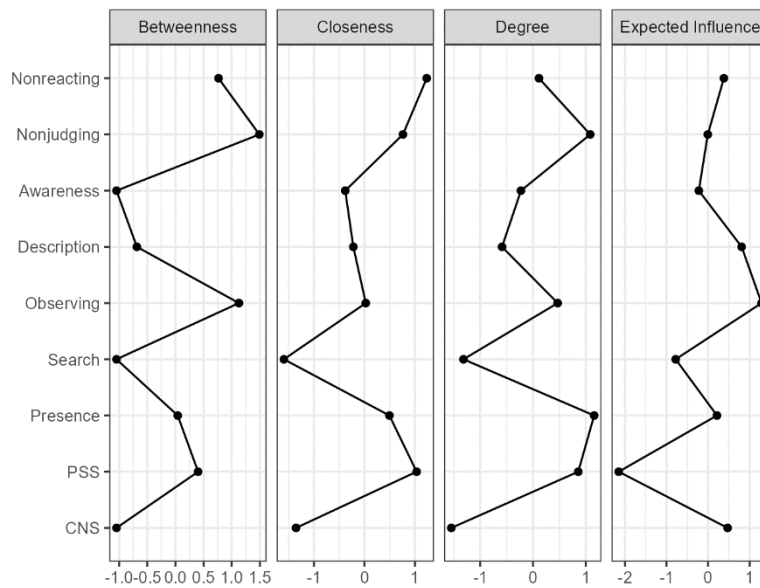


Figure 2 Centrality indices.

CNS appeared on the periphery with a “think” edge (strong correlation) with Observing (FFMQ subscale), which taken with Observing’s centrality in the network in terms of betweenness and expected influence, indicated it bridged the relationship between the CNS and other scales/subscales. There were weaker edges between CNS and MLQ Presence and Search subscales, but the CNS edges are generally not as strong as the Observing edges. The other FFMQ subscales,

with the exception of Awareness, (Nonjudging, Nonreactivity, Describing) contributed to the centrality of the network, but did not have a direct edge with CNS.

4. Discussion

Overall, this research is supportive of the current body of literature suggesting a significant positive relationship between nature connection, wellbeing, and mindfulness, with the Observing facet of mindfulness seeming to bridge the relationship between nature connection and wellbeing. Additionally, time spent in nature was significantly associated with nature connectedness. These effects were present in a general population sample who were not subjected to a targeted nature based therapeutic intervention. Although the direction of these relationships could not be ascertained due to the methodological focus on correlational network analysis, the findings from this research when paired with previous literature suggest a cyclical relationship where nature exposure leads to positive wellbeing outcomes and increased nature connection and as a result individuals are more likely to re-engage with nature.

The network analysis revealed that the FFMQ's mindfulness facet of Observing was central to the network (betweenness and closeness) and bridged the relationship between CNS scores (on the periphery) and PSS. The important role of the Observing facet is consistent with Sadowski's [10] finding that Observing had strong associations with wellbeing and nature connection, including partially mediating the relationship between positive affect and nature connection, while also fully mediating the relationship between life satisfaction and nature connection. However, in Sadaowski's study Non-reactivity also showed a similar pattern of relationships to Observing, which also mediated the relationship between nature connection and negative affect. In the current network, Non-reactivity did have numerous connections (as many as Observing) but were generally with a thin edge (weak relationship), with the relationship between Non-reactivity and CNS being bridged by Observing.

There are several factors that could be considered to account for the differences found between these two studies. One is that a different measure of nature connection was used: Sadowski et al., [10] used the Nature Relatedness Scale (NRS), while the CNS was used here. While both scales attempt to measure the level of emotional and cognitive closeness to nature, the NRS also measures physical closeness [16]. This inevitably brings in some variation, however, even without considering the CNS in the network, Observing still showed thicker edges to other nodes than Non-reactivity. Sadowski's study also used a smaller sample ($n = 250$) that consisted of University students. In this study we had close to twice the sample size ($n = 472$) and drawn from a general population who evaluated their responses in a general, non-specific time frame (i.e., how they felt in general rather than in the last two weeks). Therefore, these latter results maybe more representative of a general population in Auckland, New Zealand (note that bootstrapping with 500 bootstraps returned the same network results).

Observing involves the way in which we use our sensory awareness. How we feel, see, perceive both the internal and external world and select stimuli that sustains our focus and attention. Thus, the ability to focus and bring awareness to the present moment increases the ability for individuals to attend to environmental stimuli [10]. Given these results it may be pertinent to strategize the development of a mindfulness practice in nature to prioritise observation qualities of mindfulness. Interestingly, Van Gordon et al's [7] contemplative mindful river practice incorporates observational

qualities which are used as a tool to facilitate the understanding of the law of impermanence. Furthermore, the ecopsychology perspective utilises observational techniques to extract metaphorical examples connecting humans with nature to develop learning and growth [2].

Interestingly, both Sadowski et al [10] and Unsworth et al [30] argue that mindfulness traits are conducive to the positive outcomes that are associated with nature connection (e.g., a reciprocal relationship). The cyclical nature of this relationship appears logical given the strong focus on continuous attention towards moment-to-moment experiences that mindfulness entails [48]. Kaplan & Kaplan's [6] attention restoration theory posits that natural environments can help to restore the capacity for focused attention given our inherent fascination with nature. This, coupled with Wilson's [3] Biophilia hypothesis that the brain's functions are tailored towards extracting, processing and critically examining information drawn from the natural environment suggest that the ability to sustain attention moment to moment should be easier when interacting with the natural environment. Consequently, enhancing both mindfulness and nature connection, therefore increasing the probability of experiencing positive wellbeing outcomes. Indeed, direct contact with natural landscapes can facilitate the restoration of attention capability and ease the challenge of becoming present [31].

4.1 Implications

One of the fundamental advantages of the benefits of nature connection is that nature exposure is free and accessible to everyone and, as per the findings of this research, these benefits are observable in people's everyday lives over the longer term, as opposed to the benefits of a specific nature-based program. Developing knowledge of the human-nature relationship could provide motivation for individuals to incorporate nature experiences into their weekly or monthly schedules as a tool for fostering nature connection and increasing wellbeing. Such knowledge provides insight into how individuals can utilise nature exposure in a productive and efficient manner. Both current and future research could facilitate the development of a range of nature practices that can be tailored towards individuals in a way that suits them. Based on this research for example, someone pressed for time may perhaps spend 15-20 minutes walking in nature 2-3 times per month. Whereas an individual wanting to maximise their connectedness may spend 60 minutes or more per exposure. Indeed, nature exposure is associated with greater nature connection. Both of which are associated with greater wellbeing. Greater wellbeing tends to reduce the risk of a variety of health issues and uplifts quality of life [40].

In a similar fashion knowledge drawn from exploring our connection with nature can be utilised to inform professional therapies. The Canadian Mental Health Association has begun training health professionals to run hiking programmes for adults struggling with mental illness. Their 'mood walks' have thus far resulted in increased happiness, energy, and decreased anxiety [8]. The results from this research suggest that to maximise nature connection a therapeutic practice should include at least 2-3 sessions per month lasting 60 minutes or more. In addition, mindfulness techniques focusing on observation skills could be used to enhance the benefits of the experience. Perhaps the implementation of mindfulness practice in nature might reduce the time required per nature experience while reaching a similar level of connection. After all, mindful practice in nature has been shown to increase the efficiency of experiencing nature's benefits (e.g. [11]). Furthermore, nature has been shown to increase the benefits of mindfulness in an MBSR course (e.g. [28]).

The research to date provides evidence that there is a benefit to nature experiences and developing a connection with nature. However, there is much to learn. Further research is required to strengthen our understanding of the relationship between time spent in nature and both nature connection and its association with wellbeing and mindfulness. Measurement of short term versus long term effects of these experiments is also desirable as little research has explored the longevity of nature's impact. In addition, it is worth considering the findings of Buijs et al [49] that reflect a preference for natural environments based on prior positive experience in nature as well as cultural norms. If experiences at a young age are critical for developing connectedness to nature, then it is essential that children experience nature in a safe manner. Lastly, nature experience may not have to be physical. Li [23] found that naturally scented essential oils and sounds of nature produced beneficial effects on wellbeing. Perhaps techniques such as these could be utilised in times where natural environments are not currently accessible.

Perhaps drawing insight into the benefits of nature connection will result in more individuals engaging in environmentally friendly behaviours. Prior research found that increased nature connection was associated with pro-nature behaviours (e.g. [8]). Thus, there is potential for providing a motivational force towards nature protection and preservation. Lastly, the evidence suggesting the benefit of exposure to nature may also inform future urban planning projects that could implement little slices of nature within the urban environment. Providing those in more central locations with greater accessibility to natural settings in a balanced manner that does not negatively impact economic development.

4.2 Limitations

At the time of data collection Auckland was part way through a significant COVID-19 lockdown. Participants were not allowed to travel unless it was for necessities such as food shopping or undertaking safe recreational activities that were within the local community. Therefore, all participants at the time were restricted to the availability of natural environments within their local residential area. There are a variety of ways this may have influenced their responses. Perhaps having less access made people realise just how connected to nature they are, and that experiencing deprivation increased their level of appreciation for the environment. Or perhaps participants were a lot more active in getting out to their local park or beach as it was one of the only activities that could be done outside of the house. COVID was undoubtedly a stressful time for many. Participants' wellbeing scores may have been skewed negatively due to the overwhelming experience of being confined to the household. Overall, this was an unusual time and likely influenced the data in a number of complex ways.

A significant limitation of this research is its methodological focus on correlational analysis. Although the data was able to provide evidence of a significant relationship between nature connection, wellbeing and mindfulness, we cannot be sure of the direction of this relationship. The strength of these findings are that nature connection benefits were replicated to a smaller degree in a general population rather than a targeted programme and are likely to be sustained over time. Future research could explore what types of nature experiences the general population engages in and how these influence mindfulness and wellbeing outcomes.

The sample population was significant in size ($n = 472$) however it was not entirely randomised and there was also a significant gender imbalance with most participants being female (81.1%).

Females scored significantly higher on the CNS than males on average. Those above the age group of 18-25 tended to score higher on the CNS on average, suggesting that there may be demographic influences on nature connectedness. However, due to the sample size for males being below that recommended for the number of network parameters we could not conduct a split network analysis with this variable. Future research could explore these differences in detail, particularly how they relate to both mindfulness and wellbeing.

5. Conclusion

This study provides correlational evidence, in the form of a network analysis, that mindfulness (Observing facet) is central to the network of nature connection (CNS) and wellbeing (PSS) in terms of the everyday experience of participants. The findings support a reciprocal relationship between mindfulness and connection to nature that benefits wellbeing, and is consistent with the attention restoration hypothesis. However, due to the correlational nature of the study, further research is needed using experimental protocols to examine casual mechanisms.

Author Contributions

Capizzi developed the research idea, collected the data, analysed the demographic data, performed the correlations and ANOVAs, and wrote the majority of the article. Kempton gave input into the research development, performed the network analysis and wrote it up, and contributed to the overall writing of the article.

Competing Interests

The authors have declared that no competing interests exist.

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