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Testing the Unsolved Problems Hypothesis: The Evolutionary Life Issues-Mitigating Function of Nature Exposure and Its Relationship with Human Well-Being

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Highlights

- Results afford mixed support for the unsolved problems hypothesis
- Unsolved problems mediate the link between nature exposure and psychotic symptoms

- Relationships with annual income and reproduction are similarly mediated
- Nature exposure is only directly predictive of combined duration of romantic bonds
- Imaginativeness is not a significant predictor in any of the proposed models

Abstract

Theories on the benefits of spending time in natural settings – a growingly crucial topic in a progressively urbanized world – have been developed with varying success, and none could comprehensively illuminate the evolutionary underpinnings of this phenomenon. This paper posits that the alleviation of unsolved life problems by means of unique personal (imaginativeness) and environmental (nature exposure) factors and their synthesis, so as to free up opportunities for other evolutionarily-essential tasks in humans, is posited to be pivotal – the unsolved problems hypothesis. Six hundred participants completed a study testing these assumptions on Amazon's Mechanical Turk. Results highlight the relevance of unsolved existential issues in environmental (but not personal or integrative) influences on the majority of well-being indicators (e.g., extent of psychotic symptoms, annual income and procreative outcomes). Findings could initiate new lines of enquiry to unravel the evolutionary mechanism underlying a phenomenon that has huge implications for human functioning and well-being.

Keywords: Contact with nature; evolutionary mismatch; unsolved life issues; psychotic symptoms; annual income; reproductive outcomes

Introduction

There is an increasing amount of empirical evidence in the literature converging on the notion that humans have a profound penchant for nature in juxtaposition to man-made settings (e.g., Kaplan, Kaplan, & Wendt, 1972; Purcell, Lamb, Peron, & Falchero, 1994; Staats, Kieviet, & Hartig, 2003), with exposure to these preferred landscapes linked to a wide variety of psychological and physical advantages (e.g., De Vries, Verheij, Groenewegen, & Spreeuwenberg, 2003; Hartig, Evans, Jamner, Davis, & Gärling, 2003). Having more contact

with nature has been associated with a host of beneficial effects including superior gestational outcomes (Laurent, Wu, Li, & Milesi, 2013), lower risk of developing numerous health conditions (Maas et al., 2009), enhanced hardiness in the face of existential stressors (Wells & Evans, 2003), more cheerful experiences (MacKerron & Mourato, 2013), and greater lifespan (Villeneuve et al., 2012).

As a result of such considerable influences on human functioning and well-being, several researchers have respectively presented distinctive theoretical formulations that could potentially account for humans' attraction to, and the beneficial experiential effects of natural environments; for example Appleton's (1975) prospect refuge theory. According to this approach, people would prefer settings whereby one could inspect his/her surroundings (prospect) while remaining undetected by others (refuge), because such settings were surmised to be conducive to meeting the physiological necessities for his/her continued existence as a human being (Appleton, 1975). Endorsement for this formulation has been equivocal to date, with some studies corroborating the theory in the main (e.g., Hagerhall, 2000; Heerwagen & Orians, 1993), while several others producing data that have somewhat contradicted the key tenet/s of the approach (e.g., Gatersleben & Andrews, 2013; Stamps III, 2008). In a similar vein, Orians (1980, 1986) contended that humans would have favoured savanna-like natural landscapes because such settings were believed to have aided humans in their survival over evolutionary history; however, empirical evidence for this approach have analogously been mixed (e.g., Han, 2007; Hartmann & Apaolaza-Ibáñez, 2010; Sommer & Summit, 1995), with some archaeological records casting doubt on the assertion that humankind primarily evolved from savanna-like surroundings (e.g., Kingston, Hill, & Marino, 1994; Pickford, Senut, & Mourer-Chauviré, 2004).

In lieu of a focus on the specifics of the natural environment, other more dominant theoretical models have concentrated on potential advantageous reactions humans would

experience in such settings. For instance, Ulrich's (1983) psycho-evolutionary formulation suggested emotional responses triggered when individuals were exposed to natural spaces were instrumental in bringing about physiological changes with subsequent actions benefitting humans' well-being throughout evolutionary history. A range of research work has corroborated this framework (e.g., Markevych et al., 2014; Ulrich et al., 1991), although questions remain as to why precisely would humans have evolved to react with pleasant emotions when being exposed to certain natural landscapes in the first instance (Joye & Van den Berg, 2011).

Another leading model that has followed a similar approach is the attention restoration theory (Kaplan, 1995; Kaplan & Kaplan, 1989). This formulation postulated that spending time in natural settings would allow one to regain cognitive resources that were essential for "directed attention" (Kaplan, 1995, p. 169). Natural surroundings were conceived to possess useful elements (such as "fascinating objects" and landscapes that could induce a "sense of being away") which could facilitate this recuperative process (Kaplan, 1995, p. 174). Some natural stimuli (e.g., a lake that might potentially be teeming with fish) were believed to be readily processed without needing focused attention as they have been highly relevant to the continued existence of Homo sapiens since prehistory (Kaplan, 1995). A number of empirical studies have substantiated the attention restoration theory formulation over the years (e.g., Berman, Jonides, & Kaplan, 2008; Berto, 2005); however, a recent review indicated that there is also a sizable amount of contradictory evidence (Ohly et al., 2016). Additionally, it is likewise equally puzzling as to the exact evolved mechanism regarding how readily-processed natural objects could bring about attentional recuperation and other associated functional outcomes (Joye & Dewitte, 2018). Joye and van den Berg (2011) have attempted to tackle the shortcomings of these formulations by advancing a distinctive theory whereby beneficial effects emanating from nature exposure were proposed to be due to the relative efficiency in

dealing with perceptual information pertaining to natural landscapes among humans. However, it could be argued that such a theory, has similarly not provided a compelling answer to the riddle originated from its predecessors regarding the underlying reason as to why humans have evolved to respond positively to natural settings in general – why are humans more adept at processing perceptual information about natural environments than urban environments in the first place?

Urban environments are considered to be evolutionarily novel settings that could induce individuals to be more vigilant about potential perceived threats in their surroundings. Indeed, urbanised locations tended to be more crowded (Gallego, 2010), less green (DeFries, Rudel, Uriarte, & Hansen, 2010); and packed with evolutionarily-unfamiliar stimuli such as edifices (Kasanko et al., 2006), vehicles (Downs, 2004), and technology-enabled images. Put differently, the broadly inferior outcomes of experiencing urban settings are grounded on the premise that many urban stimuli are evolutionarily unfamiliar for Homo sapiens (O, 2018). In recent era, comparatively meteoric developments in modern living circumstances have vastly outpaced genetic/psychological alterations such that people are still primarily adapted to natural settings than otherwise in the current world (O, 2018; Spinella, 2003). Indeed, the concept of an evolutionary mismatch is gaining ground in psychological sciences (see Li, van Vugt, & Colarelli, 2018), and has recently been proposed in the context of the development of various psychopathologies (Kavanagh & Kahl, 2016, 2018) and other wellbeing issues (e.g., Li, Lim, Tsai, & O, 2015; Tsatsoulis, Mantzaris, Bellou, & Andrikoula, 2013).

In light of the issues surrounding extant theories about the benefits of exposure to natural environments, the current paper seeks to advance and empirically evaluate a novel evolutionary mismatch proposition that could potentially provide some clues to this conundrum – the unsolved problems hypothesis. Fundamentally, while the attention restoration theory has suggested that contemplation (and other associated advantages) were outcomes of attentional

recuperation (Herzog, Black, Fountaine, & Knotts, 1997; Kaplan, 1995), our proposition instead asserts that the capacity to invest time and cognitive resources on addressing life issues (and not attentional recuperation in itself) afforded by some evolutionarily-familiar safe settings (e.g., certain natural environments that are readily assessed to be safe and are largely free of danger) is the key factor behind many wellbeing effects of nature exposure. This argument is based on two fundamental assumptions. Firstly, most urban environments tend to have an almost unrelenting and excessive amount of evolutionary-relevant stimuli (e.g., one is expected to encounter numerous strangers, who could have posed huge threats to oneself in the ancestral past, while walking down a street) that would have required a massive amount of processing; this processing would far exceed what is typically needed in natural settings, thereby often depleting cognitive resources. Secondly, urban environments present many evolutionary-novel stimuli that require a lot of cognitive resources to process as humans have not evolved to efficiently discern and react to them (e.g., vehicles on the road). In short, it is posited that urban environments often present one with many more stimuli that humans have not yet evolved to process efficiently, thus often rendering it almost impossible for humans in such surroundings to reflect and problem-solve on other evolutionary-important cognitive tasks.

Such environmental contributions are also believed to be influenced by the imaginativeness of the specific individual. By extension and modification to existing diametric theorisations of mental health (e.g., Crespi & Badcock, 2008; Jung, 2014), the current formulation propounds that a more imaginative person would likely be more adept at developing solutions to his/her problems as compared to his/her counterparts under natural environmental settings (but would likely be worse off in a more urbanised environment due to it being an evolutionarily-mismatched setting as described above). The ability to imagine is posited to be a double-edged sword leading to both positive and negative outcomes depending

on the circumstances. If individuals who are relatively more imaginative are given the time and space to think about their own life problems/issues on a consistent basis (where natural environments would notably be most conducive for such mental tasks), it is postulated that they will then be more likely to report better general well-being than others; vice versa. Such lines of reasoning are based on existing empirical findings suggesting that, inventiveness, of which imaginativeness is an embodiment of (Gaut, 2003), is related to a general preference for profound levels of thinking (e.g., Dollinger, 2003), and is severely affected by time scarcity (Groth & Peters, 1999) – factors that might jeopardise imaginative individuals' decision-making much more than their lower need-for-cognition counterparts when not given the time and space to ponder on life issues.

This formulation could provide a fundamental, complementary framework accounting for humans' preference for, and the beneficial effects of nature exposure in general and should also be useful as an approach in explicating specific phenomena deriving from a relatively lack of contact with nature in the present context (such as the preponderance of psychotic symptoms among those with more urban experiences, especially given the empirically-supported link between imaginativeness and psychotic symptoms; e.g., Crespi, Leach, Dinsdale, Mokkonen, & Hurd, 2016).

Mounting evidence has demonstrated that psychotic symptoms are higher in more urbanised places and among people who grew up in locations with higher levels of urbanicity (e.g., Harrison et al., 2003; Sundquist, Frank, & Sundquist, 2004; van Os, Hanssen, Bijl, & Vollebergh, 2001). To that end, some researchers have attempted to explain this phenomenon with more psychosis-specific formulations that were mainly focused on the presence of certain factors unique to urban areas; for example the relative abundance of "Toxoplasma gondii oocysts" in faeces from cats in cities as possible agents in the pathogenesis (Torrey & Yolken, 2014, p. 300); problems during childbearing in urban locations (e.g., Eaton, Mortensen, &

Frydenberg, 2000); and potentially higher risk of being affected by environmental contaminants in such surroundings (Mortensen, 2000). But, robust empirical support for these formulations have so far been severely lacking (Torrey & Yolken, 2014).

In this regard, this paper contends that such a phenomenon can also only be truly understood when the underlying rationale (e.g., evolutionary origin) regarding why natural spaces (in contrast to urbanised ones) are so beneficial to humans is being comprehensively considered (Scott-Phillips, Dickins, & West, 2011). Abed and Abbas (2011) have attempted to offer an indirect argument along this line by contending that the much-higher level of complexity pertaining to interpersonal relationships (e.g., pervasive exposure to strangers/unrelated persons and/or a paucity of interaction with relatives and those from the same community) in present-day urban settings (in comparison to the prehistoric context from which Homo sapiens have evolved) was the core issue. Nonetheless, this formulation could not fully account for findings suggesting improved psychological functioning in individuals with psychotic conditions (among others) following an exposure to nature (Kam & Siu, 2010); or better psychological well-being among those residing in urban places with greater natural areas (e.g., Alcock, White, Wheeler, Fleming, & Depledge, 2014). The unsolved problems hypothesis could arguably provide a more convincing evolutionary exposition; whereby, psychotic symptoms are conceived to be more apparent among individuals (especially those who have higher levels of imaginativeness) in more urbanised areas because such settings do not typically afford people the time and space (like natural environments would) to reflect enough on life stressors. Taken together, it is proposed that individuals who are more imaginative and who are less exposed to environments for which humans are evolutionarily adapted (e.g., natural environments such as the sea/greenery – that could provide a conducive setting for people to have the time and cognitive resources to think through problems/issues which have occurred in their lives), are likelier to have more unsolved problems/issues of their

own. The accumulation of these unsolved problems and the distress associated with them is believed to then play a critical role in jeopardising the general functioning of affected individuals; vice versa. The relative presence/absence of unsolved problems in life emanating from the respective and interactional effects of personal (e.g., imaginativeness) and environmental (nature exposure) factors are posited to predict a range of well-being outcomes including income level, reproductive success, the extent of one's romantic engagements, and one's risk of developing psychotic symptoms**.**

Although Kuo (2001) has previously attempted to investigate the effect of nature exposure on the extent of one's life problems (from an attention restoration theoretical perspective), findings from that study arguably did not tell the complete picture of the essence of nature exposure. Specifically, Kuo (2001) did not find any link between nature exposure and personal attributes such as reproductive outcome, earnings and physical/psychological functioning (and had demonstrated negligible or inconsistent effects regarding the links between one's poor coping of life problems and reproductive outcome and physical/psychological functioning respectively) – results we argue were attributable mainly to the very specific nature of the sample utilized in the study (e.g., a relatively small sample of 145 individuals residing in a specific location in the U.S.) and were not necessarily representative of the actual phenomenon of nature exposure. In this study, a much bigger sample size that is likely more representative of the general population will be recruited to examine the proposed hypothesis that nature exposure is actually predictive of better wellbeing outcomes in relation to factors such as income, health (e.g., psychotic symptoms), romantic relationship success and the number of offspring, via the reduction of unsolved problems in one's life (especially among imaginative individuals).

Method

Participants and Procedure

Six hundred and eighteen participants, aged 18 years and older who were currently residing in the US were recruited via Amazon's Mechanical Turk and initially signed up for study; however, 18 participants did not complete the survey resulting in a final sample of 600[1] (312 males, 286 females, 2 other) with an average age of approximately 38 years (*SD* = 10.90). Participants' annual income in the final sample ranged from below USD$5000 to more than USD$150001.

Participants completed a series of questionnaires—detailed below—via an online survey format, after being directed to the information page and providing informed consent. Ethics approval was sought from, and approved by, the Department of Psychology Research Ethics Committee at Aberystwyth University.

Measures

Extent of contact with nature. The extent to which one was exposed to natural environment within and outside of his/her place of residence was evaluated by an integrative 16-item measure developed for the purposes of this study that has incorporated adapted and original items from Wells' (2000) naturalness scale (ten 5-point Likert scales); together with modified and derived new items that were adapted from Shanahan and colleagues' (2016) assessment of people's duration, frequency, and intensity of contact with nature during their typical activities (four items with a choice of 10 options plus two 5-point Likert scales). Initial factor and reliability analyses revealed that three of the items asking about exposure to built environments—as opposed to exposure to natural environments—appeared to load on a

[1] Participants were required to have at least a 99% approval rating across more than 1000 hits on Amazon's Mechanical Turk (an indicator published on the platform to demonstrate if a specific individual has been approved by other researchers to be a reliable worker based on all the surveys/tasks he/she has previously taken).

separate factor and had poor corrected item-total correlations. The remaining 13 items loaded well (> .42) on a single factor that accounted for 31.15% of the variance (Eigen > 4.61) and demonstrated good internal consistency (α = .79) were therefore summed to form an overall indication of the extent of one's contact with nature.

Imaginativeness. An adapted version of Hsu and colleagues' (2014) modified Imaginative Capacity Scale was used to examine participants' imaginativeness. Participants responded to 27-items on a 6-point Likert-type scale (1 = *strongly disagree*; 6 = *strongly agree*). The items on the scale demonstrated excellent internal consistency (α = .96) and were thus averaged to form an index of imaginativeness.

Extent of unsolved problems. The extent of unsolved existential issues in one's life were examined by adapting the 8 items from O's (2015) Previous Stressors instrument. Participants were asked to respond if they have experienced any unresolved problem over the last month and whether it has been (or still is) affecting them. The number of unresolved life issues were calculated by summing total number of problems endorsed (*M* = 1.79, *Md* = 1, *SD* = 1.76, range: 0 = 8). Total distress about unresolved problems was calculated by summing the total distress scores for each of the unresolved life problems (*M* = 3.71, *SD* = 4.06). Finally, we calculated cumulative unsolved problems by multiplying number of events by total distress (*M* = 13.37, *SD* = 21.77), with this latter index used in the main analyses.

Income level. Participants' level of annual income before tax was evaluated using a modified version of Cohen and colleagues' (2008) measure of one's yearly household income. Participants were given the choice to select the response that best fit their current earning status, with 16 options varying between values below $5,000 and upwards of $150,001 in this study (Cohen et al., 2008). Due to a clerical error the income ranges of $10,001 to $15,000 and $30,001 to $35,000 were left off the survey. As such, and to make the income level more reflective of their relative ranges, each range was dummy coded in relation to the top level of

the minimum range (i.e., using a base of $5,000) creating 16 scores with relative meaning (e.g., $5,000 = 1, $10,000 = 2, $20,000 = 4, $100,00 = 20, $125,000 = 25, $150,000 = 30).

Total duration of all romantic relationships. The total duration of all romantic relationships in which one has engaged in throughout his/her life up to the current stage was assessed by a single question: "Regardless of the length or the nature (e.g., a short fling or a marriage) of each romantic relationship you have ever had, what is the estimated total duration of all of these romantic relationships combined up to this point in your life?" There were 14 response options, ranging from nil (0) to about 16 years or more (14). These responses were then converted into weeks to provide a comparative scale (e.g., "about one month" = 4, "about a year" = 52; "about 11-12 years" = 598 [11.5 × 52]). This question was designed to appraise the amount of time one has invested in the evolutionarily important activity of mating (which could primarily be short-term or long-term focused, or a combination of both).

Reproductive outcome. The number of offspring one has successfully procreated was investigated by using O's (2015, p. 171) 1-item, 10 alternatives instrument: "How many biological children do you have?", with response options ranging from "0" to "9 or more". This scale was designed to reveal the progress in which an individual has overcome potential existential challenges in order to procreate (O, 2015).

Symptoms of psychosis. Ising and colleagues' (2012) Prodromal Questionnaire — 16 (PQ-16) was used to examine the levels of psychotic symptomatology in this study. The extent of psychotic perceptions/thoughts that were reported by the participants could be assessed by either calculating the total tally for "distress scores (range 0-48) or the total number symptoms endorsed (range 0-16)" (Savill, D'ambrosio, Cannon, & Loewy, 2018, p. 2). The distress scores calculation was utilised for the purposes of this study. The Cronbach's α for this measure was .74.

Results

Preliminary Analyses

A series of correlations (Pearson's and Kendall's τ where appropriate) were initially conducted to determine the associations between the variables of interest. As expected, cumulative unsolved problems was inversely associated with the degree of contact with nature, $r(598) = -.09$; $p = .021$; the number of biological children, $\tau(598) = -.10$, $p = .004$; and annual income, $\tau(598) = -.19$, $p < .001$. The extent of unsolved problems was likewise shown to be positively correlated with psychotic symptoms, $r(598) = .44$, $p < .001$. Furthermore, in line with predictions, level of imaginativeness was positively associated with degree of nature exposure, $r(598) = .16$, $p < .001$ and significantly correlated negatively with psychotic symptoms, $r(598) = -.13$; $p = .002$. Of note, age was significantly negatively correlated with psychotic symptoms and significant positively correlated with all other variables with the exception of unsvolved problems. See Table 1 for the full results.

A series of *t*-tests were also conducted to determine the extent to which there were any gender differences in the variables of interest. As there were only two people who did not identify as male or female, they were excluded from these analyses. The results (see Table 2), revealed a number of differences between males and females in the sample. Therefore, gender was entered as a covariate in all main analyses.[2]

Main Analyses

[2] We chose to use gender as the only covariate in the main analyses, despite age also being associated with most variables. This is because there were also significant age differences for gender and entering both of these variables as controls would lead to potential problems with multicollinearity in the analyses. Inspectiion of the results presented in Tables 1 and 2 show that gender appears to have a larger potential confounding influence over age.

Role of unsolved problems in environmental influences. A series of four mediation analyses using PROCESS (Hayes, 2013) were conducted to assess the extent to which unsolved problems mediates the relationship between nature exposure and well-being outcomes while controlling for gender (see Figure 1). The results (Table 3) supported a mediational pathway for three (annual income, number of offspring, and symptoms of psychosis) of the four models tested. That is, participants who reported a greater exposure to nature indicated a lower extent of unsolved problems (a = -0.063, p = .011), and in turn reported greater annual income (b = -0.245, p < 001), having more offspring (b = -0.026, p = .001), and less psychotic symptoms (b = 0.262, p < .001). Bias-corrected bootstrap confidence intervals (*BCI*s) for the indirect effects ($ab_{annual\ income}$ = 0.015; $ab_{offspring}$ = 0.002; $ab_{psychotic\ symptoms}$ = -0.16) were either above or below zero ($BCI_{annual\ income}$ = 0.004 – 0.029; $BCI_{offspring}$ = 0.000 – 0.004; $BCI_{psychotic\ symptoms}$ = -0.031 - -0.003).

Role of unsolved problems in personal influences. Four further mediation analyses were conducted examining the extent to which unsolved problems mediates the associations between imaginativeness and wellbeing outcomes controlling for gender (Figure 2). The results (Table 4) did not support any mediational pathways.

Nature exposure as a moderator. Next, we conducted a series of moderated mediational analyses using the PROCESS approach (Hayes, 2013) to determine if the extent to which people had contact with nature potentially moderated the pathways from imaginativeness to unresolved problems in the above reported mediation analyses. The results indicated that nature exposure did not moderate the indirect effects of imaginativeness on any of the wellbeing outcomes through unsolved problems in one's life (Imaginativeness × Nature Exposure Interaction Term coefficient = 0.025, *SE* = 0.026, p = .337, 95% *CI* [-0.026, 0.077]).

Discussion

Overall, findings from this study have provided mixed support for the unsolved problems hypothesis. As predicted, results suggested that individuals who have had more contact with nature during their typical activities were more likely to have a lower extent of unsolved problems in their lives as compared to their counterparts; and the relative absence of these unsolved existential issues was in turn demonstrated to be linked to a lower risk of developing psychotic symptoms coupled with a greater likelihood of having a higher annual income and more biological offspring; vice versa. Contrary to expectations nonetheless, the current findings indicated that exposure to nature has no indirect effect (via the curtailment of unsolved life problems) on romantic relationships; nor does it influence the indirect relationship between imaginativeness and well-being outcomes (through alleviating existential life issues)

In essence, there are some preliminary endorsement for the critical role of unsolved issues assuagement in influencing evolutionarily-relevant aspects of one's life, including the amount of his/her resources, health, and reproductive outcome (though not in relation to his/her romantic life) following an exposure to nature; however, the absence of any empirical support for the proposed links concerning one's imaginativeness in such relationships (or it being predictive of the amount of unsolved issues in one's life and his/her subsequent functioning) as theorized by the unsolved problems hypothesis has rendered the account inconclusive at this juncture. Undoubtedly though, such results do offer some tentative support for one of its core principles that the ability to successfully address existential issues via nature exposure is a key factor in determining a person's ability to survive and to procreate over the course of evolutionary history. These findings, while tentative, appear to provide a starting point in building on the proposed argument that the capacity of an environment in furnishing individuals with the time and cognitive resources necessary to contemplate and resolve life stressors might be the fundamental reason as to why nature exposure is beneficial for humans

– a potential explanation which, if endorsed by more robust empirical data in the future, could conceivably complement all the leading related theoretical formulations in the literature by providing a useful underlying framework in understanding the influence of natural settings.

As indicated above, the overall findings are admittedly tentative; nonetheless, some of the current findings could lay the groundwork for more empirical investigations that might eventually be useful in crystallizing the specific role of problem-solving as a result of nature exposure that could be helpful in complementing existing theories regarding this phenomenon. Conceivably, with more supporting data in the future, the notion that the extent to which a natural landscape could afford the conditions suitable for people to reflect and to cognitively tackle life problems could explicate why humans would presumably be attracted to (some) natural settings that were both a place of sanctuary and of opportunities as posited by Appleton's (1975) prospect refuge theory; why (some) savanna-like settings might also be favoured by humans as advanced by Orians' (1980, 1986) savanna hypothesis; why might people evolve to experience emotions when exposed to natural settings as postulated in Ulrich's (1983) psycho-evolutionary approach; how would readily-processed natural stimuli engender recuperative outcomes as indicated by the attention restoration theory (Kaplan, 1995; Kaplan & Kaplan, 1989); and why might people be more efficient at discerning natural environments as surmised by Joye and Van den Berg's (2011) processing fluency formulation. It is believed that such a formulation could likewise initiate more theorizations and research work in offering an alternative perspective to Kuo's (2001) preliminary work on this topic. The perspective that natural settings could provide time and cognitive resources that could facilitate the contemplation of life issues, if supported by more robust findings in the future that are informed by the current ones, could potentially explain the range of preferences and the variability of exposure effects relating to natural environments. Such a view could likewise shed some initial light on existing findings that have demonstrated a link associating nature

exposure with contemplative tendencies (e.g., Fuller, Irvine, Devine-Wright, Warren, & Gaston, 2007; Herzog et al., 1997). In addition, the current findings have suggested that the unsolved problems hypothesis could analogously provide some preliminary ideas for a useful framework in elucidating more specific related phenomena such as the predominance of psychotic symptoms among people in urban areas (as compared to their more nature-exposed counterparts) – whereby lesser amount of time and space to reflect on life issues so as to resolve them in areas with limited nature is believed to be the core factor underlying the heightened risk of psychotic symptoms in urban communities.

However, a couple of important questions remain with regards to the predictive value of the unsolved problems hypothesis: 1) It is unclear as to why unsolved existential issues do not appear to play a role in one's combined duration of all mating pursuits in this study despite the former being shown to be involved in mediating the relationship between nature exposure and reproductive outcome. Although one might contend this could mean that the formulation is thus likely to be only relevant for reproductively successful short-term mating, the fact that the duration of one's involvement in romantic alliances is generally a logical predictor of the number of offspring one would have has largely undermined such a notion. Follow-up empirical work that could provide a more thorough examination of this issue is thus needed; 2) the present findings have also indicated that, contrary to the proposed formulation, the amount of unsolved problems in one's life does not mediate the relationship between imaginativeness and well-being outcomes nor does imaginativeness interact with nature exposure to influence the extent of unsolved existential issues (and well-being). It could be possible that the proposed influence of imaginativeness is non-existent in these relationships and that such personal attribute is unrelated to one's functioning in reality. However, this simplistic conclusion is inconsistent with a variety of evidence in the literature highlighting an assortment of links between imaginativeness and well-being outcomes (e.g., Bonne, Canetti,

Bachar, De-Nour, & Shalev, 1999; Tower, 1985; Vassend, 1987; see also Crespi et al., 2016 for a review on the link between imaginativeness and psychotic symptoms). Alternatively, these results could be a product of a methodological problem instead – the adapted version of Hsu and colleagues' (2014) measure adopted to assess imaginativeness might not have been entirely suitable. Notwithstanding such a concern however, it was previously indicated that studies have broadly substantiated the psychometric properties of the measure and its associated versions (e.g., Hsu et al., 2014; Liang & Chia, 2014; Lin et al., 2014). Thus, future research work should explore a range of possibilities in accounting for the current findings while examining the formulation as a whole.

More generally, some broader issues could likewise limit the generalizability of the current findings. One of these main concerns pertains to the cross-sectional nature of the study, which naturally inhibits any conclusion that could be drawn regarding causality. Likewise, the present study has only targeted individuals from the U.S. and hence the current results might not be applicable for people in other countries/cultures. In addition, the current study has mainly provided a tentative picture of the mechanism underlying the role of nature exposure on well-being (and has posed additional questions regarding personal attribute/s that might be involved, given that imaginativeness does not seem to play a crucial part in such a process according to the current findings) and thus a more comprehensive exploration of potential specific factors (e.g., the presence/absence of other unfamiliar/trusted human beings in the surroundings; specific configurations of a natural landscape; the impact of other conceivably relevant individual characteristics such as one's level of intelligence and/or his/her need for cognition) that could be instrumental in this process (e.g., with regards to alleviating one's existential issues) would be necessary and useful in shedding more light on such a phenomenon. To these ends, while resource constraints have rendered other research designs/sample groups and a more extensive investigation unfeasible in this instance, future

studies could potentially provide a more compelling test of the theory (and critical related adjustments) by means of a larger-scale, cross-cultural longitudinal and/or an experimental approach.

Conclusion

In summary, results from this study have suggested that, consistent with the unsolved problems hypothesis, individuals who have had the time and cognitive resources (e.g., conditions that are typically afforded by natural environments as compared to more urbanized ones) to reflect on their existential issues would tend to generate more solutions to their problems in life and would hence be more likely to have the capability to focus on other evolutionarily-important tasks that are relevant to their survival and reproduction (e.g., to accumulate resources and to have more offspring) and would also be of a lower risk of developing psychotic symptoms; vice versa. However, the current findings have also suggested that the relative presence/absence of unsolved life stressors is not related to one's level of imaginativeness nor was the latter useful in predicting his/her functioning as a result of nature exposure – outcomes that are proposed by the unsolved problems hypothesis. In short, the current findings have provided some tentative evidence to suggest that the amount of unsolved existential issues is instrumental in elucidating the role environmental influences could have on one's well-being from an evolutionary mismatch perspective but is extraneous in clarifying the potential contribution of personal attributes to one's functioning. Hence, given the far-reaching impact physical surroundings could have on well-being, future studies are needed to achieve a better understanding of the veracity of the formulation and/or to offer valuable modifications to it.

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Conflict of Interest

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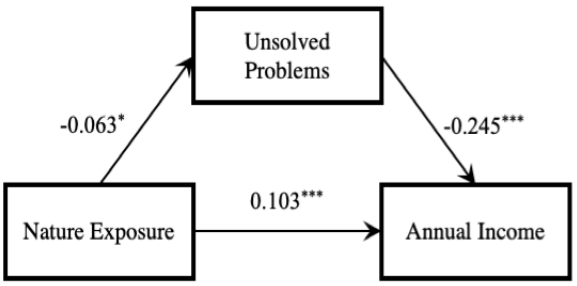

Figure 1a

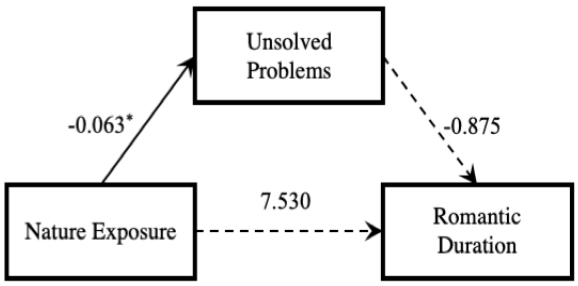

Figure 1b

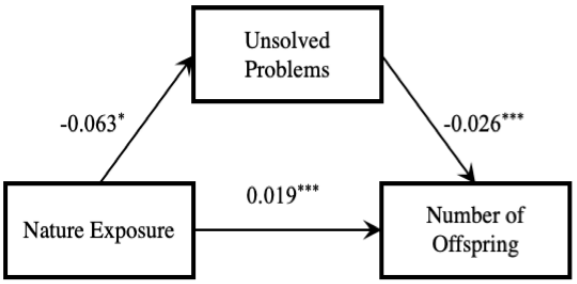

Figure 1c

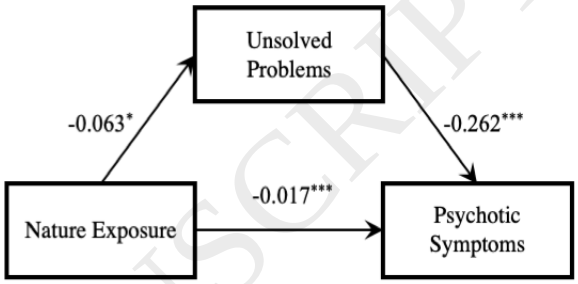

Figure 1d

Figure 1. Model examining the indirect effect of nature exposure on well-being outcomes through the extent of unsolved problems in one's life.

$^{*}p < .05$. $^{***}p < .001$

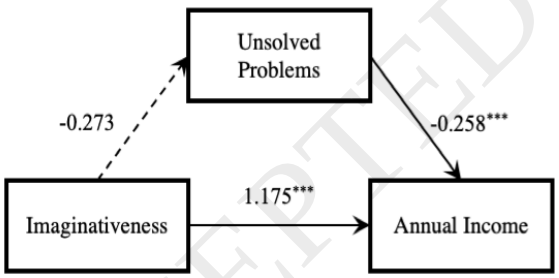

Figure 2a

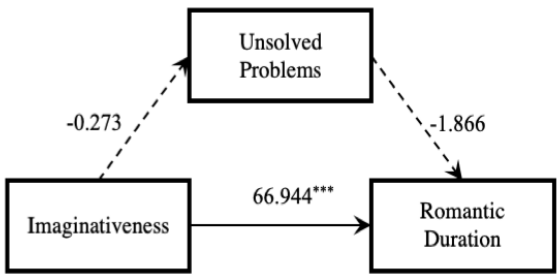

Figure 2b

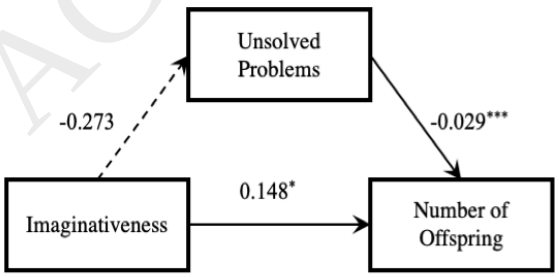

Figure 2c

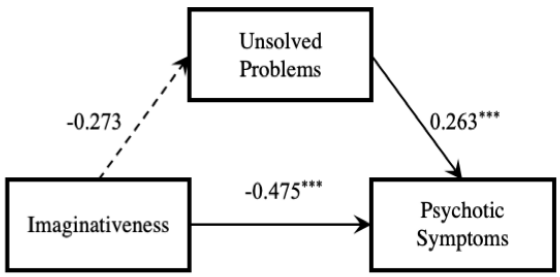

Figure 2d

Figure 2. Model examining the indirect effect of imaginativeness on well-being outcomes through the extent of unsolved problems in one's life.
$^{*}p < .05$. $^{***}p < .001$

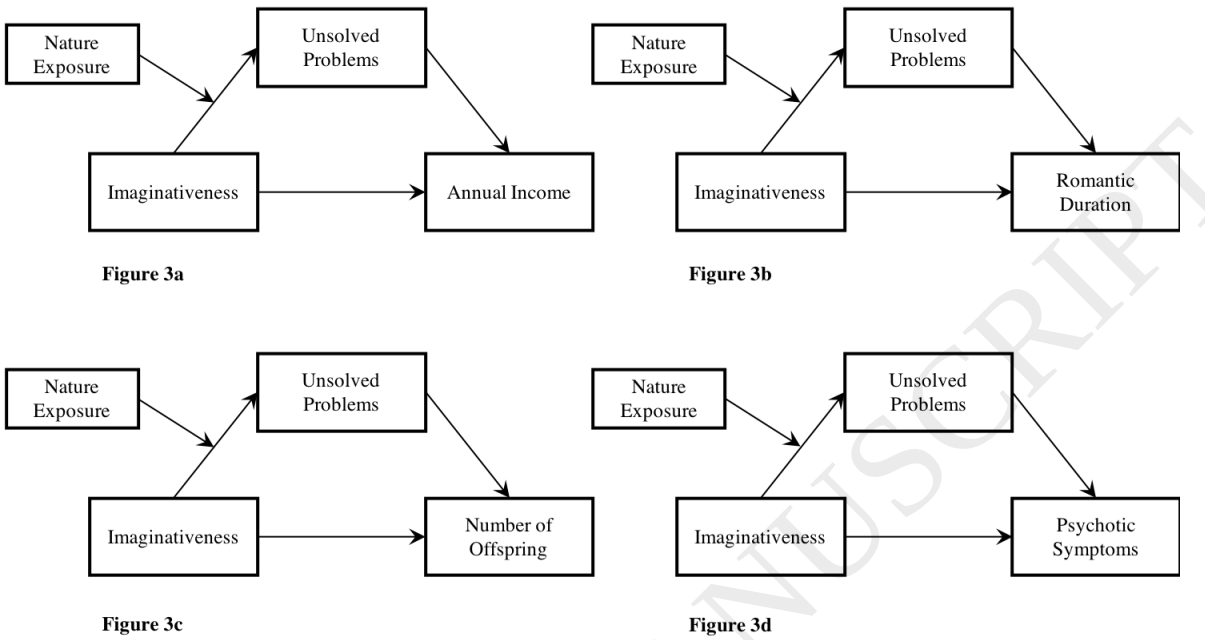

Figure 3. Model examining the moderating effect of nature exposure on the mediational relationship between imaginativeness and well-being outcomes through unsolved problems.

Table 1. *Means, Standard Deviations, Alphas, and Zero-Order Correlations Between Variables*

Variables	*M* (*SD*)	α	1	2	3	4[a]	5[a]	6[a]	7
1 Nature exposure	42.38 (9.61)	.79	–						
2 Imaginativeness	4.58 (0.74)	.96	.23***	–					
3 Cumulative unsolved problems (A x B)	13.37 (21.77)	–	-.09*	-.02	–				
A. Number of unresolved problems	5.50 (5.75)	.68							
B. Unresolved problems (distress)	3.71 (4.06)	.69							

4	Annual income[a]	–	–	.11***	.11***	-.19***	–			
5	Romance duration[a]	491.63 (303.85)	–	.22**	.14***	-.01	.11***	–		
6	Number of offspring[a]	0.82 (1.18)	–	.18**	.11***	-.10**	.13***	.44***	–	
7	Psychotic symptoms	2.11 (3.23)	.74	-.09*	-.13**	.44***	-.15***	-.14***	-.12***	–
8	Age[a]	38.05 (10.90)	–	.19**	.06*	.05	.06*	.43***	.27***	-.12***

Notes: Romantic Duration = The combined total duration of all romantic relationships in which one has engaged. [a]Kendall's τ. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$

Table 2. *Differences Between Men and Women on Demographics and Main Variable of Interest.*

	Sex		
	Males	Female	
Variable	*M* (*SD*)	*M* (*SD*)	*t* (*df* = 596)
Nature exposure	49.52 (10.12)	52.95 (10.56)	4.05***
Imaginativeness	4.58 (0.75)	4.58 (0.74)	0.16
Cumulative unsolved problems	12.24 (19.63)	14.50 (23.80)	1.27
Annual income[a]	41,950 (32,305)	39,800 (31,405)	-0.83
Romantic Duration[b]	392.84 (296.28)	598.94 (274.70)	8.80***
Number of offspring	1.46 (0.86)	2.20 (1.35)	8.05***
Psychotic Symptoms	2.03 (3.21)	2.19 (3.26)	0.63
Age[c]	36.02 (10.16)	40.34 (11.24)	4.94***

Notes: Romantic Duration = The combined total duration of all romantic relationships in which one has engaged. [a]USD. [b]Months. [c]Years. $^{***}p < .001$

Table 3 *Model Coefficients for the Effects of Nature on Exposure on Wellbeing Variables, Mediated by Unsolved Problems, Controlling for Gender.*

		Consequent						
		M (Unsolved Problems)				*Y* (Annual Income)		
Antecedent		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*
X (Nature Exposure)	*a*	-0.063	0.025	.011	*c*′	0.103	0.026	< .001
M (Unsolved Problems)					*b*	-0.245	0.044	< .001
Constant		6.896	1.190	< .001		6.119	1.302	< .001
		$R^2 = 0.014$				$R^2 = 0.082$		
		$F(2, 597) = 4.359, p = 0.13$				$F(3, 596) = 17.774, p < .001$		
						Y (Romantic Duration)		
X (Nature Exposure)	*a*	-0.063	0.025	.011	*c*′	7.530	1.198	< .001
M (Unsolved Problems)					*b*	-0.875	1.986	.660
Constant		6.896	1.190	< .001		-92.845	59.357	.118
		$R^2 = 0.014$				$R^2 = 0.169$		
		$F(2, 597) = 4.359, p = 0.13$				$F(3, 596) = 40.512, p < .001$		
						Y (Number of Offspring)		
X (Nature Exposure)	*a*	-0.063	0.025	.011	*c*′	0.019	0.005	< .001
M (Unsolved Problems)					*b*	-0.026	0.008	.001
Constant		6.896	1.190	< .001		-0.923	0.235	< .001
		$R^2 = 0.014$				$R^2 = 0.146$		
		$F(2, 597) = 4.359, p = 0.13$				$F(3, 596) = 34.098, p < .001$		
						Y (Psychotic Symptoms)		
X (Nature Exposure)	*a*	-0.063	0.025	.011	*c*′	-0.017	0.012	.160

M (Unsolved Problems)					*b*	0.262	0.020	< .001
Constant		6.896	1.190	< .001		1.305	0.608	.032
		$R^2 = 0.014$				$R^2 = 0.226$		
		$F(2, 597) = 4.359$, $p = 0.13$				$F(3, 596) = 57.984$, $p < .001$		

Table 4*Model Coefficients for the Effects of Imaginativeness on Wellbeing Variables, Mediated by Unsolved Problems, Controlling for Gender.*

		Consequent						
		M (Unsolved Problems)				*Y* (Annual Income)		
Antecedent		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*
X (Imaginativeness)	*a*	-0.273	0.317	.389	c'	1.175	0.337	.001
M (Unsolved Problems)					*b*	-0.258	0.043	< .001
Constant		5.738	1.625	< .001		4.732	1.744	.007
		$R^2 = 0.005$				$R^2 = 0.077$		
		$F(2, 597) = 1.467$, $p = 0.231$				$F(3, 596) = 16.686$, $p < .001$		
						Y (Romantic Duration)		
X (Imaginativeness)	*a*	-0.273	0.317	.389	c'	66.944	15.559	< .001
M (Unsolved Problems)					*b*	-1.866	2.010	.354
Constant		5.738	1.625	< .001		-105.924	80.649	.190
		$R^2 = 0.005$				$R^2 = 0.141$		
		$F(2, 597) = 1.467$, $p = 0.231$				$F(3, 596) = 32.615$, $p < .001$		
						Y (Number of Offspring)		
X (Imaginativeness)	*a*	-0.273	0.317	.389	c'	0.148	0.061	.016
M (Unsolved Problems)					*b*	-0.029	0.008	< .001

Constant		5.738	1.625	< .001		0.160	0.317	.615
		$R^2 = 0.005$				$R^2 = 0.111$		
		$F(2, 597) = 1.467$, $p = 0.231$				$F(3, 596) = 37.408$, $p < .001$		
						Y (Psychotic Symptoms)		
X (Imaginativeness)	*a*	-0.273	0.317	.389	*c*′	-0.475	0.156	.002
M (Unsolved Problems)					*b*	0.263	0.020	< .001
Constant		5.738	1.625	< .001		2.834	0.808	< .001
		$R^2 = 0.005$				$R^2 = 0.017$		
		$F(2, 597) = 1.467$, $p = 0.231$				$F(3, 596) = 61.168$, $p < .001$		