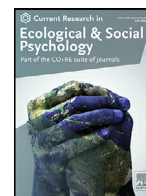




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Eco-anxiety in daily life: Relationships with well-being and pro-environmental behavior

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ABSTRACT

Prior research on *eco-anxiety*, or anxiety and worry about mounting environmental issues, has almost exclusively relied on cross-sectional trait reports. Consequently, little is known about how it is related to focal outcomes, such as well-being (e.g., happiness, meaning in life) and pro-environmental behavior, over time in daily life. To help address this issue, we conducted a preregistered daily diary study, wherein Canadian undergraduates ($N = 132$) provided trait reports and two weeks of daily reports ($n = 1439$) on eco-anxiety, positive and negative affect, meaning in life, and pro-environmental behavior. At the trait level, average scores on eco-anxiety were fairly low; yet, higher scores were associated with less positive affect and more negative affect and pro-environmental behavior. Average scores on eco-anxiety were even lower at the state level but nonetheless exhibited notable within-person variability. On days that people felt greater eco-anxiety, they also reported greater negative affect and pro-environmental behavior. Lagged analyses from one day to the next provided some evidence that eco-anxiety increases future negative affect. No significant relationships between eco-anxiety and meaning in life emerged at both levels of analysis. Together, these findings demonstrate that eco-anxiety can be productively conceived of—and studied as—both a trait and a state.

1. Introduction

Climate change and environmental degradation are some of the most serious issues facing the world today. A growing line of research has begun to examine the outcomes associated with anxiety stemming from the awareness of these problems, even in the absence of direct personal experience (e.g., Albrecht, 2011; Clayton, 2020; Clayton and Karazsia, 2020; Ojala et al., 2021; Pihkala, 2020a). The current body of work on this notion of ‘eco-anxiety’ has almost exclusively studied the construct as a trait, a relatively enduring individual difference. Some people are considered to be generally more anxious about the environment than others. However, we propose that eco-anxiety can also be viewed as a state, a more short-lived experience that varies over time within persons. Someone may feel eco-anxious one day but not the next depending on the situations and contexts they encounter in their everyday life. It is with this assumption in mind that we sought to build on two broad findings that have emerged as important in terms of delineating the maladaptive and adaptive qualities of eco-anxiety. That is, when measured as a trait, eco-anxiety has generally been shown to have mixed associations with well-being (e.g., happiness, meaning in life) and positive associations with pro-environmental behavior, suggesting that it may pose both challenges and opportunities in response to ecologi-

cal crises (e.g., Clayton, 2020; Pihkala, 2020b). The aim of the present study was to extend this work by examining these relationships at the daily level, thereby avoiding some recall biases and providing useful information about people’s quotidian experiences.

1.1. Trait and State Eco-Anxiety: Initial Considerations

Although eco-anxiety has emerged as a much-discussed topic among the public, media outlets, and researchers in recent years (e.g., Clayton, 2020; Cunsulo et al., 2020; Pihkala, 2020a), the formal study of this construct is still in its early stages. A brief survey of this burgeoning literature makes it apparent that approaches to eco-anxiety struggle with issues of conceptual clarity (e.g., Coffey et al., 2021; Pihkala, 2020a). In the current work, we adopt Passmore et al.’s (2022a) definition of eco-anxiety as “persistent feelings of worry, anxiety, dread, or doom regarding environmental degradation and the impacts and implications of climate change on our planet as a whole” (p. 3). While it is increasingly recognized that symptoms of eco-anxiety can range in severity (e.g., from mild worry to clinically significant symptoms; Lutz et al., 2023; Pihkala, 2020a), what this definition and other views of the phenomenon tend to have in common is that frequent and stronger instances of eco-anxiety are usually considered to be particularly emblem-

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atic of the construct (e.g., Clayton & Karazsia, 2020; Hogg et al., 2021; Pihkala, 2020b; Verplanken et al., 2020). This view, coupled with the fact that the work in this area has primarily relied on single-assessment global reports (i.e., cross-sectional data), paints eco-anxiety as a more enduring trait; however, we argue that eco-anxiety can also be understood as a fluctuating daily state. This idea is supported by research indicating that even constructs that are typically conceived of as more trait-like (e.g., the Big Five) can also be productively studied as states over time (e.g., Fleeson, 2004), with substantial within-person variations around reliably different trait setpoints. Although empirically and conceptually distinct, state-level research can speak to trait-level processes with some pragmatic advantages regarding causal inference. Moreover, there is a long research tradition of studying anxiety as both a trait and a state (e.g., Spielberger, 1983).

State variation in eco-anxiety has been demonstrated by Clayton and Karazsia (2020; Study 3), wherein they observed that a measure of eco-anxiety was affected by the framing of a climate change message in an experimental setting. Qualitative work has also documented that eco-anxiety can be elicited by situational and contextual cues, such as media reports on climate change, discussions with others about environmental issues, or even witnessing someone fail to recycle (Passmore et al., 2022b). An individual could have these encounters one day, which may contribute to marked symptoms of eco-anxiety (e.g., repetitive worry) but not another. Extant quantitative work on eco-anxiety has been unable to capture this daily variability and has instead focused on trait or between-person level relationships. Much of this research has focused on understanding the maladaptive and adaptive nature of eco-anxiety via its associations with well-being and pro-environmental behavior. As we describe in greater detail shortly, these cross-sectional studies have reported mixed associations between eco-anxiety and well-being (e.g., happiness, meaning in life), but relatively consistent positive associations with pro-environmental behavior. Using daily diary methodology, we sought to complement this work by examining these relationships at the state or within-person level, a level of analysis that is mathematically independent (Nezlek, 2001), and in some cases, psychologically distinct from between-person relationships (Affleck et al., 1999). Below we review research on eco-anxiety's relationships with happiness, meaning in life, and pro-environmental behavior while considering trait and state perspectives.

1.2. Happiness

The experience of happiness, or high levels of positive feelings and low levels of negative feelings (Diener, 1984), has been routinely linked to our relationship with nature. Indeed, recent meta-analyses have demonstrated that nature exposure and feeling connected to nature are positively associated with happiness (Capaldi et al., 2014; McMahan and Estes, 2015; Pritchard et al., 2020). Baxter and Pelletier (2019; see also Hurly and Walker, 2019) even went so far as to suggest that nature relatedness is a fundamental human need based in part on considerable research indicating that its satisfaction or thwarting has important implications for happiness. With this body of work in mind, it stands to reason that the numerous environmental challenges we face pose a threat to our happiness. Passmore et al. (2022a) suggest that one pathway by which this may occur is through feelings of eco-anxiety, which fundamentally signal that our relationship with the natural world is strained. Yet, support for this theorizing has been mixed. Eco-anxiety tends to be positively associated with ill-being (e.g., depression, anxiety, stress), though variability in this association has emerged (e.g., Clayton and Karazsia, 2020; Hogg et al., 2021; Lutz et al., 2023; Mougouia-Daouda et al., 2022; Schwartz et al., 2022; Stanley et al., 2021; Verplanken et al., 2020; Verplanken and Roy, 2013; Wullenkord et al., 2021). These findings are not surprising given that measures of eco-anxiety are often based on or overlap with ill-being scales (McBride et al., 2021; Ojala et al., 2021). When considering outcome measures that more closely align with notions of happiness (i.e.,

positive indicators), Lutz et al. (2023) found small and mixed associations across multiple indices of eco-anxiety.

An important caveat of the research reviewed thus far is that it utilized global reports, which use longer or unspecified reflection periods (e.g., in which participants are asked to indicate the degree to which they *generally* experience eco-anxiety and happiness). Alternatively, a daily diary report uses a shorter and more concrete reflection period (i.e., a given day), which is crucial for gaining insight into phenomena as they occur in people's everyday lives. When assessed using this shorter time span, eco-anxiety may be negatively associated with happiness, as various factors (e.g., individual differences like nature connectedness) may be less relevant day-to-day. However, as the reflection period increases or becomes more abstract, eco-anxiety's relationship with happiness may become more mixed, as the role of such factors become more prominent (Newman et al., 2021), which could help to explain the mixed findings obtained using global trait reports. Differences between global and daily reports may also influence how eco-anxiety is related to other aspects of well-being, such as meaning in life.

1.3. Meaning in Life

Humans fundamentally seek to understand their experiences and their lives, to feel that things make sense. This perception is often referred to as coherence (or comprehension) and is considered a key facet of meaning in life (George and Park, 2016; Martela and Ryan, 2016). Coherence can arise from various factors, including encounters with the natural environment. As Albrecht (2011) writes, "we rely on pattern and regularity in nature to offer us a reasonable degree of predictability in a sea of change and possibilities" (p. 43). Buttressing this idea, research has found that participants rated life as more meaningful after exposure to stimuli presented in a patterned manner (e.g., pictures of trees shown in seasonal order) compared to exposure to stimuli presented in a random manner (Heintzelmen et al., 2013). Yet, Passmore et al. (2022a) note that we are currently witnessing a period of disruption in the natural order of the environment that is unfolding at a rate unprecedented in human history (e.g., Ceballos et al., 2015). When one is unable to render their experiences as coherent, they experience a form of distress, what existential theorists refer to as "the feeling of the absurd" (Camus, 1955, p. 5), prompting efforts to reinstate a sense of order and understanding (Heine et al., 2006; Proulx, 2009; cf. Heintzelman and King, 2014). One view of eco-anxiety could be that it serves as a proxy for the feeling of the absurd, signaling a lack of pattern and predictability stemming from encounters with unsettling stimuli that pertain to the natural environment (e.g., a news report on climate change). These feelings of eco-anxiety may make one feel as though their experiences are fragmented and unclear (i.e., less coherent). This idea aligns with Passmore et al.'s (2022a) suggestion that eco-anxiety may undermine meaning in life, especially our sense of coherence. However, evidence for this has been mixed. For instance, Searle and Gow (2010) found that intolerance of uncertainty (i.e., the tendency to negatively react to uncertain events) evidenced a small to moderate positive association with climate change distress but was unable to predict measures of climate change distress in the presence of other variables. A more direct test found that, when entered with other predictors, a sense of coherence regarding one's personal future *positively* predicted worry about environmental issues (Anttila et al., 2000). More recently, Lutz et al. (2023) found null associations between various measures of eco-anxiety and coherence.

Again, it is important to note that the above research utilized global reports. When assessed as daily states, a clearer negative relationship between eco-anxiety and coherence may emerge. Notably, Heintzelman and King (2013, 2014) explicitly view meaning as a state, one that captures the feeling of rightness that accompanies the immediate presence of pattern, lawfulness, and reliable connections. It may be the case that states of eco-anxiety, which potentially signal disrupt-

tions to order and regularity, are associated with lower states of meaning/coherence.

1.4. Pro-Environmental Behavior

Researchers have made considerable efforts to understand engagement in actions that either benefit the environment or harm it as little as possible. These behaviors are broadly referred to as pro-environmental behaviors (Kollmuss and Agyeman, 2002; Steg and Vlek, 2009) and can encompass a host of different actions including eating less meat, conserving water, supporting climate friendly policies, and engaging in environmental activism (e.g., Larson et al., 2015; Schmitt et al., 2019). Eco-anxiety may hold important implications for pro-environmental engagement, with previous work offering two competing hypotheses (e.g., Albrecht, 2011; Clayton, 2020; Pihkala, 2020a; Verplanken et al., 2020). This first prediction is that eco-anxiety may manifest as a form of “practical anxiety” (Kurth, 2018), an activating response that spurs information seeking and action. The second prediction is that eco-anxiety may instead manifest as a form of “eco-paralysis” (Albrecht, 2011), a deactivating response that prompts disengagement from the threat and inaction. Overall, the practical anxiety prediction has received much more empirical support than has paralysis, as eco-anxiety (regardless of severity) tends to be positively correlated with both pro-environmental behaviors and intentions, though some variability in this association is present (e.g., Clayton and Karazsia, 2020; Lutz et al., 2023; Mouguiama-Daouda et al., 2022; Ojala et al., 2021; Schwartz et al., 2022; Stanley et al., 2021; Verplanken et al., 2020; Verplanken and Roy, 2013; Wullenkord et al., 2021).

Although we expected that a positive link between eco-anxiety and pro-environmental behavior would emerge at the within-person level, some important caveats warrant discussion. First, it is plausible that eco-paralysis occurs at the daily level, even with apparently contradictory trait-level correlations, if eco-oriented people are prone to both anxiety and action, just at different times. Still, we predict a positive daily association, as many have suggested pro-environmental action as a way of coping with eco-anxiety (e.g., Passmore et al., 2022a; Pihkala, 2020b). Additionally, it should be noted that a daily diary approach to pro-environmental behavior is not well-suited to capturing behaviors that are relatively infrequent, especially for the average person (e.g., taking one less flight, voting for a pro-environmental politician). Given that daily reports use a shorter reflection period, they are better at capturing more quotidian actions (e.g., recycling), compared to a global report over a longer period of time, which is more amenable to capturing rarer behaviors (Newman et al., 2021). As a result, the present investigation will focus on the relationship between eco-anxiety and behaviors that are likely to be relatively more frequent or habitual, but then also may be of lower individual and societal impact. Even though both high impact personal consumption behaviors and promotion of systemic social change are recommended to effectively combat climate change (e.g., Schmitt et al., 2019; Wynes and Nicholas, 2017), the study of pro-environmental behavior in the context of daily life remains an important issue to investigate because day-to-day behaviors still contribute to an individual’s environmental footprint (Bissing-Olson et al., 2016). Moreover, behaviors that have a small direct impact on the environment may still be important via social processes that signal norms of concern and action (e.g., Frank, 2020).

1.5. The Present Study

Past research has almost exclusively studied eco-anxiety’s relationships with well-being and pro-environmental behavior using cross-sectional methodology. Consequently, there is a dearth of knowledge concerning how eco-anxiety is related to these constructs in daily life. The aim of the present study was to address this gap using a daily diary approach. Participants in the present study first completed baseline trait measures of eco-anxiety, positive affect, negative affect, coherence,

and pro-environmental behavior. Eco-anxiety’s trait level relationships with positive affect, negative affect, and coherence were left as open research questions given previous conflicting findings reported at this level of analysis; however, we expected that trait eco-anxiety would be positively associated with trait pro-environmental behavior. Next, participants provided daily reports of these constructs for two weeks via a smartphone app. At the within-person level, we expected that on days people felt greater eco-anxiety relative to their typical or average amount, they would report less happiness (i.e., lower positive affect and higher negative affect) and coherence but more pro-environmental engagement. The reliance on cross-sectional methodology has also restrained researchers from drawing causal inferences about eco-anxiety’s relationships. A secondary aim of the present study was to help address this issue on an exploratory basis through the use of lagged within-person analyses.

2. Method

2.1. Transparency and Openness

We preregistered the above research questions and hypotheses, as well as all measures and data analytic decisions described below unless specified otherwise. The preregistration, materials, data, and syntax can be found on the Open Science Framework (OSF): <https://osf.io/xjek6/>.

2.2. Participants and procedure

Our initial sample consisted of 135 undergraduate students enrolled in introductory psychology courses at Carleton University located in eastern Canada. This study was approved by Carleton University’s research ethics board under the ID #116323. After applying preregistered exclusion criteria described below, our final sample comprised 132 students (72.6% female, 26.6% male, 0.8% other; 41.9% White/Caucasian, 15.3% South Asian, 15.3% Black, 6.5% Arab/West Asian, 4.8% South East Asian, 4.0% Latin-American, 4.0% other, 3.2% Asian, 2.4% Native/Aboriginal People). Ages ranged from 17 to 50 ($M = 21.20$, $SD = 4.97$). In exchange for their participation, students received course credit and one ticket for a 200 dollar draw for every survey they completed. Data collection began during the start of the winter term of 2022 and concluded at the end of the spring term so that the first author could meet degree requirements by the summer term. Although our final sample did not meet our preregistered goal of 150 participants, it still accords well with those plans and with sample size recommendations for daily diary research (Nezlek, 2012).

Small groups of participants attended an online orientation session hosted on Microsoft Teams during which they learned about the study procedure, provided informed consent, and were shown how to download the ExpiWell app (Tay, 2020) on their smartphones. After the meeting, participants were instructed to complete a baseline survey containing trait and demographic measures on the ExpiWell app before 11:59 pm that night, at which time the survey expired. Starting the day after the orientation session, participants were sent a notification every evening at 8:00 pm for 14 consecutive days informing them that their daily survey was available. Participants were asked to complete the survey near the end of their night but before 11:59 pm, as the survey would expire at that time. During the orientation session, participants had the option of receiving a reminder email for their daily surveys at a time of their choosing. We allowed for a one-hour grace period for responses to be recorded by ExpiWell and accepted entries until 1:00 am, as preregistered.

2.3. Trait Measures

These measures were administered after the orientation session. Trait measures of other constructs that were not the focus of the present

study were also collected (see OSF for full measures and order of administration). Only measures that are the focus of the present study are discussed below in the order in which their respective construct was presented in the introduction. For all trait measures, participants were instructed to “answer how you would generally respond”. We chose measures with an eye to items that would work at both the trait and state level.

2.3.1. Eco-Anxiety

Two sources of items were used to assess feelings of eco-anxiety. The first was an adapted version of the 4-item affective symptoms subscale of the Hogg Eco-Anxiety Scale (Hogg et al., 2021). Participants were asked: “How much do you generally experience each of the following because of climate change and/or other environmental issues such as the degradation of the environment?”. The original instructions of the measure included other environmental problems (e.g., deforestation, pollution of the oceans); however, we only presented participants with climate change and environmental degradation to avoid potential priming effects and because these two issues account for various ecological calamities. Items (e.g., “Feeling nervous, anxious, or on edge because of environmental issues”) were rated on 5-point scale (1 = *not at all*, 5 = *a great deal*). The second source was a face valid item (i.e., “Feeling worried, uncomfortable, or upset because of environmental issues”) adapted from Verplanken and Roy (2013) that has been used to measure eco-anxiety (Lutz et al., 2023). This item was presented along with the other four affective symptom items and together were analyzed as a single scale.

2.3.2. Positive and Negative Affect

Affect was assessed using a circumplex model (e.g., Feldman Barrett and Russell, 1998) that distinguishes between four affective experiences based on valence (positive and negative) and arousal (activated and deactivated). Items were taken from a list of emotion terms used in prior diary research (Brandstätter, 2007) and were adapted for trait use. Following prior work (e.g., Newman et al., 2020), positive activated affect was measured with the items glad, delighted, enthusiastic, excited, and happy; positive deactivated affect was measured with the items at ease, relaxed, contented, peaceful, and calm; negative activated affect was measured with the items tense, angry, annoyed, nervous, and stressed; negative deactivated affect was measured with the items miserable, depressed, disappointed, sad, and gloomy. Participants were asked to rate how strongly they generally feel each emotion on a 7-point scale (1 = *do not feel this way at all*, 7 = *feel this way very strongly*).

2.3.3. Coherence

The comprehension subscale of the Multidimensional Existential Meaning Scale (George and Park, 2017) assesses perceived coherence via five items (e.g., “I can make sense of the things that happen in my life”) rated on a 7-point scale (1 = *very strongly disagree*, 7 = *very strongly agree*).

2.3.4. Pro-Environmental Behavior

Two sets of items were used to assess pro-environmental engagement. Participants were first instructed to: “Please indicate how characteristic each of the following items is of you in general.” They were then asked two general pro-environmental behavior items used in prior diary studies (Oosterhoff et al., 2021; Wray-lake et al., 2019) that were adapted for trait use: “I work to protect the environment” and “I act in ways that are environmentally responsible.” Responses were recorded on a 7-point scale (1 = *very uncharacteristic of me*, 7 = *very characteristic of me*). Next, participants were prompted to “Please indicate how characteristic each of the following items is of you in general in response to the following statement: I make choices that are good for the environment when...”. Participants were then asked five items that aimed to assess five specific domains: “Making commuting decisions,” “Making food and drink consumption decisions,” “Making bathing decisions,”

“Using things that require electricity,” and “Disposing of things.” These items were adapted from prior work (Larson et al., 2015; Schmitt et al., 2019) and were rated on the same scale as the general items. We reasoned that they could capture both active behaviors (e.g., recycling), as well as choosing to avoid an environmentally deleterious behavior (e.g., not taking an optional car trip). Participants were given example behaviors for each specific item during the online orientation session (see OSF). Each set of items were averaged to create separate scales, but we also conducted analyses using the individual specific items. This decision followed from low internal consistencies for the full scales (trait and state), and all analyses involving these individual items were not preregistered.

2.4. Daily Measures

These measures were administered during the daily diary portion of the study. Daily measures of other constructs that were not the focus of the present study were also collected (see OSF for full measures and order of administration). Only measures that are the focus of the present study are discussed below in the order in which their respective construct was presented in the introduction. For all daily measures, participants were instructed to “answer how you would respond today”.

2.4.1. Eco-Anxiety

Daily states of eco-anxiety were assessed using the same items and response scale as the trait scale.

2.4.2. Positive and Negative Affect

Daily states of positive and negative affect were assessed using the same circumplex model that was used for the trait scales but with three emotions terms for each affective experience instead of five in an effort to reduce participant burden. Positive activated affect was measured with the items delighted, happy, and excited; positive deactivated affect was measured with the items at ease, calm, and peaceful; negative activated affect was measured with the items nervous, tense, and stressed; negative deactivated affect was measured with the items sad, depressed, and gloomy. Participants were asked to indicate how strongly they experienced each emotion term that day on a 7-point scale (1 = *did not feel this way at all*, 7 = *felt this way very strongly*). These items have been used to successfully measure affective states at the daily level (e.g., Newman et al., 2020, 2021).

2.4.3. Coherence

Daily states of coherence were assessed using three items adapted from the comprehension subscale of the MEMS. These items were: “Today, I knew what my life is about,” “Looking at my day as a whole, things seem clear to me,” and “I can make sense of the things that happened in my life today.” Ratings were made on the same 7-point scale as the trait measure. The former two items have been used in a prior diary study (Lutz et al., 2022).

2.4.4. Pro-Environmental Behavior

Daily pro-environmental behavior was assessed using the same general and specific items as the trait scales. Items were rated on a 7-point scale (1 = *very uncharacteristic of me today*, 7 = *very characteristic of me today*). As per the trait scale, analyses were also conducted using the individual specific items. This decision and all analyses involving these individual items were not preregistered.

2.5. Data Cleaning Procedures and Compliance

A total of 1448 daily entries were collected from 135 participants. In our preregistration, we noted that we would first remove daily entries that were duplicates and then those that were completed after 1:00 am; however, there were no such entries. Next, following previous diary

Table 1
Descriptive Statistics and Trait Eco-Anxiety Correlations

Variable	<i>M</i>	<i>SD</i>	α	<i>r</i>	<i>p</i>
Eco-Anxiety	2.13	.82	.91	–	–
Positive Activated Affect	4.45	1.04	.86	.04	.669
Positive Deactivated Affect	4.09	1.04	.83	–.18	.047
Negative Activated Affect	3.92	1.24	.86	.26	.004
Negative Deactivated Affect	3.41	1.42	.91	.22	.012
Coherence	4.43	1.27	.93	–.14	.120
General PEB	4.20	1.29	.84	.32	< .001
Specific PEB Total	4.17	1.03	.64	.34	< .001
Commuting	4.19	1.78	–	.24	.008
Food and Drink Consumption	4.06	1.54	–	.26	.003
Bathing	3.37	1.46	–	.19	.036
Electricity	4.15	1.66	–	.15	.103
Disposal	5.07	1.60	–	.25	.005

Note. PEB = pro-environmental behavior.

studies (e.g., Lutz et al., 2022; Newman et al., 2020) and our preregistration, we excluded data from participants who completed fewer than five daily entries. This left 1439 (99.38%) entries from 132 (97.78%) participants for analysis. Participants completed an average of 11.45 of the possible 14 daily reports ($SD = 2.23$; median = 12, minimum = 5). Overall, compliance was good and consistent with many diary studies (Nezlek, 2012).

3. Results

3.1. Between-Person Trait Relationships

Descriptive statistics and trait eco-anxiety correlations are reported in Table 1. Participants reported fairly low levels of eco-anxiety, with the mean being below the scale midpoint (2.13 on a 1–5 scale). Upon examining our open research questions concerning the trait relationships between eco-anxiety and well-being, correlational analyses demonstrated that eco-anxiety was not significantly associated with positive activated affect but was negatively associated with positive deactivated affect. Eco-anxiety also evidenced positive associations with both negative activated and deactivated affect. No significant association emerged between eco-anxiety and coherence. Consistent with our preregistered hypotheses, eco-anxiety was positively associated with both general and specific pro-environmental behavior total. Additional unregistered analyses revealed that eco-anxiety was associated with all individual specific pro-environmental behavior items except for making choices that are good for the environment when using things that require electricity. Overall, effect sizes were small to moderate in magnitude.

3.2. Daily Measures: Descriptive Statistics, Reliability, and Validity

We considered the daily data to have a hierarchical structure, with days (level 1) nested within persons (level 2). Given this, we analyzed the data with a series of multilevel models using SPSS version 25.0. Prior to conducting our primary analyses of interest, we evaluated the descriptive statistics, reliability, and validity of the daily measures. Estimates of the means and variances were obtained by creating two-level null models in which each variable was entered as the outcome with no predictors, with days nested within persons:

$$\begin{aligned} \text{Day level: } y_{ij} \text{ (daily variable)} &= \beta_{0j} + r_{ij} \\ \text{Person level: } \beta_{0j} &= \gamma_{00} + u_{0j} \end{aligned}$$

These results are presented in Table 2. Of note, consistent with the trait findings, the mean for daily eco-anxiety was also below the scale midpoint (1.58 on the same 5-point scale). In an unregistered analysis, we compared the trait and daily eco-anxiety means by first subtracting each person's daily score from their corresponding trait score and then using this difference score as the outcome variable in a null model (see

Newman et al., 2021). The significance test of the intercept revealed that the trait mean was significantly higher than the daily mean, $b = .56$, $t = 6.82$, $p < .001$. A further unregistered inspection of the data revealed that participants reported feeling not eco-anxious at all on 51.95% of the days. All measures exhibited sufficient within-person variability to examine within-person relationships.

Following the recommendations of Nezlek (2017), day-level reliabilities for multi-item scales were estimated using three-level null models in which items of a given scale are nested within days and days are nested within persons (model provided below). These estimates are the functional equivalent of a Cronbach's alpha taking into account the nested data structure (Nezlek, 2017).

$$\begin{aligned} \text{Item level: } y_{ijk} \text{ (daily scale items)} &= \pi_{0jk} + e_{ijk} \\ \text{Day level: } \pi_{0jk} &= \beta_{00k} + r_{0jk} \\ \text{Person level: } \beta_{00k} &= \gamma_{000} + u_{00k} \end{aligned}$$

These analyses revealed that all measures had reasonably high reliabilities except for specific pro-environmental behavior total, which was lower than we had hoped (.58; see Table 2). Removing items from this scale did not improve its reliability and as such we retained the original measure. Although this reliability is lower than desired, it is important to note that multilevel analyses compensate for this to some extent when the parameter estimates are calculated (e.g., Raudenbush and Bryk, 2002) and that it is similar to the reliabilities of daily measures from past diary studies (e.g., Lutz et al., 2022; Newman et al., 2020).

One approach that can be taken to assess the construct validity of each daily measure is to calculate the correlation between the daily average and the corresponding trait scale (e.g., Nezlek, 2002). The correlation was obtained by specifying a two-level (days within persons) null model, as well as a model that included the corresponding trait measure as a predictor at level 2 (model provided below). Next, we calculated the square root of the percent the between-person variance from the null model was reduced when the trait measure was included as a predictor at level 2.

$$\begin{aligned} \text{Day level: } y_{ij} \text{ (daily measure)} &= \beta_{0j} + r_{ij} \\ \text{Person level: } \beta_{0j} &= \gamma_{00} + \gamma_{10} \text{ (corresponding trait measure)} + u_{0j} \end{aligned}$$

As shown in Table 2, these models indicated that these correlations were reasonably high, with the exception of eco-anxiety.

3.3. Same-Day Within-Person Relationships

Our primary analyses concerned same-day within-person relationships between daily eco-anxiety and the daily outcome measures collected (i.e., positive affect, negative affect, coherence, and pro-environmental behavior). In these two-level models (days within persons), eco-anxiety was group-mean centered (i.e., centered around each individual's mean; Enders and Tofighi, 2007) and entered as the sole

Table 2
Descriptive Statistics, Reliability, and Validity of Daily Measures

Variable	Mean	Variance			Reliability	Validity
		Within	Between	ICC		
Eco-Anxiety	1.58	.30	.43	.58	.88	.25
Positive Activated Affect	3.81	1.29	.83	.39	.71	.63
Positive Deactivated Affect	3.87	1.04	.72	.41	.72	.51
Negative Activated Affect	3.49	1.33	1.00	.43	.69	.58
Negative Deactivated Affect	2.74	1.21	.98	.45	.73	.60
Coherence	4.35	.86	.86	.50	.81	.64
General PEB	3.53	1.37	1.62	.54	.67	.59
Specific PEB Total	4.22	.91	1.56	.63	.58	.67
Commuting	4.11	2.62	2.32	.47	-	.52
Food and Drink Consumption	4.10	1.94	1.82	.48	-	.49
Bathing	4.17	2.01	1.97	.50	-	.41
Electricity	4.17	1.77	1.68	.49	-	.55
Disposal	4.58	1.73	1.97	.53	-	.49

Note. ICC = intraclass correlation coefficient; proportion of between-person variance divided by total variance; ICCs calculated using unrounded variances. Day-level reliabilities for multi-item measures were calculated using a procedure outlined by Nezelek (2017). Validity refers to the correlation between the daily average and corresponding trait scale (e.g., Nezelek, 2002). PEB = pro environmental behavior.

Table 3
Same-Day Within-Person Relationships Between Eco-Anxiety and Well-Being and Pro-Environmental Behavior

Outcome	<i>b</i>	<i>t</i>	<i>p</i>	$r_w^{(f1v)}$
Positive Activated Affect	.06	.78	.437	.14
Positive Deactivated Affect	.04	.55	.587	.17
Negative Activated Affect	.15	2.02	.048	.16
Negative Deactivated Affect	.16	2.14	.036	.20
Coherence	.11	1.57	.120	.23
General PEB	.22	2.35	.021	.29
Specific PEB Total	.19	2.89	.005	.23
Commuting	.18	1.67	.101	.16
Food and Drink Consumption	.26	2.66	.010	.23
Bathing	.25	3.06	.004	.16
Electricity	.25	2.82	.006	.20
Disposal	.08	.85	.397	.20

Note. *b* = unstandardized coefficient; $r_w^{(f1v)}$ = the square root of the proportion of within-cluster outcome variance explained by level-1 predictors via fixed slopes and random slope variation/covariation. This is comparable to a measure of the square root of the proportion reduction in variance, which is akin to a correlation (Raudenbush and Bryk, 2002). Given that these estimates combine the variance associated with both fixed and random effects, they may not intuitively correspond with *p*-values. PEB = pro-environmental behavior.

predictor of each outcome. Intercepts and slopes were permitted to vary randomly across participants. In the preregistration, we noted that, following guidelines offered by Nezelek (2017), we would trim error terms with *p*-values greater than .15. However, we did not need to do so for these models, as the *p*-values were below this threshold. We calculated $r_w^{(f1v)}$ as an index of effect size based on the recommendations of Rights and Sterba (2019). This statistic is defined as the square root of the proportion of within-cluster outcome variance explained by level-1 predictors via fixed slopes and random slope variation/covariation. This is comparable to a measure of the square root of the proportion reduction in variance, which is akin to a correlation (Raudenbush and Bryk, 2002). Given that these estimates combine the variance associated with both fixed and random effects, they may not intuitively correspond with *p*-values. These estimates were obtained using R code from Rights and Sterba (2019). The models were as follows:

$$\text{Day level: } y_{ij} \text{ (positive affect, negative affect, coherence, or pro-environmental behavior)} = \beta_{0j} + \beta_{1j} \text{ (eco-anxiety)} + r_{ij}$$

$$\text{Person level: } \beta_{0j} = \gamma_{00} + u_{0j}$$

$$\beta_{1j} = \gamma_{10} + u_{1j}$$

The results of these models provided mixed support for our preregistered hypotheses (see Table 3). More specifically, contrary to expectations, eco-anxiety on a given day did not significantly predict positive activated affect, positive deactivated affect, or coherence. However, as anticipated, eco-anxiety on a given day did predict greater negative activated and deactivated affect, as well as greater general and

specific pro-environmental behavior total. Further unregistered analyses revealed that eco-anxiety significantly predicted all individual specific pro-environmental behavior items except for making choices that are good for the environment when making commuting decisions, as well as disposing of things. Effect sizes were small to moderate in magnitude overall.

3.4. Exploratory Lagged Within-Person Relationships

We sought to move beyond same-day covariation by exploring the direction of eco-anxiety’s relationships with well-being and pro-environmental behavior using lagged within-person analyses. We first ran a set of two-level models (days within persons) in which positive affect, negative affect, coherence, or pro-environmental behavior on day *n* was predicted by eco-anxiety on the previous day (*n* - 1) while accounting for positive affect, negative affect, coherence, or pro-environmental behavior on the previous day (*n* - 1). We then ran a set of reverse sequence models in which eco-anxiety on day *n* was predicted by positive affect, negative affect, coherence, or pro-environmental behavior on the previous day (*n* - 1) while accounting for eco-anxiety on the previous day (*n* - 1). As per the preregistration, all predictors were group mean-centered, intercepts and slopes were allowed to vary randomly, and error terms with *p*-values greater than 0.15 were trimmed from the models. Also as preregistered, given that we were only interested in the effect size of the focal predictor of a given model and that the R code from Rights and Sterba (2019) only calculates the entire effect size for all

Table 4
Lagged Within-Person Relationships Between Eco-Anxiety and Well-Being and Pro-Environmental Behavior

	Lag From Eco-Anxiety			Lag to Eco-Anxiety		
	<i>b</i>	<i>t</i>	<i>p</i>	<i>b</i>	<i>t</i>	<i>p</i>
Positive Activated Affect	-.03	-.48	.633	.02	1.43	.154
Positive Deactivated Affect	-.03	-.46	.648	.02	1.10	.273
Negative Activated Affect	.14	2.23	.026	-.02	-1.03	.304
Negative Deactivated Affect	.11	1.89	.059	-.03	-1.87	.065
Coherence	-.00	-.06	.952	.00	.16	.871
General PEB	.09	1.38	.168	.02	.99	.327
Specific PEB Total	-.05	-.98	.327	.02	.65	.520
Commuting	-.04	-.42	.676	-.01	-1.00	.321
Food and Drink Consumption	.02	.23	.816	.01	.81	.422
Bathing	.01	.13	.899	.01	1.04	.301
Electricity	-.00	-.00	.999	.01	.58	.566
Disposal	-.12	-1.58	.115	.03	2.27	.023

Note. PEB = pro-environmental behavior.

predictors in a model, effect sizes estimates were not obtained for lagged models, as they included covariates. The models were as follows:

Lagged model from eco-anxiety:

Day level: y_{ij} (positive affect, negative affect, coherence, or pro-environmental behavior day n) = $\beta_{0j} + \beta_{1j}$ (eco-anxiety day $n - 1$) + β_{2j} (positive affect, negative affect, coherence, or pro-environmental behavior day $n - 1$) + r_{ij}

Person level: $\beta_{0j} = \gamma_{00} + u_{0j}$

$\beta_{1j} = \gamma_{10} + u_{1j}$

$\beta_{2j} = \gamma_{20} + u_{2j}$

Lagged model to eco-anxiety:

Day level: y_{ij} (eco-anxiety day n) = $\beta_{0j} + \beta_{1j}$ (positive affect, negative affect, coherence, or pro-environmental behavior day $n - 1$) + β_{2j} (eco-anxiety day $n - 1$) + r_{ij}

Person level: $\beta_{0j} = \gamma_{00} + u_{0j}$

$\beta_{1j} = \gamma_{10} + u_{1j}$

$\beta_{2j} = \gamma_{20} + u_{2j}$

The results of these lagged analyses are summarized in Table 4. Few significant lagged relationships emerged. Eco-anxiety on a given day significantly predicted increases in next-day negative activated affect, while the reverse path was not significant. There was also evidence of eco-anxiety predicting greater next-day negative deactivated affect and negative deactivated affect predicting lower next-day eco-anxiety, though these relationships were only marginally significant. Lastly, unregistered analyses indicated that making choices that are good for the environment when disposing of things significantly predicted greater next-day eco-anxiety. All other lagged relationships were nonsignificant.

4. Discussion

Research on the growing phenomenon of eco-anxiety has primarily been conducted at the trait or between-person level; however, it is also possible for eco-anxiety to be viewed as a state, one that varies over time within individuals. The cross-sectional methods routinely employed in prior investigations have struggled to adequately examine this dynamic quality of eco-anxiety. The aim of the present study was to bridge this gap by studying eco-anxiety as a fluctuating state in daily life using daily diary methodology. This approach allowed us to examine if eco-anxiety functions differently at trait and state levels.

4.1. Eco-Anxiety at Different Levels of Analysis

The prevalence of eco-anxiety across levels of analysis was fairly low. Indeed, mean scores on both the trait and daily scales were below the scale midpoint, and perhaps more interesting, the trait mean

was significantly higher than the daily mean. Moreover, the diary data revealed that people reported feeling not eco-anxious at all (across multiple items) on just over half of the days. Many views of eco-anxiety converge on the notion that it captures a more pronounced form of distress (e.g., Clayton and Karazsia, 2020; Hogg et al., 2021; Passmore et al., 2022a; Pihkala, 2020b). Reflecting this, four of the five items of the measure of eco-anxiety we used were modeled on a measure of generalized anxiety disorder (Hogg et al., 2021); therefore, these scores are relatively unsurprising in a sample not selected for distress and are consistent with trait-level findings using more severe measures (e.g., Clayton and Karazsia, 2020; Hogg et al., 2021), which seem to be particularly emblematic of the construct. Despite these relatively low scores, eco-anxiety still exhibited both between- and within-person variability.

The higher mean on the trait eco-anxiety measure relative to the corresponding daily measure aligns with prior research demonstrating that single assessment global (trait) reports often overestimate aggregated daily states, especially for negatively-valenced phenomena (Newman et al., 2021; Newman and Stone, 2019). Global reports ask people to reflect on longer periods of time or their lives in general, which is more likely to prompt the recollection of peak experiences and major events. By contrast, a daily report asks people to reflect on their day, which is more likely to capture more ordinary and less extreme occurrences than a global report. These differences between global and daily reports may help to explain the relatively low correlation between the trait eco-anxiety scale and the corresponding aggregated daily states. The trait-states correlation was quite high for measures of other constructs, even for negative affect, so it is possible that the true relationship between trait and state reports of eco-anxiety is rather weak. People may think of different aspects of their lives when making these different evaluations. When people are asked to think about how eco-anxious they generally are, they may bring to mind bigger or more emotionally salient things (e.g., a direct experience with a natural disaster) or beliefs about themselves (e.g., as someone more worried about the environment than peers; Robinson and Clore, 2002). When asked how eco-anxious they were on a given day, they may instead think of less intense things (e.g., witnessing someone fail to recycle) and the recent associated experience. There may be relatively little correspondence between these two judgments. It is also important to note that the variance estimates used to calculate the correlation could have been affected by participants consistently reporting fairly low levels of eco-anxiety in the present study, which could have contributed to the lower correlation as well.

4.2. Eco-Anxiety and Happiness

Broadly mirroring past findings (Lutz et al., 2023), at the trait level, we found eco-anxiety was unassociated with positive activated affect but was negatively associated with positive deactivated affect. Trait

eco-anxiety was also associated with greater trait negative activated and deactivated affect. We are unsure if the trait level relationships between eco-anxiety and positive affect represent robust relationships (i.e., eco-anxiety really is typically associated with lower positive deactivated affect and not positive activated affect) or if these associations could instead be explained by other factors (e.g., sampling variability). Past work in this area has tended to adopt broad measures of affect that distinguish between valence (positive vs. negative) but not arousal (activated vs. deactivated; Lutz et al., 2023). However, emotion terms often included in eco-anxiety measures (i.e., worry, fear) have been positively associated with individual positive activated emotion terms (e.g., interested; Smith and Leiserowitz, 2014), and so too has a measure of eco-anxiety and an emotion cluster consisting of seemingly only positive activated emotion terms (e.g., determined; Verplanken et al., 2020). It may be that these correlations are due to the common feature of high arousal more than the apparent contradiction in pleasantness. Yet, it is important to note that these two studies used affect measures that had environmentally relevant instructions, which may capture something qualitatively different than the measures employed in the current study and by Lutz et al. (2023) that did not. Future research may want to continue to investigate eco-anxiety's associations with affect measures that follow a circumplex model and that vary the presence of an environmental framing.

At the state level, we expected that eco-anxiety would more clearly predict lower positive affect and greater negative affect, as the shorter reflection period of a daily report may help to attenuate the influence of individual differences (e.g., nature connectedness) that could have contributed to mixed associations between eco-anxiety and happiness at the trait level. However, we observed that state eco-anxiety only predicted greater state negative activated and deactivated affect. Taken together, these findings offer some limited support for Passmore et al.'s (2022a) theorizing about broad well-being effects. Accumulating evidence suggests that it may be more likely that eco-anxiety heightens negative affect instead of reducing positive affect, consistent with their theoretical and empirical independence. At the same time, it is possible that eco-anxiety's relationship with negative affect at both levels of analysis could be strongly driven by content overlap between eco-anxiety, negative affect, and ill-being scales (Lutz et al., 2023; McBride et al., 2021; Ojala et al., 2021). Nonetheless, this association may still be internally valid (i.e., if one is eco-anxious, they are anxious; McBride et al., 2021).

4.3. Eco-Anxiety and Meaning in Life

Generally in line with past empirical work (Anttila et al., 2000; Lutz et al., 2023; Searle and Gow, 2010), we observed that trait eco-anxiety was unrelated to trait coherence. When considering this relationship at the within-person level, we hypothesized that it would be more clearly negative. This assumption was based on work that views meaning/coherence as a feeling state that accompanies the presence of pattern, lawfulness, and reliable connections (Heintzelman and King, 2013, 2014). If eco-anxiety signals disruptions to order and regularity, it may be more clearly related to lower coherence when these constructs are studied as more immediate daily states than chronic dispositions. Contrary to this expectation, daily states of eco-anxiety did not predict daily states of coherence. There could be multiple explanations for this finding. For example, it may be that, at both levels of analysis, eco-anxiety is simply not typically strong enough to make one feel as though their life and experiences are fragmented and unclear given the importance of other life domains. Another possibility is that eco-anxiety does undermine perceptions of coherence, but it may only do so on a momentary basis. Researchers could employ ecological momentary assessment methods that prompt participants to report on their current state multiple times throughout the day to examine if people feel lower coherence at *moments* when they feel eco-anxious. Researchers could also exam-

ine if eco-anxiety has an immediate effect on coherence in experimental settings.

4.4. Eco-Anxiety and Pro-Environmental Behavior

Providing some additional support for eco-anxiety's motivating potential (e.g., Pihkala, 2020a), we found that it tended to be positively associated with general and specific measures of pro-environmental behavior at both levels of analysis. The exceptions stemmed from the analysis of the five specific pro-environmental behavior items, which indicated that eco-anxiety was not significantly associated with electricity behavior at the trait level, as well as commuting and disposal behavior at the state level. Although these analyses provide some more nuanced information, they were not preregistered and possible explanations for the observed associations could be speculated about ad nauseum. It seems more appropriate to instead focus on the broader finding that eco-anxiety tended to be associated with most pro-environmental behaviors, rather than concluding that it may only be associated with certain behaviors at different levels of analysis, until more work on this issue is done.

Moving forward with this in mind, it is worth highlighting some important implications of these findings, particularly those derived at the state level. First, past research has suggested that people who score higher on a constellation of individual differences indicative of a pro-environmental orientation may be particularly likely to experience eco-anxiety (e.g., Lutz et al., 2023; Verplanken et al., 2020). It is possible that these various individual differences explain eco-anxiety's association with pro-environmental behavior at the trait level. That is, people who care a lot about the environment might be prone to eco-anxiety and sustainable behaviors, in general, but not necessarily at the same time; the trait correlation may be primarily due to these 'third variables'. While this account is still possible, the present findings argue against this as an explanation of the state level relationship, as the within-person analyses of daily ratings helps rule out trait level third variable explanations of daily covariation. Observing eco-anxiety and pro-environmental behaviors coming together on the same day links these two constructs closer in time. Additionally, the shorter reflection period improves recall of actual experience (rather than people's general beliefs about such things). Although causal direction remains ambiguous with correlational methods, our approach takes a further step in suggesting that naturally occurring states of eco-anxiety may prompt pro-environmental behavior (but further discussion below). Second, although the daily diary approach likely made it difficult to capture more infrequent and perhaps more impactful behaviors, the daily reports likely provided more accurate information about quotidian, lower impact actions than the trait reports (Newman and Stone, 2019). It is possible that our reports also captured regular and substantial choices that avoid environmental damage, though one could question whether or not habitual patterns are sensitive to the daily shifts in eco-anxiety that predicted pro-environmental behavior.

4.5. Lagged Relationships

A secondary aim of the present thesis was to further probe the direction of eco-anxiety's relationships examined herein through the use of lagged within-person analyses. These analyses revealed the presence of few lagged effects from one day to the next. Eco-anxiety on a given day significantly predicted increases in next day's negative activated affect. There were also marginally significant lagged effects between eco-anxiety and negative deactivated affect in both directions. Lastly, taking the environment into consideration when disposing of things on a given day significantly predicted greater next-day eco-anxiety. Overall, these results point most strongly to a temporal relationship in which eco-anxiety leads to greater negative affect. It is difficult to discern whether the lagged relationship between disposal behavior and eco-anxiety represents a true relationship or an idiosyncrasy of the dataset (e.g., a

statistical anomaly given the fairly large number of tests). Given that no other lagged relationships emerged between eco-anxiety and pro-environmental behavior, it seems prudent to conclude that the present data leaves the direction of this relationship ambiguous. There could be multiple explanations for this. For example, experiencing eco-anxiety on a given day may be more likely to prompt pro-environmental behavior that same day instead of the next. Researchers could employ ecological momentary assessment methods to examine eco-anxiety's even shorter-term effects (e.g., same-day lags from one moment to the next). There still remains a dearth of longitudinal and experimental studies examining the antecedents and consequences of eco-anxiety. This is a research priority, in our view.

4.6. Limitations and Future Directions

There are a number of limitations and future directions beyond those already discussed that merit consideration. First, our participants were undergraduate students attending Carleton University, located in southern Ontario, Canada. This may pose a constraint on the generalizability of our findings. For example, the links observed here may differ in areas that are experiencing even more pronounced direct impacts of environmental issues. It will be important for future research to draw on different samples (e.g., from different parts of Canada, non-western countries; Coffey et al., 2021) when studying eco-anxiety as it occurs in daily life. Replication is especially important given that effect sizes were small to moderate in magnitude and often just below traditional levels of statistical significance. Second, although the lagged analyses allowed us to probe the direction of potential causal relationships, such analyses are still vulnerable to third variable confounds. Experiments will be needed to help rule out such variables. Third, it is important to highlight that the more severe nature of the eco-anxiety measure we used likely had a notable impact on our results. Lutz et al. (2023) provided preliminary evidence that scores on more severe measures of eco-anxiety tended to be lower and sometimes more maladaptive (e.g., associated with poorer mental health) relative to less severe measures. Although more severe measures seem to be typically viewed as more representative of the construct, work on the full continuum of eco-anxiety responses is needed (e.g., Lutz et al., 2023; Pihkala, 2020a). The severity of the eco-anxiety measure should be taken into consideration when conducting future daily life studies (e.g., a less severe measure may be more appropriate for a more frequent reporting schedule).

5. Conclusion

This is the first investigation, to the best of our knowledge, that examines eco-anxiety as it occurs in daily life using an intensive longitudinal design. Adopting a daily diary approach, we found that levels of eco-anxiety tended to be fairly low when measured as a trait, and even lower when measured as a state, though it still nonetheless exhibited both between- and within-person variability. Overall, eco-anxiety tended to exhibit similar maladaptive (i.e., associated with greater negative affect) and adaptive (i.e., associated with greater pro-environmental behavior) qualities at both these levels of analysis. Finding these associations at the daily level links constructs closer in time such that a direct route from eco-anxiety to pro-environmental behavior seems more plausible than previous trait-level data. Lagged analyses provided some evidence that eco-anxiety leads to greater future negative affect. Together, these findings provide evidence that eco-anxiety can be productively approached as both a trait and a state.

Author contributions

PKL and JMZ designed the study. PKL collected, cleaned, and analyzed the data and received guidance from DBN. PKL wrote the first draft of the manuscript. JMZ and DBN provided edits.

Ethics and informed consent statement

The present research was approved by Carleton University's research ethics board under the ID #116323. All participants provided informed Consent.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Materials, data, and syntax can be found on OSF: <https://osf.io/xjek6/>.

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