Caring for the Environment and Others: Investigating the Reciprocal Influence of Pro-Environmental and Prosocial Behaviors in Italian Young Adults through a Daily Diary Study

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Abstract

Introduction: Existing studies highlight a positive correlation between pro-environmental (PEB) and pro-social behavior (PB) at the between-person level, yet overlook their reciprocal relations. This study took a within-person perspective to explore their day-to-day relations and the moderating role of self-transcendence values in strengthening such associations.

Method: We employed a daily diary design and recruited 60 Italian young adults (Mean Age = 25.8; SD = 3.6; Women = 58%) who reported their behavior once a day over 21 days.

Results: Using Dynamic Structural Equation Modeling, we found no significant day-to-day spillover effect of PB and PEB. However, we identified significant same-day positive associations, namely, on days when individuals engaged in PB, they also showed higher than usual levels of PEB. Additionally, we found positive carryover effects in both PB and PEB, suggesting that young adults are likely to persist in their daily prosocial and pro-environmental efforts. No significant cross-level interaction between self-transcendence values and the spillover effect from PB to PEB was found.

Conclusion: The findings provide new insights into young adults' daily engagement in prosocial and pro-environmental behaviors, highlighting the role of day-to-day within-person changes, while accounting for stable, between-person differences in behavioral and motivational tendencies.

Keywords: Pro-environmental behavior, Prosocial behavior; Young adults; Experience Sampling Methods; Spillover; Dynamic Structural Equation Modeling.

1. Introduction

Global environmental problems, such as climate change, pollution, and biodiversity loss, represent existential threats to humanity, ecosystems, and non-human species (IPBES, 2019; IPCC, 2023). Addressing these problems requires extensive actions and changes across all aspects of society, including individual behavior (Creutzig et al., 2022; Nielsen et al., 2021; Nielsen et al., 2024). By adopting pro-environmental behaviors (PEBs), defined as actions that benefit the environment or reduce harm to it (Kollmuss & Agyeman, 2002; Steg & Vlek, 2009), people can contribute to minimizing their environmental impacts and thereby help address pressing environmental problems. Adopting PEBs can also support the collective good by promoting human, animal, and environmental well-being (Klein et al., 2022). Although PEBs sometimes come with immediate personal costs (De Groot & Steg, 2009), people may prioritize the well-being of other people, species, or ecosystems over immediate personal gains because they assign personal and moral value to it (Nielsen & Hofmann, 2021; Steg, 2016). In this context, PEBs conceptually overlap with prosocial behaviors (PB) (Nolan & Schultz, 2013), which are actions undertaken with the intent to benefit other people (Eisenberg, 2006).

1.1 The relation between PEB and PB

Various authors have emphasized the similarities between PEB and PB (Barszcz et al., 2023; Neaman et al., 2018; Nolan & Schultz, 2013; Otto et al., 2021; Zelenski & Desrochers, 2021). PB includes diverse actions, such as helping someone complete a task by offering practical aid, sharing tangible resources when they lack access, and comforting someone experiencing emotional distress (Dunfield, 2014). Other forms of PB involve cooperating, donating, and volunteering (Batson, 1998; Caprara & Steca, 2007; De Groot & Steg, 2009). The ability and motivation to engage in prosocial acts is an essential, universal, and relatively unique characteristic of human social life (Silk and House, 2011; Tomasello, 2009), with important implications for well-being across individual and societal levels (Dunfield, 2014). Prosocial acts can extend to non-human beneficiaries, such as nature or animals (Nolan & Schultz, 2013). By engaging in PEBs like limiting

energy use, eating plant-rich diets, and recycling, people cooperate to preserve shared resources (Klein et al., 2022), ultimately contributing to the common good (Berger & Andaur, 2022). The concept of the common good here includes human well-being and the interconnected welfare of people and the natural environment (Crimston et al., 2016; 2018).

PEB and PB can be challenging since they often involve immediate personal costs (De Groot & Steg, 2009; Hui, 2022). Nevertheless, people may be motivated to engage in these behaviors because of the moral meaning they attribute to them (e.g., Sachdeva et al., 2015). Specifically, PB often requires people to invest personal resources to address another person's material and emotional needs (Dunfield, 2014). Similarly, PEBs often demand changes to established habits or actions that may be inconvenient or costly, with benefits that are typically intangible, long-term, or indirect for the individual (De Groot & Steg, 2009; Klein et al., 2022; Barszcz et al., 2023). However, people may prioritize the well-being of others, species, or ecosystems over immediate personal gains (Nielsen & Hofmann, 2021; Steg, 2016), especially when PEBs are perceived as morally and societally meaningful acts.

From a socio-cognitive perspective (Bandura et al., 2001), people develop moral standards through socialization processes that shape their understanding of right and wrong. These moral standards can guide behavior by encouraging morally aligned actions and discouraging those that are not (Bandura et al., 1996). Although PEB and PB might involve some self-sacrifice, they can also be self-rewarding (Hui, 2022; Steg, 2016). For example, PB can enhance self-acceptance and positive mood, improve life satisfaction, and promote community integration (Caprara & Steca, 2007). For example, a recent study found that daily acts of helping, sharing, and comforting others were linked to increased positive affect, life satisfaction, and self-realization (Gregori et al., 2024). Similarly, engaging in PEB can be perceived as doing something meaningful, which, in turn, may induce positive emotions and promote subjective and psychological well-being (e.g., Krumm, 2024; Zawadski et al., 2020).

Although PEBs differ in the personal and contextual factors that predict their engagement (Nielsen et al., 2024), studies have documented common predictors that highlight their moral nature. For instance, self-transcendence values, representing trans-situational goals prioritizing the well-being of human beings and nature (Schwartz, 1992), often positively predict both the engagement of PEBs and PBs (Caprara & Steca, 2007; Steg, 2016). Similarly, extensive research shows that people who strongly endorse altruistic and biospheric values, which overlap conceptually with self-transcendence values, are typically more likely to engage in PEBs (Bouman et al., 2020; Steg et al., 2014). Values can also indirectly influence behavior through social norms. People are generally more inclined to engage in PEBs and PBs when they believe such behaviors are approved and supported by their social groups (Cialdini, 2003; Steg, 2016). Moreover, self-transcendent and moral emotions, such as compassion, awe, and gratitude, as well as guilt arising from causing harm to other people and nature, are linked to PEBs and PBs (Rees et al., 2015; Van Kleef & Lelieveld, 2022; Zelenski & Desrochers, 2021).

1.2. PEB and PB among young adults

Young adults represent an interesting population segment for both PEB and PB research because their current behavior, values, and attitudes can significantly shape their future engagement in social and environmental sustainability practices (e.g., Bartolo et al., 2023; Eisenberg et al., 2014; Gomez-Baya et al., 2020). This life period is critical for developing PEBs, as young adults demonstrate growing commitment to and concern for environmental issues (Carrero et al., 2020), with pro-environmental habits being formed or consolidated (Ojala & Anniko, 2020; Pereira & Freire, 2021). In this context, they play a pivotal role in shifting to and developing sustainable lifestyles (Gomez-Baya et al., 2020). At the same time, they may be particularly vulnerable to the adverse physical and psychological effects of environmental issues (Pereira & Freire, 2021). From the perspective of Positive Youth Development (PYD), the transition to adulthood is also a time of increased resources that enable young people to foster their well-being while positively contributing to shaping their communities and the broader social context (Lerner et al., 2015; Ojala

& Anniko, 2020). According to the Five Cs Model (Lerner et al., 2015), caring, which involves experiencing empathy and concern for others, is a fundamental psychosocial capacity that supports healthy youth development. Caring has been extensively studied in relation to PB (e.g., Pastorelli et al., 2021), with which PEBs present several commonalities (e.g., Berger & Andaur, 2022; Nolan & Schultz, 2013). As helping, sharing, and comforting reflect caring for others, PEBs can similarly underscore care for the collective good, including human and non-human beings (Berger & Andaur, 2022). In this context, PEBs can also be understood as a form of youth civic engagement, which involves contributing to the community and society (Krettenauer, 2017; Wray-Lake et al., 2017).

Young adults can benefit from engaging in PB to navigate developmental challenges related to their life stage, such as forming relationships, gaining autonomy, and developing identity (Arnett, 2000). These behaviors can foster positive social interactions and enhance academic and work achievement, promoting positive mood and overall well-being (Caprara et al., 2015; Caprara & Steca, 2007; Kakulte & Shaikh, 2023). Likewise, PEBs, which encompass a broader sense of care toward the community, society, and the environment (Berger & Andaur, 2022), allow youth to actively contribute to addressing environmental issues (Sawitri et al., 2015) while also potentially alleviating negative emotions and concerns related to environmental challenges (Ojala, 2022; Gomez-Baya et al., 2020). Ultimately, these behaviors can contribute to the fulfillment of basic human needs of agency (i.e., people's efforts to realize their potential and actively shape the social and physical context) and communion (i.e., people's desire to cultivate a sense of belonging and establish positive social connections; Bakan, 1966). Thus, understanding the interconnection between PEB and PB is especially important, as both are linked to individual and societal well-being (e.g., Berger & Andaur, 2022).

Although the existing evidence offers promising findings, studies examining the relationship between PEB and PB in young adults remain limited (Berger & Andaur, 2022). For instance, Neaman et al. (2018) identified a moderate positive correlation between PEB and PB in a sample of Chilean young adults, which is consistent with Otto et al.' s (2021) findings on the relationship

between altruism (i.e., PB) and PEB. Similarly, Berger and Andaur (2022) reported that PB (i.e., helping, sharing, comforting) and PEB (e.g., recycling, saving energy, raising environmental awareness) were positively associated among Chilean adolescents.

The positive association between PEB and PB has also been observed in other cultural contexts. Neaman et al. (2022) found a positive correlation between PB and a range of PEBs, such as recycling, saving energy, and participating in environmental organizations, in two samples of young adults and adults from Russia and Spain. Tapia-Fonllem et al. (2013) also identified positive correlations between pro-environmental, frugal, altruistic, and equitable behaviors. Conversely, a study in a sample of Mexican students found that tolerance for antisocial behaviors (e.g., hitting, stealing, cheating) was linked to increased waste of water (Corral-Verdugo et al., 2003). Moreover, a multi-year survey by Waring et al. (2016) of a representative sample of University of Maine students in the United States revealed that prosociality, influenced by perceived social support, predicted increased PEBs and pro-environmental intentions. Relatedly, Uitto et al. (2015) found in a large sample of Finnish adolescents that in-school prosocial experiences, such as schoolyard or neighborhood cleanups and aid campaigns, indirectly promoted students' engagement in PEB by strengthening values, norms, and self-efficacy. Interestingly, ecological experiences, like participating in school recycling events and energy-saving campaigns, had a lesser impact on promoting PEB and pro-environmental intentions than prosocial experiences, highlighting the potential role of PB in motivating PEBs.

1.3. Methodological limitations in existing research

Most research on the association between PEB and PB has taken a cross-sectional approach, thereby regarding these behaviors as stable characteristics and focusing on between-person differences. Cross-sectional research can provide valuable insights into the association between PEBs and PBs, such as testing whether people who engage in PEBs more than others are also more likely to engage in PBs (Kuper et al., 2021) and whether psychological characteristics moderate this

association. However, PEBs and PBs and their associations are likely dynamic processes, especially when frequently performable.

Studying PEBs and PBs at the within-person level can shed light on the intra-individual variation and changes that occur in daily life. For example, it permits investigating whether an increase in PEBs influences the likelihood of engaging in more PBs (Hamaker, 2012; Kuper et al., 2021). Moreover, it may reveal how the potentially reciprocal effects of PEB and PB unfold over time, creating opportunities for causal inferences (Rohrer & Murayama, 2023). Unpacking these dynamic processes requires a different methodological approach. Here, experience sampling methods (Hektner et al., 2007), which involve collecting intensive longitudinal data with high ecological validity and reduced recall bias (Hamaker & Wichers, 2017), are particularly well-suited (e.g., Hamaker et al., 2018). Experience sampling methods like daily diaries (Bolger et al., 2003) can provide deeper insights into how behavioral processes evolve within individuals over hours, days, and weeks. Furthermore, the analytical techniques used with these data (Hamaker et al., 2018) allow for explanatory inferences by disentangling the between-person and within-person components of variability, capturing both interpersonal and intrapersonal differences (Rohrer & Murayama, 2023). Despite their potential to unpack novel insights into PEBs and their link to PBs, experience sampling methods remain rare in environmental psychology (Diel & Friese, 2024; Nielsen & Hofmann, 2021).

1.4. Present study

The present study aims to extend research on the association between PEB and PB in two ways. Firstly, by exploring the reciprocal relationships between these behaviors in everyday life, the study can contribute to the behavioral spillover literature, which examines how changes in one behavior influence distinct or subsequent behavior (Galizzi & Whitmarsh, 2019). Most research on spillover has focused on behaviors within the same domain, whether pro-environmental or prosocial (Galizzi & Whitmarsh, 2019; Geiger et al., 2021; Kumar et al., 2023). Studying PEBs and PBs simultaneously can offer new insights into how these interact on a daily basis. This approach can

contribute to the spillover promotion literature on PEBs (Behn et al., 2025) by taking a cross-domain approach to examine whether and how prosocial acts can sustain an individual's pro-environmental behavior and vice versa. Additionally, this study contributes to the temporal spillover literature (Nilsson et al., 2017) by investigating the persistence of these behaviors, or carryovers, over short time frames. Secondly, by analyzing spillover and carryover effects in the short term and distinguishing between state-like and trait-like levels, we can better understand how young adults engage in these behaviors in their daily lives (within-person level) while controlling for individual (between-person) differences (Kuper et al., 2024).

Specifically, in this study, we explored the dynamic, reciprocal association between PEB and PB through a daily diary study conducted in Italy. Our investigation focused on Italian young adults who reported daily on their behavior over 21 days. We considered PEBs that young adults are likely to engage in daily life, such as recycling, saving energy and water, limiting plastic consumption, and motivating others to adopt PEBs. The first three are private-sphere behaviors (Stern, 2000), through which people can directly benefit the environment (Neaman et al., 2022; Steg et al., 2014). Individuals can also have an indirect impact by exercising personal influence in the social context, including by raising awareness about environmental issues (Neaman et al., 2022) or encouraging others to perform PEBs (Hanss & Böhm, 2010).

To analyze the data, we used Dynamic Structural Equation Modeling (DSEM; Hamaker et al., 2018) to control for stable differences between people in behaving prosocially and pro-environmentally (trait-like) and explore day-to-day fluctuations in PBs (state-like) and PEBs within a short time frame. We thereby explored whether daily fluctuations in PB predicted daily increases (i.e., peaks) in PEB. Building on existing between-person evidence (e.g., Uitto et al., 2015), we hypothesized a positive spillover effect, namely that behaving more prosocially than usual would lead to higher than usual levels of PEB on consecutive days. We also explored the reverse spillover effect: whether positive fluctuations in PEB on a given day would result in positive fluctuations in PB. Finally, we examined whether day-to-day positive fluctuations in one behavior (PEB/PB)

would lead to positive fluctuations in the same behavior (PEB/PB), i.e., the carryover effects, expecting them to be positive and significant (Gregori et al., 2024; Van Der Werff & Steg, 2018).

Considering the positive relationships between self-transcendence values and PEB and PB (e.g., Bouman et al., 2020; Caprara & Steca, 2007), as a secondary aim, we explored their role as a between-person variable in influencing the intensity of the spillover and carryover effects. While not having specific a priori hypotheses, we did not exclude the possibility that people with higher self-transcendence values could experience stronger spillover effects. Namely, self-transcendence values could strengthen the reciprocal influence between the prosocial and environmental domains of moral functioning, as they both reflect an individual's tendency to prioritize the well-being of others and the natural world (Schwartz, 1992, 2010; Steg, 2016). Considering the carryovers, we hypothesized that individuals with higher levels of self-transcendence values would be more likely to persist in their daily prosocial and pro-environmental efforts, perceiving these actions as consistent with their core principles of caring for the collective (Bandura, 2001). No hypotheses were preregistered for this study.

2. Method

2.1. Sample and procedure

The sample consisted of 60 Italian young adults drawn from a larger intensive longitudinal study designed to explore the influence of prosocial behavior, emotional regulation, and pro-environmental behavior on well-being in young people's everyday lives. The study received ethical approval from the relevant institutional review board (identity withheld for blind peer review). The average age of participants was 25.8 years (SD = 3.6, range = 19-35), with 58% identifying as female. Data collection took place in May 2023. Following the recommendations of Maas and Hox (2005) for analyzing nested data, the goal was to recruit over 50 participants. Before the study began, research assistants instructed participants to download the experience sampling app (i.e., Metricwire) to their iOS or Android smartphones. After receiving informed consent, participants were asked to report their socio-demographic information and baseline self-transcendence values by

answering an online survey. One week later, over a period of 21 days, participants received online daily diaries via their smartphones. They received the dairies once a day at 24-hour intervals between 8:00 pm and 12:00 am, with a reminder notification for missed surveys. Each day, participants rated their performance of PEBs, such as energy and water consumption, and PBs, including helping, comforting, and sharing. As a token of appreciation, participants were informed they would receive a €25 bookshop gift card if they completed 80% or more of the daily diary protocols or a €15 voucher if they completed at least 50%. Of the total 1,260 possible observations (60 participants x 21 days), 1200 were at least partially completed across the 21 days, corresponding to a compliance rate of 95.2% (1192/1260). The retention rate was high, with 68.3% (n = 41) of the participants providing data for at least 17 days. In detail, 5% (n = 3) of participants provided data for seven or fewer days, 15.3% (n = 8) answered between eight and 14 daily diaries and 81.7% (n = 49) answered between 15 and 21 daily diaries.

2.2. Measures

Pro-environmental behavior (Daily diary; within-person level). Participants reported their daily PEB using four items that assessed recycling, plastic consumption, energy conservation, and encouraging others to engage in PEBs. Adapted from Menardo, Brondino, and Pasini (2020) and Kaiser and Wilson (2004), the three items included: "Today I recycled," "Today I limited my plastic consumption (for example, water bottles, products with excessive packaging, etc)", "Today I conserved water and electricity," and "Today I motivated others to care more about the environment." Responses were answered on a five-point Likert scale, ranging from 1 = "Not at all" to 5 = "Very Much." The average score of the three items was used for analysis. Reliability was assessed using multilevel McDonald's ω (Geldhof et al., 2014) for momentary measures nested within participants. The internal consistency estimates for the four items were ω = .57 on the within-person level and ω = .85 on the between-person level, respectively. The low reliability of the within-person measure might stem from the heterogeneous nature of the PEB construct (e.g., (Lange, 2024), suggesting it may be better conceptualized as a formative construct, defined as a

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composite of its specific component variables (Edwards & Bagozzi, 2000). In formative measurement models, high internal consistency is not required, as the measures are not necessarily correlated, nor is their correlation necessarily attributable to a common cause (Brose et al., 2020).

Prosocial behavior (Daily diary; within-person level). Participants answered three items assessing the three core forms of prosocial behavior (Dunfield, 2014), each addressing a different need: emotional, instrumental, and material. Participants rated each of the following statements on a five-point Likert scale, ranging from "Not at all true" (1) to "Always true" (5): "I comforted others," "I tangibly helped others," and "I shared what I had with other people." The average score of the three items was used for analysis. Omega reliability coefficients were .66 at the within-person and .90 at the between-person levels (Geldhof et al., 2014).

Self-transcendent values (S-TRV; Baseline, Between-person level). Self-transcendence values were assessed as a baseline measure using five items of the Portrait Values Questionnaire (PVQ-21; Capanna et al., 2005; Schwartz, 2003), which evaluates values based on brief descriptions of a person's goals, aspirations, or desires derived from Schwartz's theory of values. Participants answered on a seven-point Likert scale ranging from "Very much like me" (1) to "Not like me at all" (7). An average score of the self-transcendence items was calculated for analysis. The Cronbach reliability coefficient was .61.

2.3. Data analytic approach

To analyze the data, we used Dynamic structural equation modeling (DSEM; Hamaker et al., 2018), which is a novel statistical approach to analyzing intensive longitudinal data. It encompasses multilevel structural equation modeling, as the data have a nested structure with repeated measures from multiple individuals, and time series modeling to estimate time-lagged relationships between variables (Hamaker et al., 2018). DSEM allows for a decomposition of the data into a within-person and a between-person part, which are modeled separately. The between-person component reflects the trait-like average levels of observed variables (e.g., average mean levels of PEB over the 21 days) that inform interpersonal differences. On the other hand, the within-person component

captures the dynamic fluctuations of observed variables around their stable mean levels (e.g.,

positive or negative peaks or deviations in PEB levels on a given day). We estimated a two-level

DSEM model to account for the nesting of daily dairy surveys within individuals[1]. All within-

person parameters were treated as random effects, allowing them to vary across individuals

(Hamaker et al., 2018). At the between-person level, these random effects were allowed to correlate

freely. To account for momentary intraindividual changes in the variables, we modeled two lagged

effects at the within-person level: the carryover effect and the spillover effect. The carryover effect

is an autoregressive term that reflects the extent to which a variable at time t is predicted by the

same variable at time t-1, namely whether deviations from one's mean level (i.e., peaks) can be

predicted from deviations in the same variable at the preceding time interval. This accounts for

behavioral stability or persistence over time. The spillover effect is a cross-lagged parameter that

reflects predictive and potentially causal relationships between two different variables, namely the

extent to which a variable at time t is predicted by another at time t-1 or, in other words, whether

peaks in a variable are predicted by peaks in another variable at the preceding time point (Hamaker

et al., 2018).

We ran two models to examine the reciprocal relationship between PEB and PB and the

moderating role of S-TRV. In a first model (Model 1), PEB and PB were allowed to mutually

influence each other. Notably, PB exhibited a pronounced floor effect, with a significant percentage

of values at the lowest level. We employed two-part modeling to avoid potential biases in the

estimates due to this effect, as suggested by Muthén et al. (2024). In this approach, PB

(PB_MEAN) was split into two variables analyzed simultaneously: PB_BIN (0 and 1), indicating

the presence or absence of such behavior, and PB_POS (greater than 0), capturing the positive

values of the variable. As outlined in Figure 1, at the within-person level (Level 1), we estimated

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[1] The graphical representation of the DSEM model can be found in the supplementary materials
(Figure 2), available at the following link:
https://osf.io/57fkx/?view_only=9ebc7fec152f427394b10f3a7c0f2e8e.

four spillover effects from PEB to PB and vice versa, considering both the dichotomous and positive components of PB. Namely, we modeled two lagged effects from PEB at t-1 ($PEB_{i,t-1}$) to PB_BIN at time t ($PB\_BIN_{i,t}$) and from $PB\_BIN_{i,t}$ to $PEB_{i,t-1}$. We assessed whether a person i's peaks in PEB at time t (PEB_{it}) were predicted by peaks in PB_BIN at time t-1 ($PB\_BIN_{i,t-1}$) and whether individual i's deviations in $PB\_BIN_{i,t}$ were predicted by deviations in $PEB_{i,t-1}$. Similarly, we estimated two reciprocal spillover effects of PEB and PB_POS. We also estimated carryover effects for PEB and both components of PB to examine whether momentary changes in one variable were predicted by changes in the same variable on consecutive days. Moreover, we modeled the time-specific within-person correlations between PEB and both components of PB and between PB_BIN and PB_POS to account for their concurrent, occasion-specific associations. At the between-person level (Level 2), carryover and spillover effects were modeled as random effects, accounting for the variability in their strength across participants.

Figure 1. *Graphical representation of the within-person component of a dynamic structural equation model for pro-environmental behavior (PEB) and prosocial behavior (PB) with floor effects.*
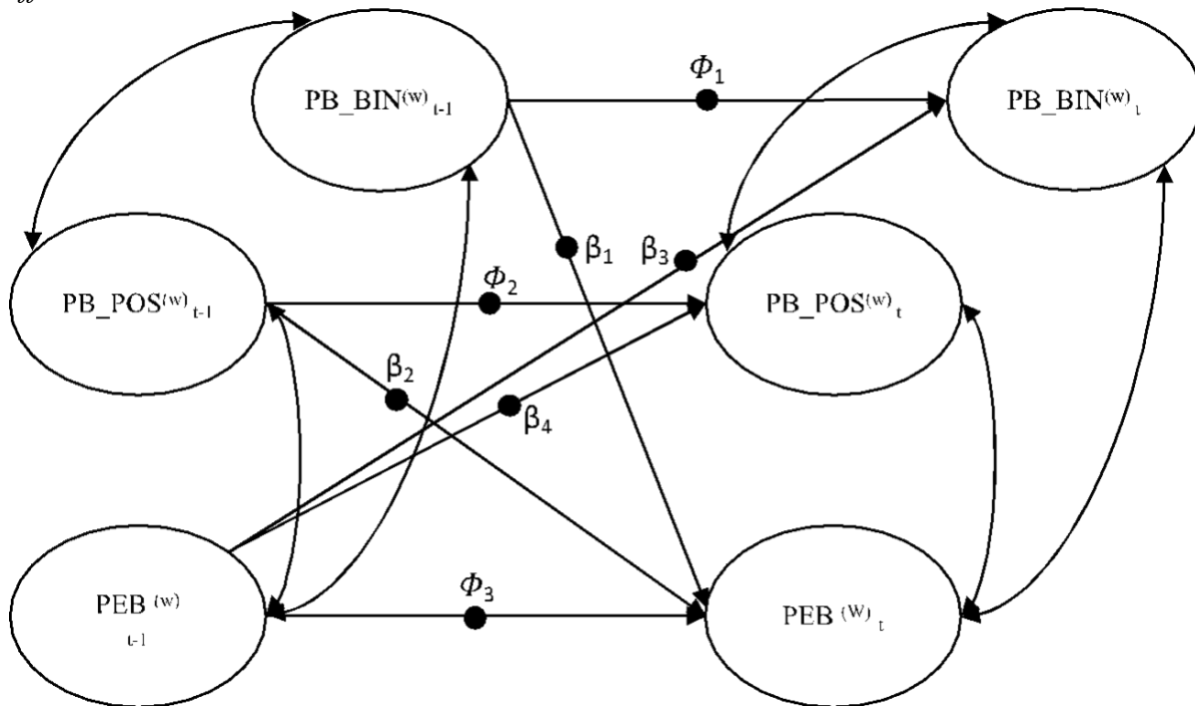
Note. PB_BIN = Prosocial behavior dichotomous (presence/absence); PB_POS= positive values of prosocial behavior. PEB = pro-environmental behavior; Φ_1= carryover effect of PB_BIN; Φ_2= carryover effect of PB_POS; Φ_3= carryover effect of PEB; β_1 = spillover effect from PB_BIN to

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PEB; β_2 = spillover effect from PB_POS to PEB; β_3 = spillover effect from PEB TO PB_BIN; β_4 = spillover effect from PEB TO PB_POS.

In a second model (Model 2), we explored the role of S-TRV as a between-person predictor by testing its cross-level interactions with the carryover and spillover effects of PEB and PB (i.e., the two components) and its effect on the variables' random intercepts.

We adopted a Bayesian estimation of the parameters to account for the large number of random effects (Hamaker et al., 2018). We used the default Mplus settings for model priors and estimated the model with two Markov Chain Monte Carlo (MCMC) chains, applying a thinning factor of 10 to minimize autocorrelations in the posterior draws. To account for the unequal spacing of measurement occurrences (e.g., missing data on specific days), we created the variable DAY (21 days for each person) and estimated lagged effects for a 1-day time interval using the TINTERVAL option in Mplus (McNeish & Hamaker, 2020). The analyses were repeated across 1,000, 3,000, and 5,000 iterations to identify effects that consistently maintained statistical significance. In the results section, we report only the statistically significant effects that remained stable across the 5,000 iterations and were also stable in the models with 1,000 and 3,000 iterations. We used 95% credible intervals (95% CI; McNeish & MacKinnon, 2022) to assess statistical significance, considering effects significant if their credible intervals did not include zero. We used a thinning factor of 10 to reduce the autocorrelations of the draws from the posterior distributions. We checked model convergence using Potential Scale Reduction (PSR) values close to 1, as well as trace and autocorrelation plots from the posterior distribution to detect any irregularities (Asparouhov & Muthén, 2023; Hamaker et al., 2018). The analyses were performed using MPlus software, version 8.11 (Muthén & Muthén, 1998–2019).

3. Results

3.1. Descriptive analyses and bivariate associations

Average levels of PEB and PB were obtained by calculating the mean of participants' scores from the 21 daily diaries. Concerning PEB, participants reported moderately high average levels, M

= 2.877, SD = .851. Mean levels of PB were moderately low (M = 2.022, SD =.931), and the variable exhibited a pronounced floor effect, with 48.9% of respondents selecting values at the lower end of the scale. This indicates that in a substantial proportion of time occasions, participants chose the minimum item response option, corresponding to "Not at all true". Additionally, 79.8% of participants responded one of the two lowest options on the response scale. All measures showed considerable variation within and between individuals, with intraclass correlation coefficients (ICCs) of .735 for PEB and .436 for PB. This indicates the proportion of variance attributable to stable individual differences at the between-person level. The remaining variance—27% and 56%, respectively—was due to daily fluctuations within individuals. These day-to-day fluctuations were positively and significantly correlated (r=.150, p <.001), as shown in Table 1. At the between-person level, the correlation between PEB and PB (r=.090, p <.001) was positive and significant. This suggests that the trait-like components of PEB and PB across the study period were positively associated[2]. S-TRV (M = 4.913, SD = .586) was positively correlated with PEB (r=.374, p<.001), while the correlation between S-TRV and PB was non-significant (r=-.035, p=.264).

3.2. Two-part DSEM

For the DSEM analyses (Model 1), we report the unstandardized fixed and random effects with their 95% credible intervals in Table 1. The within-person standardized parameter estimates can be found in Table 2 in the supplementary materials. Model 1 convergence was evaluated using the potential scale reduction (PSR), which was satisfactory, with a maximum PSR of 1.024. Visual inspection of trace plots and autocorrelation plots revealed no irregularities.

3.2.1.   Within-person associations

The credible intervals (CI) for the average fixed spillover effect from the dichotomous component of PB to PEB (i.e., $PB\_BIN_{i,t-1}$ to $PEB_{i,t}$) included the zero, indicating that this effect

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[2] The within- and between-person correlations among the single items of PEB and PB, along with the ICC correlations, are reported in Table 4, available at the following OSF link: https://osf.io/57fkx/?view_only=9ebc7fec152f427394b10f3a7c0f2e8e.

was not statistically significant (B = .055, 95% CI [-.040, .146]). Similarly, the CIs for the fixed

spillover effect from PB_POS (indicating the positive values of PB) to PEB included the zero,

suggesting a not statistically significant effect (B = .039, 95% CI [-.039, .119]). Similarly, the

spillover effects from $PEB_{i,t-1}$ to $PB\_BIN_{i,t}$ (B = -.081, 95% CI [-.347, .193]) and from $PEB_{i,t-1}$ to

$PB\_POS_{i,t}$ (B = .036, 95% CI [-.147, .220]) were not statistically significant. In contrast, positive

within-person covariances between the residual terms of PEB and PB_POS (r =.113; 95% CI: [.013,

.209]) indicate that on the same day, individuals registered peaks in both PEB and PB.

Additionally, we found significant positive carryover effects for PEB, PB_BIN, and

PB_POS. The fixed effects were B = .270, 95% CI [.145, .392] for PEB, B = .248, 95% CI [.087,

.403] for PB_BIN, and B = .189, 95% CI [.077, .310] for PB_POS. This indicates that these

behaviors remained stable over time. The standardized carryover effect for PEB was β = .268, 95%

CI [.179, .361], suggesting that increases of one person-specific standard deviation in PEB

predicted increases of .268 in the same variable on consecutive days. Similarly, when participants

reported positive peaks in PBs on a day, they were likely to report positive peaks of the same

behavior the following day. In particular, the standardized carryover effects for PB_BIN and

PB_POS were β = .244, 95% CI [.100, .392] and β = .188, 95% CI [.087, .289], respectively.

3.2.2. Between-person associations

We observed significant between-person variability in the carryover effects. Specifically, the

random slope variance for the carryover effect of PEB was .097, 95% CI [.049, .175], with the SD

of the random slope being 1.53 times the average fixed effect. For the carryover of PB_BIN, the

random slope variance was .058, 95% CI [.005, .166], with the SD approximately 0.97 times larger

than the average fixed effect. Finally, the random slope variance of PB_POS was .045, 95% CI

[.006, .118], and the SD was 1.32 times larger than the average fixed effect.

Table 1. *Results of the two-part DSEM model (Model 1). Unstandardized Fixed and Random Effects.*

Parameters	Fixed effects (means)			Random effects (variances)		
		95% CI			95% CI	
	Estimate	Lower	Upper	Estimate	Lower	Upper
Intercepts						
PEB	2.863*	2.649	3.076	.573*	.386	.881
PB_MEAN	1.075*	.902	1.249	.422*	.284	.653
PB_BIN	-.928*	-1.246	-.637	.927*	.494	1.684
PB_POS	1.332*	1.176	1.481	.143*	.062	.292
Spillover effects						
$PB\_BIN_{t-1} \rightarrow PEB_t$	.055	-.040	.146	.068*	.040	.116
$PB\_POS_{t-1} \rightarrow PEB_t$	-.039	-.039	.119	.029*	.003	.082
$PEB_{t-1} \rightarrow PB\_BIN_t$	-.081	-.347	.193	.105*	.007	.519
$PEB_{t-1} \rightarrow PB\_POS_t$	.036	-.147	.220	.142*	.019	.371
Carryover effects						
$PB\_BIN_{t-1} \rightarrow PB\_BIN_t$	.248*	.087	.403	.058*	.005	.166
$PB\_POS_{t-1} \rightarrow PB\_POS_t$	.189*	.077	.310	.045*	.006	.118
$PEB_{t-1} \rightarrow PEB_t$	.270*	.145	.392	.097*	.049	.175

(presence/absence); PB_POS= positive value of prosocial behavior. PEB = pro-environmental behavior. * The credible interval did not include zero.

3.2.3. DSEM with S-TRV as a between-person predictor

Model convergence was satisfactory, with a maximum PSR of 1.008. Visual inspection of trace plots and autocorrelation plots revealed no irregularities. Model 2 revealed a positive and significant cross-level effect of S-TRV on the intercept of PEB (B = .592, 95% CI [.249, .936]), indicating that individuals with higher levels of self-transcendence reported higher levels of PEB across the 21 days. These results are reported in Table 3 in the supplementary materials. We also found a cross-

level interaction of S-TRV with the spillover effect of $PEB_{i,t-1}$ on $PB\_POS_{i,t}$ (B = -.343, 95% CI [-.671, -.026])[3].

4. Discussion

This study explored the dynamic and reciprocal relations between PEB and PB in young adults' daily lives. Previous research on youth has shown a positive relation between PEBs and PBs (Berger & Andaur, 2022; Neaman et al., 2018; Uitto et al., 2015). However, past studies have not assessed whether the relation between PEB and PB is driven by stable differences between individuals (trait-like tendencies) or dynamic changes within individuals (state-like variations; Hamaker et al., 2018). To address these gaps, we employed daily diary data from Italian young adults followed over three weeks.

At the within-person level, we did not observe a significant spillover effect from PB to PEB. Specifically, across consecutive days, neither the dichotomous component of PB (i.e., the presence of PB) nor its positive component predicted positive peaks in PEB. Similarly, we found no evidence for the reverse spillover effect from PEB to PB. These findings suggest that performing higher-than-usual levels of PBs on one day did not lead to higher-than-usual engagement in PEBs the next day, and vice versa. In other words, days with increased engagement in one type of behavior were not followed by days with greater engagement in behaviors from the other domain.

These findings suggest that internal or external factors may limit daily cross-domain spillover, as they can influence individuals' motivation or opportunity to engage in these behaviors. For example, considering the lack of spillover from PB to PEB, caring actions directed toward close others, likely perceived as morally good, may have resulted in immediate benefits for participants, such as an enhanced positive self-view and personal satisfaction (Caprara & Steca, 2007). This self-fulfilling

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[3] To further examine this cross-level effect, we estimated simple slopes in a third, trimmed model to assess whether participants with higher or lower levels of S-TRV reported stronger or weaker spillover effect from $PEB_{i,t-1}$ to $PB\_POS_{i,t}$. No significant effects emerged. Full results of these analyses are available at the following OSF link:
https://osf.io/57fkx/?view_only=9ebc7fec152f427394b10f3a7c0f2e8e.

experience might not have motivated participants to extend their caring behavior to others beyond their immediate social context the next day, potentially due to challenges in self-regulation (Nielsen, 2017) or the use of moral disengagement strategies (Bandura & Cherry, 2020) that could hinder sustained engagement in effortful and moral conduct. On the other hand, the lack of spillover from PEB to PB might be because the effects of PEBs are often intangible and delayed over time (Steg et al., 2014). This may make it challenging for people to perceive and experience the benefits of PEBs and thus be motivated to engage in additional self-sacrifices by also enacting more PBs than their usual. Moreover, other influences, such as practical or situational constraints or non-moral motives like material or hedonic incentives (Steg et al., 2014), may have shaped participants' daily behaviors and the observed lack of associations. Future research should consider the potential moderating roles of these personal or contextual factors in shaping spillover effects (Nielsen et al., 2024).

Importantly, the present results are limited to the specific time lag examined (Hamaker et al., 2018). Thus, exploring alternative temporal windows, such as hourly intervals, may offer more insights into the presence of these spillover effects. Supporting this reasoning, when examining same-day associations, we found positive correlations between both components of PB (dichotomous and positive) and PEB. This suggests that on days when participants reported engaging more than usual in helping, sharing, and comforting behaviors, they also reported increased engagement in environmentally friendly actions such as recycling, conserving plastic, energy, and water, as well as encouraging others to adopt similar behaviors. These findings may reflect the fact that both behaviors are oftentimes perceived as moral actions (Markowitz & Shariff, 2012; Nielsen & Hofmann, 2021), especially among youth, who are particularly sensitive to and aware of climate change and environmental degradation (Gomez-Baya et al., 2020). Therefore, the self-rewarding experiences associated with each type of behavior (Caprara & Steca, 2007; Steg, 2016) may have helped sustain participants' motivation to engage in the other in the short term. Notably, PEBs are not only driven by environmental concerns but can also stem from prosocial motives, such as the desire to help others or contribute to the common good (e.g., Klein et al., 2022).

Our results also revealed significant positive carryover effects for PB (i.e., its two components) and PEB. Specifically, participants reported positive peaks on subsequent days, suggesting that these behaviors remained stable over the three weeks. This result indicates that participants persisted in their daily prosocial and pro-environmental efforts. One possible reason could be that they attributed greater meaning to these actions because they were, at some level, personally challenging, consequently being more self-rewarding (Venhoeven et al., 2013). Supporting this reasoning, two recent experience sampling studies found that these behaviors can provide immediate benefits, such as an enhanced sense of connectedness with others and meaning in life (e.g., Caldaroni et al., 2025; Gregori et al., 2024). Importantly, the process of reporting behaviors over a 21-day period may have promoted self-reflection, enabling participants to evaluate whether their daily actions aligned with their moral standards (Bandura, 2001). This reflection on daily behavior may have enhanced participants' awareness of the significance and benefits of their actions, which, in turn, might have fostered both the persistence of these behaviors and the spillover from the prosocial domain to specific areas of the pro-environmental domain. Given the exploratory nature of these findings, they should be interpreted cautiously.

At the between-person level, contrary to previous research, the correlation between PEB and PB was not significant. Namely, over the 21 days, participants who reported higher levels of PB than others did not report higher levels of PEB. When considered alongside the significant within-person correlations, these findings suggest that, in our sample, daily experiences played a more influential role than stable, trait-like tendencies in shaping daily engagement in behaviors directed toward the common good (Berger & Andaur, 2022). These results underscore that there can be marked differences between within-person and between-person relationships (Hamaker et al., 2018; Rohrer & Murayama, 2023), concerning the association between certain prosocial and pro-environmental behaviors individuals engage in their daily life.

Additionally, we observed significant variability in the carryover effects, suggesting that for some participants the stability of PEB and PB was stronger than for others. Thus, we explored the

moderating role of self-transcendence values as a stable individual characteristic to better understand whether individual differences could explain the heterogeneity in such temporal dynamics. For both models, self-transcendence values did not significantly influence the strength of the spillover and carryover effects, although they were associated with higher mean levels of PEB during the 21-day period. This suggests that daily engagement in PB and PEB may occur independently of a person's general propensity to give importance to others' well-being and the common good. In turn, daily prosocial experiences can promote participants' dedication to caring for the environment and the broader society. Considering the exploratory nature of the study, these findings should be interpreted carefully.

Our study contributes significantly to the spillover literature by examining the cascade effect of behavior (Hamaker et al., 2018) between the prosocial and the pro-environmental domains. It emphasizes the importance of considering not only specific PEBs when analyzing within-person associations but also other behavioral domains that reflect moral functioning, such as PB (Caprara & Steca, 2007), which may serve as relevant motivators for engagement in PEB (e.g., Uitto et al., 2015). These behaviors appear to be associated at the within-person level only on the same day, underscoring the need for a more nuanced understanding of the underlying factors that enable or hinder such cross-domain spillovers.

Moreover, by adopting a within-person approach, the study provides a dynamic perspective on spillover and carryover processes, including how the relation between these behaviors unfolds over time (Rohrer & Murayama, 2023). Our study also sheds light on intra-individual (i.e., state-like) processes of influence rather than focusing solely on inter-individual differences (Kuper et al., 2021), revealing how day-to-day changes in PEB and PB can persist in everyday life within the same individuals. Finally, the study lays the foundation for making causal inferences about these relationships, as spillover and carryover effects represent predictive relationships that may reflect underlying causal mechanisms (Hamaker et al., 2018).

Considering the sample, these results are particularly important for young adults, as they demonstrate that daily engagement in acts of care toward others can promote individuals' involvement in actions aimed at the common good, including nature (Berger & Andaur, 2022). Given youths' potential to drive significant changes toward more sustainable lifestyles (Gomez-Baya et al., 2020) as well as their vulnerability to environmental challenges (Pereira & Freire, 2021), supporting them in adopting PEBs is a crucial way to address both the ecological crisis and promote their positive development (Ojala, 2022). In line with Neaman et al. (2018), fostering prosocial experiences can be a key strategy for nurturing these behaviors in young people.

5. Limitations and future research

While our study makes noteworthy contributions to the literature, several limitations should be considered. Firstly, our results are limited to a daily time lag (Hamaker et al., 2018). Thus, future research should explore different time lags (e.g., hours or weeks) to gain a deeper understanding of the associations between PB and PEB employing other ESM designs such as Ecological Momentary Assessments (Shiffman et al., 2008). Secondly, we focused on a limited number of PEB and PB types, using a composite measure that may not fully capture the diversity of these behaviors (e.g., Dunfield, 2014; Lange, 2024; Stern, 2000). Future research could benefit from studying other PEBs and PBs and their reciprocal associations or exploring the temporal dynamics between specific dimensions of PEB and PB. Moreover, the studied PEBs were chosen for their potential to exhibit higher within-person variability (i.e., behaviors Italian young adults could realistically engage in daily life); however, they primarily represented lower-impact behaviors. Therefore, future studies should consider higher-impact behaviors, such as reducing red meat consumption or managing home heating and cooling (Nielsen et al., 2024), that may have lower intraindividual variability.

Thirdly, although intense longitudinal data can offer the advantage of reduced recall bias (Hamaker & Wichers, 2017), the use of self-reported measures may introduce potential bias due to the low accuracy of the reported behavior (Lange, 2024). This underscores the need for complementary methods such as observational data or objective measures (e.g., Xia & Liu, 2021).

The low within-person reliability of our PEB measure may also reflect both the heterogeneity of the behaviors considered and potential challenges arising from adapting items from existing between-person scales (Brose et al., 2020). To date, there is no standardized pool of validated within-person measures for PEB, which may limit the ability to select items that effectively capture the complexity and variability of these behaviors over time. Future studies should focus on developing and validating reliable within-person measures for PEB that can better account for these behaviors' dynamic and context-dependent nature (Brose et al., 2020).

Fourthly, because myriad factors can influence daily engagement in PEB and PB (Kollmuss & Agyeman, 2002), future research should explore additional internal and external enablers of spillover (Behn et al., 2025). These include factors such as self-identity, self-efficacy beliefs, personality traits, self-regulation abilities, and social norms (Behn et al., 2025; Nielsen & Hofmann, 2021; Soutter & Mõttus, 2021; Steg, 2016). Furthermore, time-varying factors (e.g., life events) and time-invariant factors (e.g., age, gender; Gifford & Nilsson, 2014) should be examined as potential contributors to these temporal dynamics. Investigating these factors will help to better understand how to amplify positive environmental outcomes through spillover effects. Furthermore, future studies should also explore how daily fluctuations in PEB and PB translate into stable, long-term between-person differences (Neubauer et al., 2024).

Finally, while the use of intensive longitudinal data obtained through ESM and the application of DSEM offers significant advantages for inferring potential causal relations (Hamaker et al., 2018; Rohrer & Murayama, 2023), the observational nature of these data prevents drawing strong causal conclusions, due to the presence of uncontrolled factors that may explain the reciprocal influences between daily PEB and PB (Hamaker & Wichers, 2017; Rohrer & Murayama, 2023). Future research could combine within-person data with experimental methods to address these limitations. For instance, micro-randomized interventions within intensive longitudinal designs could be employed to uncover within-person causal effects,

complemented by instrumental variable modeling (Caldaroni et al., 2025; Neubauer et al. 2024; Schmiedek & Neubauer, 2020).

6. Conclusion

This study highlights that engaging in morally good actions toward others does not necessarily lead to greater daily involvement in caring for the environment, and vice versa. However, our results also show that these behaviors are positively and significantly associated on the same day, suggesting that, beyond stable, trait-like tendencies, individuals who engage in one type of behavior on a given day also tend to engage in the other. Furthermore, our findings suggest that young adults are likely to persist in their daily prosocial and pro-environmental efforts, as evidenced by the presence of positive carryover effects. Overall, these findings provide a deeper understanding of young adults' everyday engagement in prosocial and pro-environmental behaviors, emphasizing intra-individual variability beyond stable, between-person differences in enacting these behaviors and in valuing collective welfare.

This has direct applications for interventions. Specifically, adopting a more holistic approach to studying PEBs, rather than treating them as separate from PBs, could inform educational programs that emphasize cultivating a sense of care and responsibility toward others to promote environmental protection (Berger & Andaur, 2022; Neaman et al., 2018; Schultz et al., 2005). Moreover, as suggested by the Social-cognitive theory (Bandura, 1991), the within-person approach adopted in this study could be incorporated into interventions to promote self-reflection and self-regulatory capacities, which are key to sustaining everyday life's effortful behaviors (e.g., Nielsen & Hoffman, 2021).

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