Master's Thesis

Examining the Effect of Mindfulness on the Relationship between Compassion and Pro-Environmental Behavior in Daily Life

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Abstract

Background. Due to the fact, that pro-environmental behavior (PEB) is a major contributor to fighting climate change and nature pollution, more and more studies examine predictors of PEB or constructs which could increase PEB. Compassion and mindfulness have been shown to enhance PEB. Additionally, mindfulness, as an awareness and attention to the present moment, is often part of the definition of compassion. PEB motivated by the experience of compassion, could be mediated by being more mindful during the day.

Objective. The purpose of this study is to examine daily variations in compassion, mindfulness and PEB. It explores the relationship between compassion and PEB. Additionally, it investigates the mediating role of mindfulness on the relationship between compassion and PEB.

Method. This study was conducted with an experience sampling method (ESM). With the use of a mobile application daily levels of compassion, mindfulness and PEB were measured for eight consecutive days. On the ninth day, a final long-format questionnaire of the respective study variable took place. The sample consisted of 31 mostly higher-educated participants (M_{age}= 26.2 years; 71% females).

Results. Linear mixed modeling (LMM) analysis revealed no significant mediation effect for mindfulness on the relationship between compassion and PEB within the participants' daily experiences, as well as for the overall experience between participants.

Conclusion. This study examined daily levels of compassion, mindfulness and PEB. The hypothesized association of compassion and PEB and the mediation of this association by mindfulness were not found to be significant. Therefore, compassion, PEB, and mindfulness as assessed in this study might not be related in their daily experience. We discuss those findings in terms of the conceptualization of the compassion and mindfulness items. We assume that compassion has different underlying constructs that could be measured during the day and the item, used in this study, asked for a cognitive, stable construct, that seems to not be related to PEB in daily life. Furthermore, mindfulness has different facets and the one examined in this study was neither related to PEB, nor associated with compassion in daily life. Thus, different facets of mindfulness in their association to PEB need to be investigated in further research.

Introduction

Environmental research and current developments in our climate, nature and atmosphere indicate that climate change is occurring and awareness, as well as action by people, is needed to mitigate the consequences (Maibach et al., 2014; Wamsler & Brink, 2018). Climate change is defined in different ways (Werndl, 2016). Overall, an increasing concentration of greenhouse gases in the atmosphere leads to a rapid rise in temperature in the earth's atmosphere, on the earth's surface and in our oceans (Crowley, 2000; Werndl, 2016). Our nature and ecosystem, and thus we as humans and all other living beings, can no longer adapt naturally and sufficiently to the rapidly increasing global warming (Werndl, 2016). As a result, biodiversity loss, sea level rise, and natural disasters harm the environment, our food production, and economic development, and thus directly or indirectly harm ourselves (Panno et al., 2018; Parry et al., 1996). As research has shown, we as humans and our behavior have a strong impact on the environment and must accept that we are contributing to problems such as water pollution and global warming (Steg & Vlek, 2009; Stern, 2000b). If our behavior is a key to causing or contributing to some of these problems, our behavior, i.e., pro-environmental behavior (PEB), can be an important factor in minimizing this loss or critical change and allows us to save this planet (Byerly et al., 2018; Parodi & Tamm, 2018; Thiermann et al., 2020).

Pro-Environmental Behavior

Pro-environmental behavior (PEB) can be defined as actions in favor of the environment to minimize one's own environmental impact (Stern, 2000a). PEB appears in various areas of human living, for example in the daily consumption of water, the energy use, one's meat consumption and the reduction of waste (Byerly et al., 2018; Larson et al., 2015; Markowitz et al., 2012). These behaviors can be shown in different types, such as reducing water or energy use, taking public transportation or a bike instead of a car, as well as sustainable organic nutrition and lessened meat consumption (Bissing-Olson et al., 2016; Markle, 2013; Steg & Vlek, 2009). PEB can be motivated by preventing someone's own health risk (self-interest) and the risk for the ecosystem, animals, and nature (concern for others) (Bamberg & Möser, 2007; Udall et al., 2020).

Values, morals, and empathy can increase PEB and also positively influence sustainable attitudes (K. Brown et al., 2019; Gatersleben et al., 2014; Markowitz et al., 2012). Especially values like transcendence and altruism were found to be very present and important in people who act pro-environmentally (Stern, 2000a). In particular, intrinsically motivated PEB, e.g. by altruism, is more long-term and stable than extrinsically motivated

PEB, e.g. through political or legal regulation and restriction (Stern, 2000a; Thiermann & Sheate, 2020). Consequently, PEB and the motivation to behave pro-environmentally can be sustainably influenced by values, moral concepts and assumptions that a person carries within him or herself, as well as pass over into everyday behavior and daily motivation to engage in PEB, and thus becomes commonplace (Baum & Gross, 2017; Thiermann & Sheate, 2020; van der Linden, 2015).

Empathy can create a new or re-learned connection from the individual with their environment and thus play a vital role in motivating an individual to behave in an environmentally protective and sustainable manner (K. Brown et al., 2019). Empathy is defined by experiencing the emotional state of someone else and the cognition to understanding his or her emotions (K. Brown et al., 2019). Next to empathy for other human beings, empathy can be experienced towards non-human beings such as animals, nature or the environment (K. Brown et al., 2019; Tam, 2013). Therefore, empathy can contribute to a feeling of oneness with the natural world (Sevillano et al., 2007; Tam, 2013). If someone is sensing oneself as being part of nature, he or she is more likely to have pro-environmental intentions (K. Brown et al., 2019; Sevillano et al., 2007). This intention nudged by empathy can be followed by an action if we are confronted with suffering and act to alleviate it (Thiermann & Sheate, 2020).

Compassion

Compassion is defined as being affected by the suffering of others and being motivated to act to alleviate the suffering as well as improving the wellbeing of the sufferer (Khoury, 2019; Lama & Jinpa, 1995). Compassion has much in common with the conceptualization of empathy and sympathy (Goetz et al., 2010; Tam, 2013). All of these concepts involve reactivity to or toward another person, another living being, or even the environment (Tam, 2013). Compassion, specifically, involves reacting to the suffering of others in my environment (Runyan et al., 2019). This response may be affectively shaped and guided by feelings or cognitively describe a basic attitude of a person as always wanting to help people as much as possible; here the connection to altruism becomes apparent (Goetz et al., 2010; Khoury, 2019; Miller, 2013). When confronted directly, an individual is more likely to respond affectively compassionately. The general trait-like expression of compassion may increase or decrease the affective response (Goetz et al., 2010). The more an individual experiences compassion in everyday life, thus state-like, the more pronounced compassion is developed as a trait (Goetz et al., 2010). A compassionate response need not be limited to the suffering of another person, but can also arise or be perceived as a response to the suffering of

sentient beings and nature (Lama & Jinpa, 1995; Tam, 2013). In empathizing with the suffering of nature and our environment, pro-ecological intentions and actions can develop and be heightened, especially when the harm and suffering of nature is seen as unjustified (Goetz et al., 2010; Pfattheicher et al., 2016). When the person recognizes his or her own responsibility in this suffering, he or she may become aware that he or she can alleviate it through PEB (Miller, 2013; Pfattheicher et al., 2016). Someone's previously polluting behavior or recognizable harm to nature may be deemed morally wrong when they become aware of it. Because people always try to act in line with their moral beliefs, compassion can intrinsically motivate a person to behave in a more environmentally friendly way and increase PEB or make it commonplace (Goetz et al., 2010; Thiermann & Sheate, 2020). Compassion encompasses multiple dimensions, from recognizing suffering, to feeling empathy for the sufferer, to noticing the intention to help, to being motivated to actively alleviate suffering (Jazaieri et al., 2016; Khoury, 2019). Anyone who feels compassion brings an awareness of suffering (Gilbert & Choden, 2015). In order to actively alleviate the suffering of other people, animals, and the environment, one must first perceive the suffering and evaluate it as unjustified as well as unfair (Amel et al., 2009; Goetz et al., 2010).

Mindfulness

Mindfulness, whose original concept comes from Buddhism, describes a non-judgmental and accepting concentration on the present moment, as well as on everything that is there or arises in this moment, e. g. emotions, body sensations or thoughts (Amel et al., 2009; Wallace & Shapiro, 2006). This focus on the moment and acceptance toward all that is there can elicit a broader view of different situations and allow for perspective taking or perspective shifting (Amel et al., 2009; Langer, 1993). Through mindfulness, one becomes more aware of one's own inner world on the one hand, and on the other hand, one becomes more mindful of one's environment and outer world (Rosenberg, 2004). Through mindfulness of the inner as well as the outer, one feels more connected to one's outer world (Rosenberg, 2004).

The concept of mindfulness, as an awareness of the here and now, is part of many definitions of compassion (Khoury, 2019; Neff & Germer, 2013). Conversely, compassion involves an awareness of suffering (Gilbert & Choden, 2015). Mindfulness practice can thus increase compassion, but higher levels of compassion can also be associated with increased mindfulness in everyday life (Khoury, 2019; Neff & Germer, 2013). Mindfulness can develop a sense of being significant for change, such as reducing suffering (Amel et al., 2009; Fischer

et al., 2017). Compassionate mindfulness can elicit intentional and conscious action to reduce suffering and help the sufferer (Rosenberg, 2004; Thiermann et al., 2020).

In particular, the sense of connectedness with the outside world, that mindfulness induces, can create a stronger relationship with the environment and nature, as well as evoke a sense of reciprocity between all beings and nature (Amel et al., 2009). Mindfulness can create more awareness of one's own importance and contribution to changing the suffering of nature and the environment (Amel et al., 2009; Thiermann et al., 2020). Awareness of the problem, e.g., nature's suffering, is crucial for the intention to act (Bamberg & Möser, 2007). Mindfulness alongside compassion could thus promote PEB. Research on mindfulness and its relationship with PEB is very recent, but suggests an association between higher levels of mindfulness as well as meditation and increased PEB (Barbaro & Pickett, 2016; Panno et al., 2018; Thiermann et al., 2020). This connection of mindfulness and PEB has only been studied for trait variables with single measurements (Amel et al., 2009; Barbaro & Pickett, 2016; Thiermann et al., 2020). Furthermore, the interaction of compassion, mindfulness and PEB has been investigated mainly retrospectively (Barbaro & Pickett, 2016; Pfattheicher et al., 2016; Thiermann & Sheate, 2020). Longitudinal studies could contribute to testing the correlation of these constructs in daily life and examining their relationship across more than one measurement point (Barbaro & Pickett, 2016).

The Current Study

To date, PEB, compassion, and mindfulness and their association have been measured predominantly retrospectively (Pfattheicher et al., 2016; Steg & Vlek, 2009). Therefore, a more detailed picture and the fluctuation of PEB, compassion, and mindfulness over time as well as changes in their association can be measured with ESM. PEB, compassion, and mindfulness can be measured in real life and overtime, with minimizing recall biases (Myin-Germeys et al., 2009).

This study uses the experience sampling method (ESM). The ESM, as an in vivo measurement it can provide data from daily living (Myin-Germeys et al., 2009). It enables to assess multiple data of emotions, behaviors, and their interactions in daily life (Myin-Germeys et al., 2009). This study used ESM to build up daily measurement of PEB, compassion and mindfulness. As mentioned earlier, PEB differs in its forms and characteristics, e.g., whether or not it is a habit, different manifestations of behaviors related to energy or water use, recycling, and nutrition that can be evident over time or on specific days (Bissing-Olson et al., 2016, 2016; Steg & Vlek, 2009). Therefore, ESM can record PEB and PEI during a day. Because compassion is a reaction to suffering it might vary over days

and during the day (Jazaieri et al., 2016; Runyan et al., 2019). Someone might show compassion when confronted with suffering of someone or something, as well as being compassionate as a longer lasting virtue shown in various situations (Runyan et al., 2019). Similarly, mindfulness might show different specifications in daily living, but can also lead to less fluctuation in behavior and reactivity due to more inner balance (Hülsheger et al., 2020).

The purpose of this study was to examine the association between compassion, mindfulness, and pro-environmental behavior in daily living and to establish if compassion and mindfulness significantly influence the intention to engage in PEB, as indicated in former research (Barbaro & Pickett, 2016; Pfattheicher et al., 2016; Wamsler & Brink, 2018). The variability of compassion, mindfulness, and PEB was measured three times a day over eight days. ESM enables associations between compassion and mindfulness on PEB to be identified in daily life and whether the respective concepts tend to be more stable or do vary over time (Csikszentmihalyi & Larson, 2014; Myin-Germeys et al., 2009).

Hypothesis 1 (*H1*). *It is expected that there is a positive association between compassion and pro-environmental behavior.*

Hypothesis 2 (*H2*). *It is anticipated that mindfulness will mediate the effect of compassion on pro-environmental behavior.*

Method

Design

This study examined the daily levels and association of compassion and PEB. Furthermore, it investigated the mediation effect of mindfulness on this effect between compassion and PEB. The study was part of a larger project using the same dataset. The ESM was used to measure the experience in participant's normal daily life (Myin-Germeys et al., 2009). As a measurement in the moment of the participant's real world, ESM minimizes the vulnerability to recall bias, thus improves ecological validity (Myin-Germeys et al., 2009).

The study was ethically approved by the Behavioural, Management and Social Sciences (BMS) Ethics Committee of the University of Twente (Request-Nr. 210386). The participants took part in the study voluntarily. Participants gave their informed consent online prior starting the study. They were informed about the option to retract their consent by withdrawing from the study at any time without justification. The information to contact the researchers was presented in case questions arose before or during the questioning.

Participants

The requirements to participate were understanding English, owning a mobile device (Android or Apple) and being able to use the mobile application Ethica, as well as being 18 years and over. Participants were recruited by researcher's personal acquaintances.

The initial sample size was 41 participants. Ten of them were excluded from the analyses due to more than 50 % missing data (van Berkel et al., 2019). Because ESM studies often comprise missing data, the cut-off of 50% and more missing data stated by Connor and Lehmann (2012) was chosen to exclude the data of those participants. In conclusion, 31 participants were included in the further analysis.

Procedure

The participants took part in the study for nine consecutive days in April 2021, starting with the day they attended the study. During the eight days, daily measurements needed to be filled in. With the use of the mobile application *Ethica* participants answered daily questions measuring all study variables, respective compassion, mindfulness, and PEB, for three times a day on their own smart phones. Participants received daily notifications three times a day to fill in the daily survey. Thus the measurements were scheduled in the morning between 9am and 12am, in the afternoon between 2pm and 5pm, and in the evening between 7pm and 10pm. The participants received reminders within timeslots and with an expiry time of 2 hours after being notified. The reminder for the daily questionnaires used the phrase '*Please tell me how you feel at the moment*'. Participants could quit the survey each time. The last and 9th day consisted of one measurement point, where the participants had to answer questionnaires about the trait study variables by long form questionnaires in *Ethica*.

Items relevant to this study entailed questions about PEB, compassion and mindfulness. Next to these questions, also introduced as followed, other areas were inquired for different studies of the subordinate research project. The additional questions comprised of *nature connectedness, affect, being outdoors* and *being with others,* who are or are not interested in pursuing PEB themselves (see Appendix A). In detail, four items to measure daily PEB, a single item for state compassion and a single item for state mindfulness were surveyed per measurement time point. Long form questionnaires were used to measure the constructs of interest as trait-like variables for this study.

Material and Measures

App Ethica

Ethica is an online platform, enabling to monitor various behaviors via tracking or with a diary function. *Ethica* can be used as an application on smartphones, as in this study,

and can be downloaded via Google Play Store or App Store to facilitate the usage on various devices (running iOS or Android). Additionally, observations can be complemented by surveys and questionnaires to track behavior, opinions and states of various psychological factors during the day and over time.

Daily measures

State pro-environmental behavior. Items for PEB were self-designed, oriented to the Pro Environmental Behavior Scale (PEBS) developed by Markle (2013). The PEBS differentiates four categories: food, conservation, environmental citizenship and transportation. The four categories predefined the following question used in this study: *'To me it is important to limit my energy use'* (conservation)*; 'To me it is important to limit my meat consumption'*(food)*; 'To me it is important to talk to others about their environmental behaviors'* (environmental citizenship)*; 'To me it is important to limit my use of the car'* (transportation). The answer categories were rated on a 7-point Likert scale with the ordinal style values representing agreement from 1 = 'totally disagree', through 7 = 'totally agree'. Therefore, four items were designed and a mean score was used to build up the average daily PEB of participants. We asked for the intentions to act pro-environmentally, because PEB might not be shown every day or various times during the day and could depend on various factors (e.g. weather, mood, etc.) (Bissing-Olson et al., 2016; Pfattheicher et al., 2016; Steg & Vlek, 2009).

State compassion. State compassion was measured by the question *'I like to be there for others in times of difficulty'* (Pommier et al., 2020). The answer categories for this item were given on a 7-point Likert scale measuring an ordinal scaled agreement from 1 = 'totally disagree', through 7 = 'totally agree'. This item was adopted from the Compassion Scale by Pommier et al. (2020). It was closest to the awareness for the suffering of others and the intention to alleviate this suffering, as the definition of compassion (Goetz et al., 2010; Khoury, 2019).

State mindfulness. To measure state mindfulness, the item *'It seems I am "running on automatic" without much awareness of what I'm doing'* was selected from the Mindfulness Attention Awareness Scale (MAAS; K. W. Brown & Ryan, 2003). Answer categories for this item could be rated on a 1-7 Likert Scale with the values that represent the agreement in an ordinal measure from 1 = 'totally disagree', through 7 = 'totally agree'. This item was highest in factor loading in the study from Brown and Ryan from 2003. Furthermore, this item is a reversed coded item.

Trait Questionnaires

Trait pro-environmental behavior. To measure trait PEB, the Pro-Environmental Behavior Scale, consisting of 19 items, was applied (PEBS; Markle, 2013). The scale was established as a validated and reliable measurement for PEB (Lange & Dewitte, 2019; Markle, 2013). All items were measured on a Likert Scale, where highest scores or agreement is always described by a score of 5. However, it should be noted that answer categories were labeled differently. As an example for the conservation-item '*How often to you turn off the lights when leaving the room?'* answer categories ranged from 1 "*never*" to 5 "*always*", and for the food-item '*During the past year have you decreased the amount of beef you consume?*' answer categories were 1 "*no*", 5 "*yes*", and 5 "*I do not eat beef/pork/poultry*". A mean score was calculated for the rating of high to low expression of PEB.

Trait compassion. Compassion as a trait-like variable was assessed with the Compassion Scale (CS) by Pommier and colleagues (2020). The CS is a 16 item scale with strong psychometric properties, being overall reliable and good validated (Pommier et al., 2020). The CS consists of four subscales including greater kindness ('*I like to be there for others in times of difficulty*.'), common humanity ('*Everyone feels down sometimes, it is part of being human.*'), mindfulness ('*I pay careful attention when other people talk to me.*'), and lessened indifference ('*I don't concern myself with other people's problems.*') (Pommier et al., 2020, p. 23). All items were rated on a scale from 1 = 'totally disagree', through 7 = 'totally agree'. An overall mean score describes the total level of trait-like compassion, meaning higher scores indicating a higher level of compassion.

Trait mindfulness. The Mindfulness Attention Awareness Scale (MAAS) was utilized to measure trait mindfulness (K. W. Brown & Ryan, 2003). Regarding convergent and discriminant validity, the MAAS was found as convergent with theories about mindfulness and what a mindfulness scale aims to measure (K. W. Brown & Ryan, 2003, pp. 831–844). The MAAS was established as a reliable measurement for trait-like mindfulness (K. W. Brown & Ryan, 2003, p. 827). All items of the MAAS comprised the answer categories from 1 = 'totally disagree' to 7 = 'totally agree'. Higher mean scores describe stronger expressions of trait-like mindfulness. The mean score was used to interpret high or low expressions.

Data Diagnostics

Psychometrics

Cronbach's alpha was calculated to assess the internal consistency of the items for state PEB. For the reliability analysis of the PEB state items, the internal consistency was satisfactory with Cronbach's alpha $\alpha = .75$.

For validity on a BP level, Pearson correlation between the PM score of the respective item with the mean of the trait scale was calculated. The correlation should indicate that those constructs are related but different in their expression. If correlations are high, items might measure the same construct, thus did not adequately measure state different to trait variables (Horstmann & Ziegler, 2020).

By assessing the validity, the overall PM scores for PEB were significant, and highly positive correlated with the trait PEB mean scores of the PEBS in this sample ($r = .81$, $p < .001$) (Markle, 2013). The PM scores for the compassion single item correlated strongly significantly positive with the trait compassion mean scores of the Compassion scale by Pommier ($r = .64$, $p < .001$) (Pommier et al., 2020). By correlating the PM scores of state mindfulness with the participant's mean scores of the MAAS by Brown and Ryan (2003), a significant moderate positive correlation was found ($r = .45$, $p < .001$).

Intraclass Correlation Coefficient

The intraclass correlation coefficient (ICC) was calculated to examine the general amount of variance in the study variables (Fisher, 1992; Hausknecht et al., 2008; Hoffman & Stawski, 2009). An ICC = 0, indicates no variance between participants. No variance within participants is assumed if ICC = 1 (Liljequist et al., 2019).

Data Analysis

The analysis was conducted using IBM SPSS Statistics Version 26.0 (IBM Corp., 2019). Descriptive data was recorded for age, gender, nationality and English skills. Descriptive statistics were used to calculate the mean trait PEB, mean trait compassion and mean trait mindfulness, as well as mean state scores for all three variables.

Little's Missing Completely at Random (MCAR) test was conducted to classify the missing data, being missing at random (MAR) or missing not at random (MNAR) (Carter & Emsley, 2019; Little & Rubin, 2020). Little's MCAR test revealed that the data of the studied variables was missing completely at random, with χ^2 (6, $N = 579$) = 3.39, $p = .759$. Accordingly, no imputation method was used because values were missing at random and no pattern of missing data over time could be determined. The average missing data rate was

22% per variable, corresponding to an average of 164 missing response points out of a total 744 response points per variable over the 24 measurements.

The goal of this study was to investigate the hypothesized associations and mediation within each participant (WP) thus per timepoint and over time as well as between participants (BP), meaning per individual. ESM data consists of those two levels and based on the WP and BP variance described by the ICC values, the mediation analysis was calculated on a between and within participant level (Bolger & Laurenceau, 2013). Person mean scores (PM) were calculated to provide an overview of the average compassion, PEB and mindfulness state level per participant as an average of the 8 days of measurement, this allowed for a BP analysis. Person mean-centered (PM-centered) scores were calculated by subtracting the participants mean score from every momentary score per time point. PM-centered scores were generated for each participant's measurement of compassion, PEB and mindfulness to carry out WP analyses. These scores assess momentary levels of compassion, PEB and mindfulness and show deviations in these three variables per timepoint. Therefore, the study variables were measured as time-varying variables.

The association between state compassion and state PEB was examined by Linear Mixed Model (LMM) analysis on a BP as well as WP design. LMM analyses were conducted, using an autoregressive covariance structure (AR1) and Maximum Likelihood Estimation (ML) method. To test the hypothesized mediating effect of mindfulness (M = Mediator) on the relationship between compassion (IV = independent variable) and PEB (DV = dependent variable) within and between participants, three LMM analyses were calculated for the following four main effects and on each level, thus using either PM (BP level) or PM-centered (WP level) scores. In the first analysis, for the total effect (*c* path) of compassion (IV) on PEB (DV), PEB was set as the dependent variable with compassion as the predictor and fixed factor. The IV-to-M effect (*a* path) was examined in the second analysis, where compassion described the dependent variable with mindfulness as the predictor and fixed factor. The third analysis comprised the M-to-DV effect (*b* path) and the direct effect (*c'* path) analyzed by setting PEB as the dependent variable with compassion as well as mindfulness as predictors and fixed factors. Furthermore, the indirect effect of compassion via mindfulness on PEB was calculated by the product of path *a* and *b* (*ab* path). The A Sobel test was done to examine the significance of the mediation (Sobel, 1982).

Microsoft Excel (Office 2016) and IBM SPSS Statistics Version 26.0 were used to depict the data with creating line graphs for visual analysis of the BP variation in the variables over time. WP variation of the study variables for each participant and the comparison of

these variations between the participants were illustrated in boxplots. ESM has the advantage to capture real-life experiences of the participant (Myin-Germeys et al., 2009; van Berkel et al., 2018). Therefore, two example participants were selected to visual analyze their daily fluctuations of the study variables in detail. Our aim was to map exemplary participants who were particularly conspicuous in the expression of the respective study variables and to reflect the core message of the sample as best as possible.

Results

Descriptive Statistics

The 31 participants included ranged from age 21 to 40 years. Overall, more women than men participated in the study, their nationalities were German, Dutch, British, Nigerian and French. None of the participants indicated a poor level of English skills, overall English skills were on an average level. The majority of participants were higher educated and being omnivore or semi-vegetarian, therefore consuming (red) meat at least once a week. The detailed demographic data is outlined in Table 1. The sample showed moderate to high expression in average daily PEB. Overall, participants were already highly motivated to engage in PEB at the trait level. On daily average, participants were highly compassionate, feeling with others who suffer, and the overall sample was characteristically highly compassionate. On average, participants experienced themselves mostly in the here and now over time and were highly mindful as a sample overall.

Table 1

Means (M) and standard deviations (SD), frequencies (n) and percentages (%) for the general demographic characteristics of the 31 participants.

Variables	Participants (N=31)
Age, M (SD)	26.2 (5.9)
Gender, n (%)	
Male	9 (29%)
Female	22 (71%)
Nationality, n (%)	
German	27 (87.1%)
Dutch	1 (3.2%)
British	1 (3.2%)
Nigerian	1 (3.2%)
French	1 (3.2%)
Education, n (%)	
High school diploma	12 (38.7%)
College degree	2 (6.5%)
Vocational training	1 (6.5%)
Bachelors degree	8 (25.8%)
Masters degree	6 (19.4%)
Professional degree	2 (6.5%)
English skills, M (SD) Poor (1) – Excellent (5)	3.7 (0.8) | 2 - 5
Diet*, n (%)	
Omivore	5 (16.1%)
Pesco-vegetarian	1 (3.2%)
Semi-vegetarian	5 (16.1%)
Vegetarian	3 (9.7%)
Vegan	2 (6.5%)
No answer/missing	15 (48.8%)
State PEB **, M (SD)	5.5 (1.0)
Trait PEB, M (SD)	2.9 (0.3)
State Compassion, M (SD)	6.2 (0.7)
Trait Compassion, M (SD)	5.6 (0.5)
State Mindfulness, M (SD)	4.7 (1.5)
Trait Mindfulness, M (SD)	4.7 (0.9)

*Note: omnivore = eating meat or fish almost every day, pesco-vegetarian = consuming no meat but fish, semi-vegetarian = consuming red meat, poultry or fish no more than once a week, vegetarian = not consuming any meat or fish, vegan = not consuming any animal products.

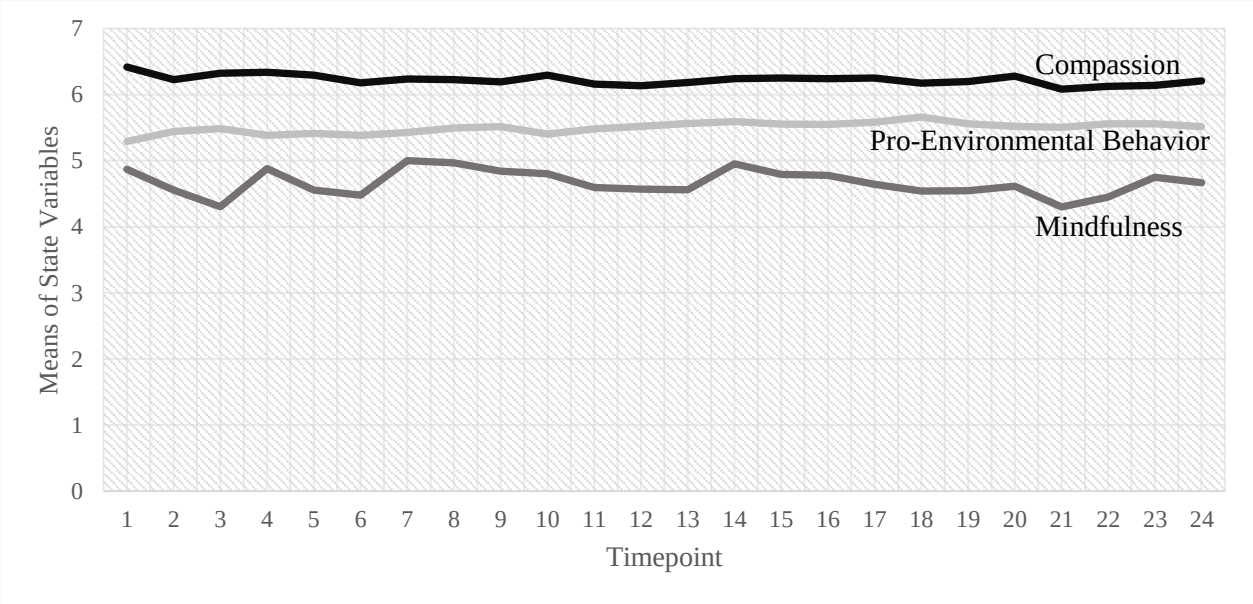
** PEB = Pro-Environmental Behavior

Variations of study variables

The state study variables varied over time, with the most fluctuation in state mindfulness. Figure 1 indicates these fluctuations across the 24 measurement points. The small changes in state PEB indicate a very stable PEB over all 24 time points. Overall, the variables studied varied to a small extent in their mean scores over time (Figure 1).

Figure 1

Mean state compassion (in black), mean state pro-environmental behavior (PEB; in light grey) and mean state mindfulness (in dark grey) per measurement point over time.



A more detailed picture is illustrated in Figure 2 – 4 for the WP and BP variation of the study variables state PEB, state compassion and state mindfulness for all 31 participants. The overall low fluctuating pattern in mean scores over time (Figure 1) is also visible in the variability of scores within and across participants, as visualized in Figures 2 and 3 below. As can be seen in Figure 2, participants showed an overall high level of state PEB. Most participants experienced just a few distributions from their average level of state PEB. The ICC value for PEB (ICC_{peb} = 0.90) indicated that approximately 90% of the variance was attributable to BP differences and 10% was explained by WP variability over time. The WP variation of PEB scatters less around the PM score for each individual and larger variations were identifiable between participants. Therefore, the ICC value for PEB supports the visual analysis, that almost all variance in the scores can be attributed to BP differences. Even less fluctuations can be seen for state compassion in Figure 3. With foremost no variation in scores within individuals over time, state compassion remained very stable around the individuals mean or resembles the mean score for all timepoints (Figure 1 and 3). This visual

outcome is also described by the ICC for compassion. The ICC for compassion ($ICC_{compassion}$ = 0.79) revealed that about three-quarter of variance was described by BP differences and the remaining one-quarter is attributable to WP differences. Some participants scored the maximum for almost all measurement timepoints, for example participant 17 and participant 22. Others, for example participant 18, had a stable score over all measurement timepoints. The picture given for state mindfulness is indicating a high variability between participant experience as well as indicating participants to differ in their daily mindfulness scores (Figure 4). The boxplots presenting within participants variations from almost no variance to great variance. Therefore, some participants, for example participant 24, experienced mindfulness as something stable, whereas others reported differences in their perception of mindfulness every day and over time, such as participant 9 (Figure 5). For mindfulness ($ICC_{mindfulness}$ = 0.71) the ICC value described that two third of the variance can be attributed to BP differences and the left one-third to WP variation. Overall, a considerable variation in the experience of state mindfulness can be observed between and within participants. Consequently, fluctuations of mindfulness are more visible between participants, but mindfulness is also fluctuating within participants over time.

Figure 2

Variation of state pro-environmental behavior (PEB) for each participant with a reference line indicating the group mean (M = 5.49).

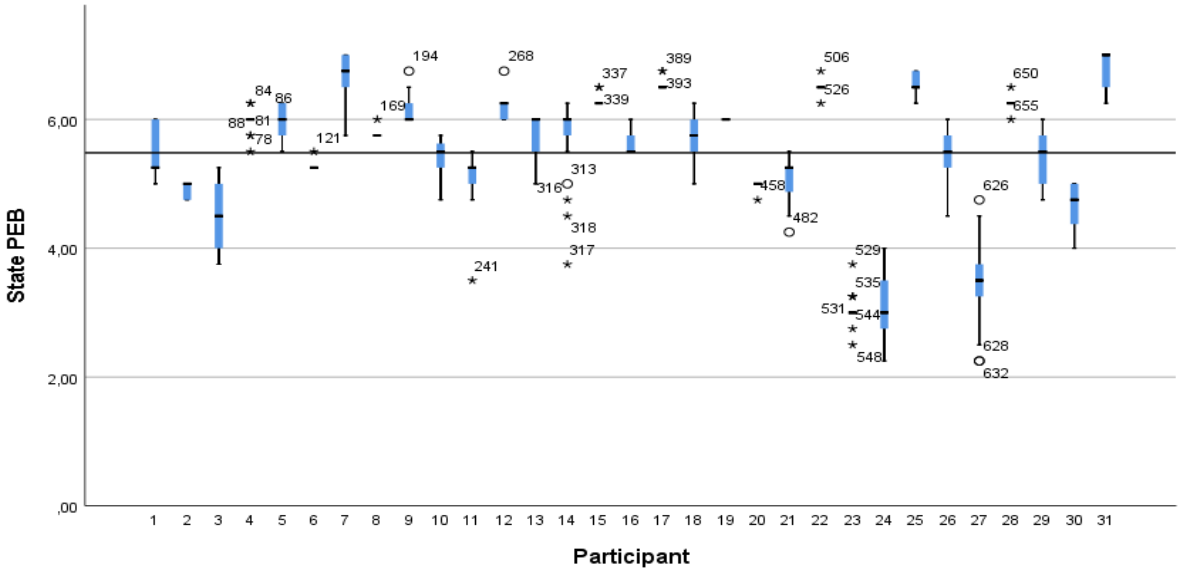


Figure 3

Variation of state compassion for each participant with a reference line indicating the group mean (M = 6.2).

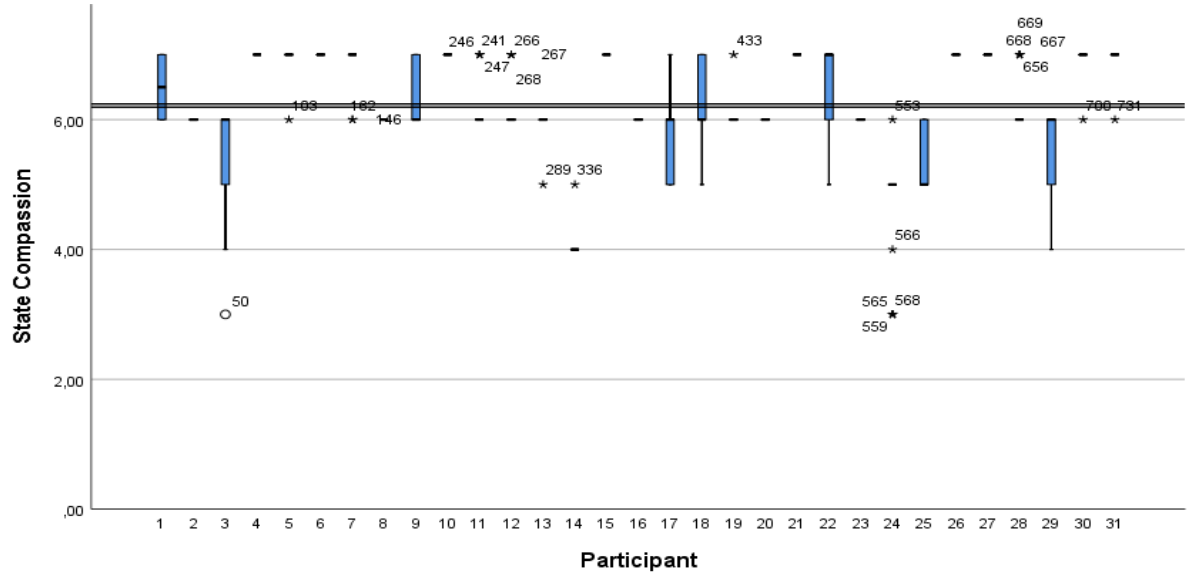
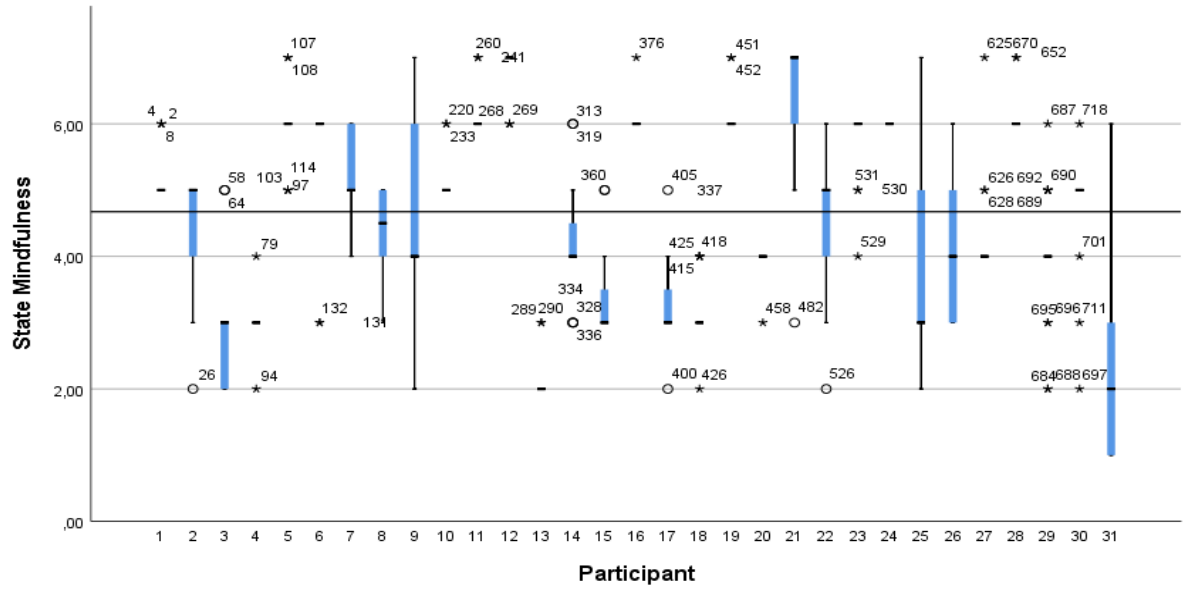


Figure 4

Variation of state mindfulness for each participant with a reference line indicating the group mean (M = 3.42).



Inferential Statistics

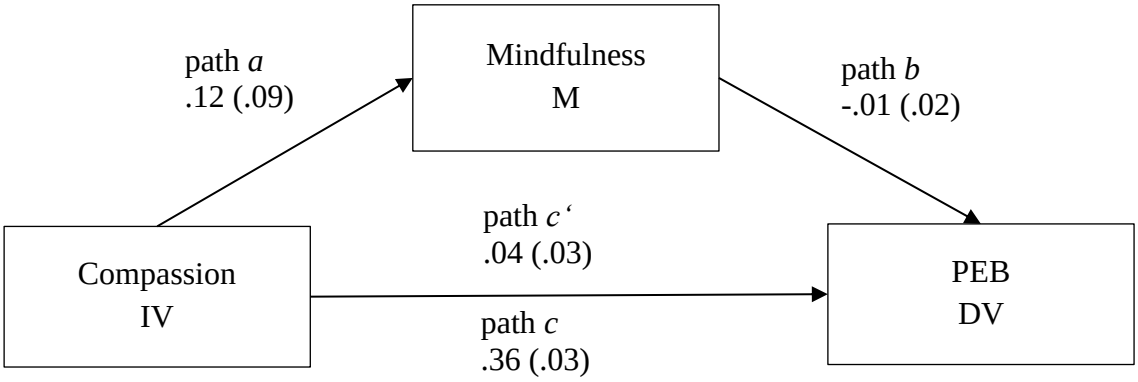
Both hypotheses were examined on both levels (WP and BP), indicating no confirmation. For the first hypothesis (*H1*) no significant effect of compassion on PEB could be supported on both levels. Additionally, the second hypothesis (*H2*) assuming a mediation of mindfulness on the relationship between compassion and PEB could also not be confirmed.

Within Participant Mediation Analysis

The mediation analysis on a within participant level is visualized in Figure 5, given the *beta*-coefficients and standard error (*SE*) for all effects. Neither the direct effect of compassion on PEB (*c* path) ($F(1, 579) = 1.12$, $p = .29$), nor the effects of compassion on mindfulness (*a* path) ($F(1, 572) = 1.95$, $p = .16$), and of mindfulness on PEB (*b* path) became significant ($F(1, 574) = 0.53$, $p = .47$). Furthermore, the effect of compassion on PEB controlled for mindfulness (*c*' path) remained not significant ($F(1, 579) = 1.21$, $p = .27$). The Sobel test revealed no significance for the indirect effect (*ab* path) of compassion via mindfulness on PEB ($z = -.468$, $SE = .00$, $p = .64$) (Preacher & Leonardelli, 2010-2021; Sobel, 1982). None of the effects did meet the conditions of Baron and Kenny (1986) to assume a mediation effect of state mindfulness. Additionally, no direct effect of state compassion on PEB could be found in this study.

Figure 5

The mediating role of state mindfulness on the association between state compassion and state pro-environmental behavior (PEB) on a within participant level with the mediation paths labeled with the respective beta-coefficients and standard errors.



Sobel-Test: $z = -0.47$, $p = .64$

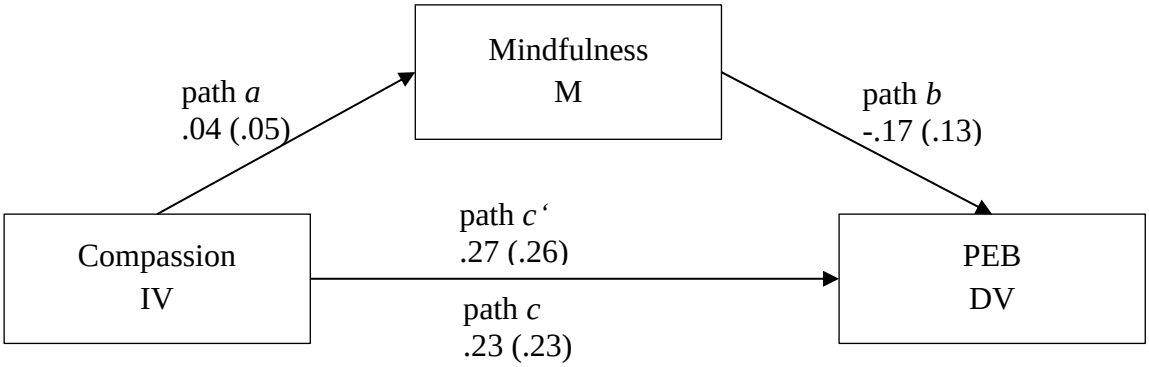
Between Participant Mediation Analysis

Figure 6 represents the mediation analysis on a between participant level, with *beta*-coefficient and standard error (SE) indicating all effects in the model. The total effect (path *c*) of compassion (IV) on PEB (DV) was not significant ($F(1, 65) = 1.00$, $p = .32$). The effect of compassion on mindfulness (path *a*) revealed no significant association ($F(1, 2631) = 0.91$, $p = .34$). The effects of mindfulness on PEB (path *b*) ($F(1, 61) = 1.56$, $p = .22$) and compassion on PEB with mindfulness as a mediator (path *c'*) ($F(1, 69) = 1.57$, $p = .21$) remained not

significant. The conditions for a mediation were not met (Baron & Kenny, 1986). For the indirect effect of the mediation, a Sobel test resulted in a not significant (z = - 0.68, SE = .00, p = .49) indirect effect of compassion via mindfulness on PEB (Sobel, 1982).

Figure 6

The mediating role of state mindfulness on the association between state compassion and state pro-environmental behavior (PEB) on a between participant level with the mediation paths labeled with the respective beta-coefficients and standard errors.



Sobel-Test: z = -0.68, p = .49

Visual Analyses of Individual Cases

The overall sample showed high PEB over time, with less variation. Participants were mostly high in compassion across all measurement time points. State mindfulness was the most fluctuating variable for most participants. Considering these three expressions of the study variables, two participants were selected to be a good example to further examine these expressions and fluctuations from measurement time point to measurement time point.

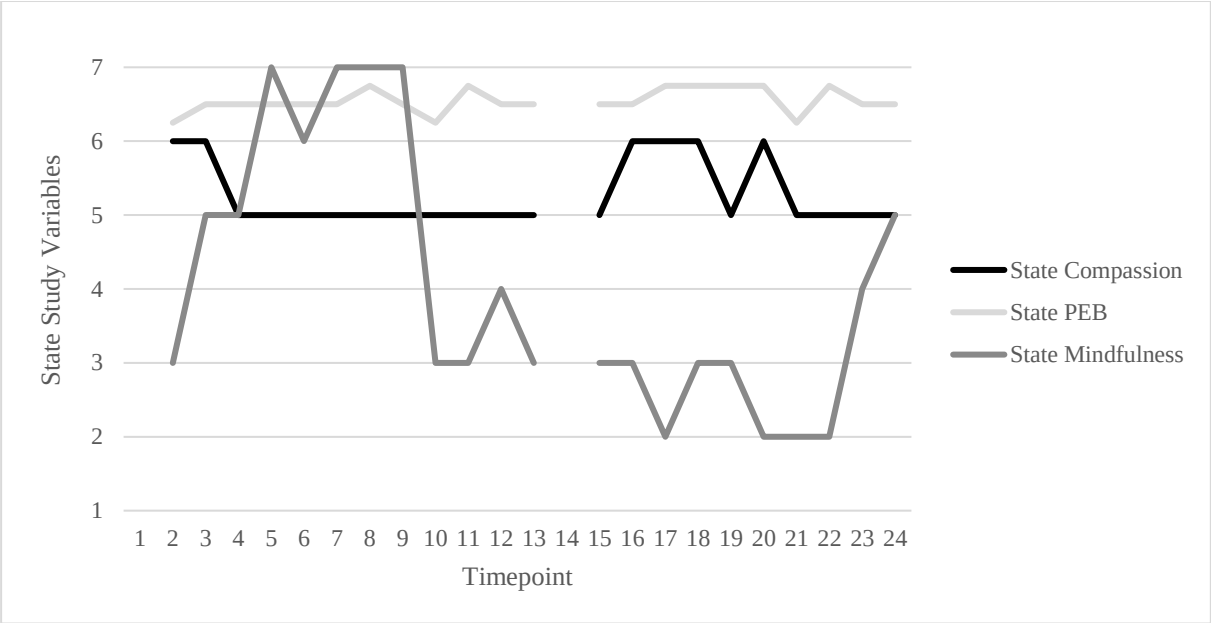
Participant 25

As can be seen for the visual analysis in Figure 7, participant 25 (P25) had an average high intention to engage in PEB on a daily basis M = 6.55 (SD = 0.17). For state compassion, P25 reported an overall stable expression over time (M = 5.27, SD = 0.46). Accordingly to the visualization in Figure 7, P25 showed a massive fluctuation in his state mindfulness scores, ranging from 1 (‘*totally disagree’*) to 6 (‘*agree*’). The mean score of P25 M = 4.04 (SD = 1.79) was slightly above the group mean. Furthermore, fluctuations were visible during one day (3 points of measurement), showing from average to maximum levels of mindfulness within one day. For P25 state mindfulness was experienced with higher fluctuations.

However, state compassion and state PEB were experienced more stable over time. Overall, no strong association becomes visible.

Figure 7

State compassion (in black), state pro-environmental behavior (PEB; in light grey) and state mindfulness (in dark grey) for participant 25 over time.



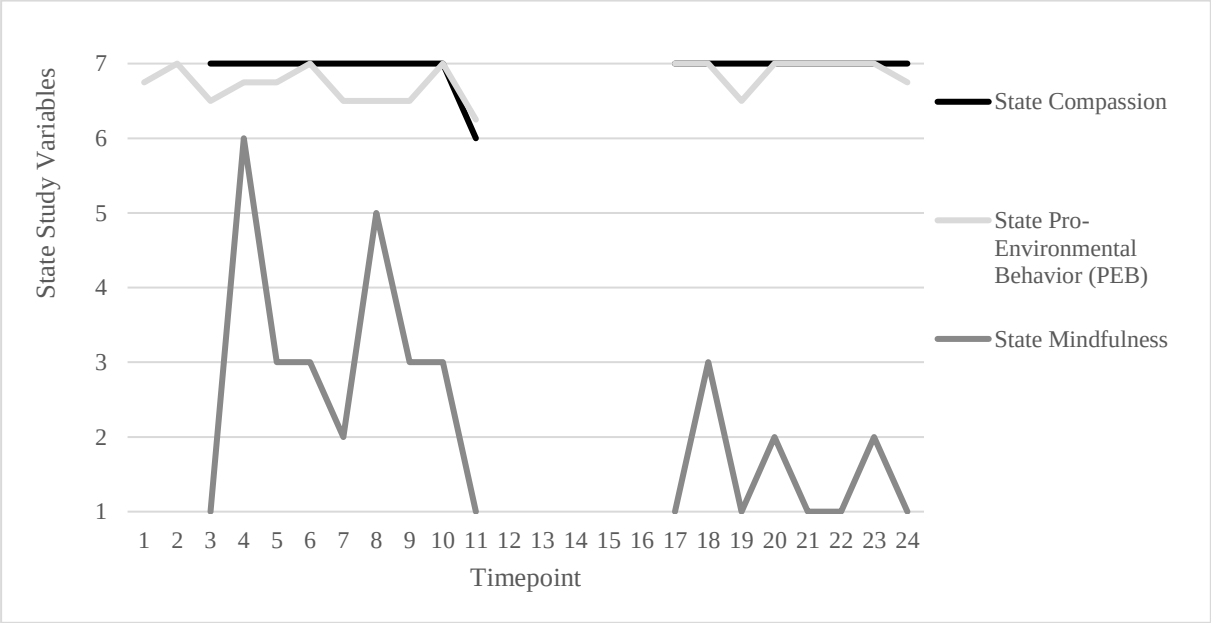
Note. Line gaps indicate no measurement at the respective time point (Timepoint 1 and 14 are missing, indicating missing data).

Participant 31

Participant 31 (P31) experienced high levels of state PEB (M = 6.80, SD = 0.25), and more average state PEB compared to the group (M = 5.49, SD = 0.95). P31 reported a high level of daily PEB's or intention to engage in PEB's. Additionally, P31 experienced compassion on a very high level with almost no fluctuation over time (M = 6.95, SD = 0.22), which is visible in Figure 8. Given the very stable line for her state compassion scores in Figure 8, compassion described a more trait-like variable than state-like for P31 in this study. State mindfulness varied over time and during the day (M = 2.40, SD = 1.64). Very high to very low mindfulness scores are visible. The experienced state variables showed low to none association in their visualization (Figure 8).

Figure 8

State compassion (in black), state pro-environmental behavior (PEB; in light grey) and state mindfulness (in dark grey) for participant 31 over time.



Note. Line gaps indicate no measurement at the respective time point (Timepoint 12 - 16 are missing, indicating missing data).

Discussion

The purpose of this study was to examine the mediating effect of mindfulness on the relationship between compassion and PEB by measuring all three study variables using three times daily experience sampling. We assumed a positive effect of compassion on PEB (*H1*). Furthermore, mindfulness should act as a mediator in this association between compassion and PEB (*H2*). Both hypotheses were studied on a between as well as within participant level. Neither our first hypothesis (*H1*) of a positive effect from compassion on PEB, nor our second hypothesis (*H2*) expecting mindfulness as a mediator of this effect turned out significant and thus could not be supported. The current study could not replicate associations of compassion with PEB or mindfulness with PEB as detected in former research, and found no mediating role of mindfulness on the effect between compassion and PEB (Pfattheicher et al., 2016; Thiermann & Sheate, 2020). We were unable to replicate this for the between participant level, whose associations would be most comparable to Pfattheicher and colleagues (2016) as well as other studies research design (Barbaro & Pickett, 2016). Therefore, we discuss three main issues about the study design and item conceptualization that were different in our research and might contribute to the insignificance in our results.

The first reason why no significant relationship was found between compassion, mindfulness and PEB in this study may be due to the conceptualization of the item for state compassion. First, the item for state compassion could mainly ask about a cognitive component of compassion. This could explain the relatively stable scores of state compassion and thus represent a more trait-like variable. The study by Pfattheicher et al. (2016) showed a causal path from compassion for humans to PEB intentions. Our selected item may have measured a part of compassion that does not appear to be related to PEB. Unlike Pfattheicher et al. (2016), who measured trait compassion by the emotional empathy scale, this study examined daily variations in compassion as measured by an item from the CS (Pommier et al., 2020). The item was chosen because it is closest to the traditional definition of compassion (Gilbert & Choden, 2015). We rated this item to be sufficient to measure response to suffering and vary over time. However, Khoury (2019) argued that the traditional definition of compassion describes a more cognitive process. The affective state of compassion may be more reactive and fluctuating over time (Khoury, 2019). Compassion is subject to definitions such as feeling empathy with others, human and non-human or experiencing a feeling in response to suffering of someone/something else and being motivated to alleviate suffering (Goetz et al., 2010; Khoury, 2019; Lama & Jinpa, 2005). However, the item only asked about compassion in relation to anyone who was suffering. Considering other research, compassion was often inquired in relation to a specific person in the respondent's environment or with the imagination of someone in need (Pfattheicher et al., 2016; Runyan et al., 2019). Thus, reactivity to a particular person, and thus compassion for another (particular) person, might elicit a specific feeling of compassion rather than the more cognitive and trait-like component measured in this study (Goetz et al., 2010; Tam, 2013).

Second, while our item is sufficient to measure trait compassion, it does not adequately capture state compassion or daily fluctuations in the feeling of compassion. We argue that the item does not encompass all three dimensions of compassion, namely the awareness of suffering (*awareness*), an emotional response to suffering (*kindness*), and the cognitive component of understanding suffering (*common humanity*), and therefore most likely could not adequately measure state compassion (Khoury, 2019; Pommier et al., 2020). Further research should consider asking about all three dimensions to determine a sufficient item for state compassion and adjust the wording of the item to examine compassion toward a particular other, which might then elicit variation in his or her daily experience of compassion.

A second reason for the non-significance in our findings may be due to the conceptualization of the item for state mindfulness. This study did not find a significant relation between compassion and mindfulness, nor a significant relation between mindfulness and PEB in daily lives. Our results are inconsistent with other research looking into those relationships on a trait level (Amel et al., 2009; Barbaro & Pickett, 2016; Khoury, 2019; Pommier et al., 2020). This study found no significant association between compassion and mindfulness. Khoury (2019) stated that mindfulness is often part in the definition of compassion and that those constructs are interrelated on some dimensions. It is possible that the selected item described a dimension of mindfulness that was not related to compassion, so no significant result was obtained. The current research measured mindfulness as being attentive in the present moment. This formulation, described as *acting* with awareness, was presumed to relate closely to PEB, because it can create awareness for the suffering of the environment and enhance the intention to act pro-environmentally (Amel et al., 2009; Barbaro & Pickett, 2016). The association between mindfulness and PEB found in other studies was obtained by all five facets of the construct, namely *observing*, *nonreactivity* to inner experience, *describing*, *nonjudging* and *acting* with awareness (Barbaro & Pickett, 2016). The facets of mindfulness found as predictors of PEB were *observing* and *nonreactivity* (Barbaro & Pickett, 2016). Even though, our utilized item most closely relates to the facet of *acting* with awareness, which was assumed to be time variant and suitable to measure state mindfulness. Our mindfulness item measured a state construct of mindfulness, but not in a significant relation to PEB. Hektner, Schmidt and Csikszentmihalyi (2007) stated that state items measured by experience sampling are likely to capture just one dimension of a subordinate concept. Considering that, the association between mindfulness and PEB might be better described by constructs like connectedness to nature or any underlying construct of mindfulness, e.g. observing and nonreactivity, as revealed in other studies (Amel et al., 2009; Barbaro & Pickett, 2016). More investigation is needed, to see, if items most closely to the mindfulness facets of *nonreactivity* and *observing* are significantly related to PEB on a daily basis. This investigation is suggested to reveal predictors for PEB in the everyday life of people and how concepts or trainings of mindfulness can contribute to act more pro-environmentally.

As a third point it is arguable if PEB could change dependent on compassion and mindfulness on a daily basis or if situational factors are more relevant in daily PEB and pro-environmentally intentions. In the study of Pfattheicher et al. (2016) PEB was surveyed by values, intentions, and donations by a one-time measurement. Our utilized item asked for a

cognitive component of importance to engage in PEB and was less behavioral, thus not measuring direct PEB. We suggested this item formulations because we assumed that PEB might not be visible multiple times a day over a time period of several days. Intending to engage in PEB could be limited due to contextual and external factor, e.g. no need to limit my car use on a day I am going nowhere. Therefore, further investigation is needed to determine whether state variables such as compassion or mindfulness may have an impact on PEB in daily life, or whether these associations are only evident in trait-like measures.

In this study, we were able to minimize biases to the best of our knowledge. In the light of *deceptive self-enhancement* participants may respond as they would like to be unconsciously, because engaging in PEB might be socially desirable (Barta et al., 2012). By the short recall period, we attempted to mitigate the risk of such social desirability bias. The reasons for engaging in PEB and the characteristics of an individual who is highly motivated to behave pro-environmentally are current issues with societal relevance (Bamberg & Möser, 2007; Bissing-Olson et al., 2016; Markowitz et al., 2012). Therefore, investigation of daily experiences and daily predictors of PEB are essential to understand motives and intention of an individual to engage in PEB on a daily basis.

Limitations, implications and future research

There are various limitations that need to be addressed. First, the use of only a single item per construct may have affected the significance of the results and the range to capture each construct in daily life. Shrout and Lane (2012) assumed at least three items to be sufficient to measure a construct in ESM studies. However, we chose this approach because ESM studies often have an increased risk of reactivity due to the satisficing of participants after three measurements per day (Barta et al., 2012). To minimize this risk of reactivity and satisficing, the momentary surveys were as short as possible using single item scales to measure the study variables (Barta et al., 2012). In particular, for between participant outcomes, findings on the effectiveness of single item scales are highly inconsistent (Fisher & To, 2012). Our aim was to contribute new insights into daily associations of compassion, mindfulness, and PEB to research. There are studies that used single items to measure state variables daily and found those single items to be sufficient as well as building up fluctuations in state scores on a within participant level (Fisher & To, 2012).

Additionally, particularly for the mindfulness item, high variations in participants' scores were visible but other items showed no variance, also visible in both example participants (Figure 6 and 7). This demonstrated different expressions and an individual answer-tendency at each measurement point. Thus, indicates that state-like variables have

been assessed or that the momentary experience of the variables have changed over measurement timepoints, albeit in part at a low level. Still, future ESM studies in this field using single items to measure compassion or mindfulness, may consider the limitations and suggestions of improvement discussed above to enhance their measurement.

Secondly, the psychometric properties for the single items could only be checked to a limited extent. In particular, validity and reliability for the within participant measurements are not assessed. However, for internal states, beliefs, and intentions, only the participant himself/herself could rate if the respective construct was measured realistically and validly at a certain timepoint (Hektner et al., 2007, pp. 104–125). Analyzing data with ESM contributes to the ecological validity and external validity, in general, by providing data from participants' daily lives (Csikszentmihalyi & Larson, 2014; Verhagen et al., 2016). To ensure reliable and valid items, we used items from existing scales that had been validated and shown to be reliable. Next to this, face and content validity was evaluated by the researchers. Furthermore, correlation with the trait mean scores supported an acceptable validity for the utilized items, interpretable only on a between participant level and as for the average state measurement (Fisher & To, 2012; Horstmann & Ziegler, 2020). Future research should consider that measuring a certain construct by more than one item may increase reliability and validity, but may also increase reactivity and satisficing.

In conclusion, this ESM study was able to show patterns in daily levels of compassion, mindfulness and PEB, especially the fluctuations in compassion and PEB scores over time were rather low and revealed more stable values. Further research is needed to determine, which constructs facilitate daily PEB and the reconceptualization of items could contribute to detect a causation between compassion, mindfulness, and PEB within individuals in everyday life. The conceptualization of compassion in response to suffering of a particular other or in response to the suffering of nature in a certain moment may be considered. Furthermore, to capture state mindfulness, facets as *observing* the environment and noticing every small detail around/in nature or accepting feelings and pausing by not immediately acting in reactivity to them (*nonreactivity*) could be important to investigate in its daily effect on PEB (Barbaro & Pickett, 2016). In addition, it is important for future research to find predictors of PEB to address climate change and natural pollution, as well as design campaigns to promote PEB in everyday life.

Conclusion

Most research investigated compassion and mindfulness in their association to PEB by trait-like constructs. Because behaviors and feelings are likely to change over the course of a day and over time, experience sampling could help to provide a closer look at how PEB is expressed on a daily basis and motives such as compassion and mindfulness that influence PEB in everyday life. The use of ESM allowed us to map some variations in participants' daily experiences of compassion and PEB as well as higher fluctuations of mindfulness over time. Both hypothesized mediations on a between participant and within participant level could not be supported. Therefore, our aim to detect those associations in the daily experiences of participants was not achieved. However, the selected compassion item did not capture daily variations and asked for a cognitive component of compassion. Therefore, we found that compassion, as a more general feeling with people who are suffering, may not be related to PEB. Furthermore, the experience of ‘running on automatic’ may not influence the daily intention to engage in PEB. We believe that different facets of compassion and mindfulness might be related to PEB in daily life and that contextual factors need to be controlled or captured to identify their influence on PEB in daily life.

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Appendices

Appendix A – Overview of ESM Items

Description of ESM items and their selection/construction. All ESM questions were answered on a 7-point Likert Scale (1 = *Totally disagree*; 7 = *Totally agree*).

Variable	Item	Selection criteria / Item construction
Pro-environmental behaviors	To me it is important to limit my energy use To me it is important to limit my meat consumption To me it is important to talk to others about their environmental behaviors To me it is important to limit my use of the car	Self-designed items, based on the four factors (conversation, food, environmental citizen ship and transportation) of the Pro-environmental Behaviors Scale (PEBS; Markle, 2013).
Compassion	I like to be there for others in times of difficulty	Selected from the Compassion scale (Pommier et al., 2020). Most close to definition "A generally accepted definition of compassion is that it is a felt response to suffering that involves caring and an authentic desire to ease distress (Goetz et al., 2010).
Mindfulness	It seems I am "running on automatic" without much awareness of what I'm doing (reverse scored)	Selected from the Mindfulness Attention Awareness Scale (MAAS;K. W. Brown & Ryan, 2003). Item with the highest factor loading.
Nature connectedness	My personal welfare is dependent of the welfare of the natural world (reverse scored)	Selected from the Connectedness to Nature Scale (Mayer & Frantz, 2004). Item with the highest factor loading.
Affect	I am enthusiastic right now I am distressed right now	Selected from the PANAS (Watson & Clark, 1988)
Outdoors	Are you outdoors (yes/no) If yes: What is the reason that you are outdoors? (enjoy nature/exercise/meeting/walking or cycling for transportation/other, fill out)	
Others	Are you with someone at the moment? (yes/no) If yes: The person(s) I am with find(s) it important to care about the environment	