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„Low vs. High Socially Desirable Pro-environmental Behaviors:  
Exploring the Predictive Differences of Connectedness to Nature,  
Environmental Attitudes and Environmental Knowledge“

verfasst von / submitted by

Yvonne Jung, BSc

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Priv.-Doz. Mag. Dr. Ulrich Tran

## Table of Contents

1. Introduction .....	1
1.1. Pro-environmental behavior .....	2
1.1.1. Methodological issues of PEB scales.....	2
1.1.2. Heterogeneity of PEB scales.....	4
1.1.3. Socially desirable responding in PEB research.....	6
1.2. Social desirability of PEBs .....	8
1.3. Determinants of pro-environmental behavior .....	10
1.3.1. Environmental attitudes.....	11
1.3.2. Nature Connectedness.....	14
1.3.3. Environmental Knowledge.....	17
1.3.4. Subjective efficacy.....	20
2. Research goals and hypotheses .....	23
2.1. Pilot study .....	23
2.2. Main study .....	23
3. Method and materials .....	29
3.1. Study design .....	29
3.1.1. Sample and procedure.....	29
3.2 Measurement instruments.....	31
3.2.1. Pro-environmental behaviors .....	32
3.2.2. Nature connectedness .....	34
3.2.3. Environmental attitudes .....	34

3.2.4. Environmental knowledge .....	36
3.2.5. Socially desirable responding .....	37
3.2.6. Raffle prize choice . .....	37
3.3. Methodological framework .....	38
4. Research question 1 .....	38
4.1. Structural equation modelling .....	39
4.2. Results .....	40
4.2.1. Latent variable measurement and structural analysis of the variables. ....	40
4.2.2. Multiple linear regression analysis .....	49
5. Research question 2 .....	58
5.1. Statistical analysis .....	58
5.2. Results .....	59
5.2.1. Multinomial logistic regression.....	60
6. Discussion .....	64
6.1. Research question 1 .....	64
6.2. Research question 2.....	74
6.3. Limitations.....	81
6.4. Conclusion.....	83
7. References .....	87
8. Appendix .....	111

List of Figures

Figure 1. Final SEM. ....	57
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## List of Tables

Table 1 Descriptive results, internal consistency and correlations for all variables .....	44
Table 2 Fit Statistics for CFA Models .....	45
Table 3 $\chi^2$ -Difference Test Results for the unconstrained vs. constrained models .....	52
Table 4 Multiple linear regression analysis of the final model .....	53
Table 5 Descriptive statistics of significant predictors of the raffle participation groups .....	60
Table 6 Multinomial logistic regression with a backwards selection method .....	62

## Appendix

Table A1 Means and standard deviations of the full and short form PEB item sets.....	111
Table A2 N, means of PEB and ePEB (Main Study), social desirability and representativity (Pilot study).....	112
Table A3 Multinomial logistic regression of main effects in a backwards selection method ....	114
Table A4 Multinomial logistic regression using one-factorial PEB in a backwards selection method .....	115

## Abstract

The gap between self-reported and objective measures of pro-environmental behaviors (PEBs) is a well-established problem in environmental research. Studies indicate self-reports to be subject to method biases, including social desirability responding (SDR). However, PEB literature only found weak effects of SDR. Responding to the call for research on the subtle effects of social desirability (Vilar et al., 2020), this study divided PEBs into two groups based on the results of an exploratory pilot study ( $N = 14$ ): In an online survey, 15 PEBs with high social desirability (PEB-SD-high) were compared with 15 PEBs with low social desirability (PEB-SD-low). Research question 1 ( $N = 411$ ) investigated whether PEB-SD-high is predicted differently than PEB-SD-low by perceived efficacy of PEBs (ePEB), nature connectedness (NC), the environmental attitudes (EA) Preservation and Utilization, action-related environmental knowledge (AC), using structural equation modeling. SDR, age and sex were included as control variables. To examine the gap between self-reported and objective PEBs, a second analysis (Research question 2,  $N = 393$ ) was conducted by analysing data of a raffle at the end of the survey with two optional prizes – one pro-environmental (WWF voucher) and one unsustainable choice (Amazon voucher). All variables of Study 1 (including PEB-SD-high and PEB-SD-low) were employed as regressors in a multinomial logistic regression analysis. Regression pathways of NC, AC and ePEB-SD-high significantly differed in the prediction of PEB-SD-high and PEB-SD-low (Research question 1). The strongest predictors of PEB-SD-high were NC, ePEB-SD-high and Utilization, whereas PEB-SD-low was best predicted by Utilization, AC and SDR. Results of Research question 2 found PEB-SD-high, Preservation and Utilization to significantly determine choosing the WWF voucher. The heterogeneity found between NC and EA subscales in predicting PEB-SD-high, PEB-SD-low and raffle prize is a key finding. Presumably, EA, especially Utilization, may be a robust predictor of all PEBs and NC may depend on the social desirability of respective PEBs. In addition, objective

environmental knowledge (AC) determined PEBs only as long as they are not socially desirable. Otherwise, subjective environmental knowledge (ePEB) predicted PEB-SD-high. Overall, the study provided initial evidence of predictive differences of PEBs due to their respective social desirability. Results are discussed against the background that the confidence intervals of the regression estimates whose paths significantly differed in the prediction of both PEB item sets overlapped. Potential explanations and implications of the predictive differences of PEB predictors are given.

*Keywords:* pro-environmental behaviors, social desirability, self-reported behavior, determinants of pro-environmental behaviors, nature connectedness, environmental attitudes

## Zusammenfassung

Die Diskrepanz zwischen selbstberichteten und objektiven Maßen für umweltschützendes Verhalten (PEBs) ist ein bekanntes Problem in der Umweltforschung. Studien deuten darauf hin, dass Selbstberichte methodischen Verzerrungen unterliegen, u.a. Social Desirability Responding (SDR), obwohl die Literatur nur schwache Effekte findet. Als Reaktion auf den Vorschlag, subtile Auswirkungen der sozialen Erwünschtheit zu erforschen (Vilar et al., 2020), teilte diese Studie basierend auf Ergebnissen einer explorativen Pilotstudie ( $N = 14$ ) PEBs in zwei Gruppen ein: 15 PEBs mit hoher sozialer Erwünschtheit (PEB-SD-high) wurden in einer Online-Umfrage mit 15 PEBs mit geringer sozialer Erwünschtheit (PEB-SD-low) verglichen. In Forschungsfrage 1 ( $N = 411$ ) wurde mittels Strukturgleichungsmodellen untersucht, ob PEB-SD

-high anders vorhergesagt wird als PEB-SD-low durch die wahrgenommene Wirksamkeit der PEBs (ePEB), Naturverbundenheit (NC), die Umwelteinstellungen (EA) Preservation und Utilization, handlungsbezogenes Umweltwissen (AC). SDR, Alter und Geschlecht wurden als Kontrollvariablen einbezogen. Um die Diskrepanz zwischen selbstberichteten und objektiven PEBs zu untersuchen, wurde in einer zweiten Analyse (Forschungsfrage 2,  $N = 393$ ) Daten einer Verlosung mit zwei Gewinnoptionen am Umfrageende analysiert - eine umweltfreundliche (WWF-Gutschein) und eine nicht-umweltfreundliche Variante (Amazon-Gutschein). Alle Variablen aus Forschungsfrage 1 (einschließlich PEB-SD-high und PEB-SD-low) wurden als Regressoren in einer multinomialen logistischen Regressionsanalyse verwendet. In Forschungsfrage 1 unterschieden sich die Regressionspfade von NC, AC und ePEB-SD-high signifikant in der Vorhersage von PEB-SD-high und PEB-SD-low. Die stärksten Prädiktoren von PEB-SD-high waren NC, ePEB-SD-high und Utilization. Utilization, AC und SDR sagten am stärksten PEB-SD-low vorher. In Forschungsfrage 2 waren PEB-SD-high, Preservation und Utilization signifikante Prädiktoren für die Wahl des WWF-Gutscheins. Die gefundenen prädiktiven Unterschiede von NC

und EA, insbesondere Utilization, sind das Hauptergebnis dieser Studie. EA, insbesondere Utilization, scheint ein robuster Prädiktor für alle PEBs zu sein, während der Vorhersagewert von NC von der sozialen Erwünschtheit der jeweiligen PEBs abhängt. Zudem sagte objektives Umweltwissen (AC) die PEB-Frequenz nur voraus, wenn diese nicht sozial erwünscht waren. Andernfalls war das subjektive Umweltwissen (ePEB) signifikanter Prädiktor von PEB-SD-high. Insgesamt lieferte die Studie erste Hinweise darauf, dass PEBs aufgrund ihrer sozialen Erwünschtheit unterschiedlich hervorgesagt werden. Die Ergebnisse werden vor dem Hintergrund diskutiert, dass sich die Konfidenzintervalle der Prädiktoren, bei denen eine Gleichheit der Regressionspfade in der Vorhersage beider PEB-Gruppen nicht angenommen werden konnte, überschneiden. Es werden mögliche Erklärungen und Implikationen für die prädiktiven Unterschiede der PEB-Prädiktoren gegeben.

*Keywords:* umweltfreundliches Verhalten, nachhaltiges Verhalten, soziale Erwünschtheit, Selbstberichte, Prädiktoren von umweltfreundlichem Verhalten, Naturverbundenheit, Umwelteinstellungen



## 1. Introduction

The recent COVID-19 pandemic and its impact on our daily lives, consumption and lifestyle habits has clearly shown us how vulnerable nature is to human behavior: Researchers found that the pandemic led to a 9.3% reduction in humanity's ecological footprint compared to last year's same time period (Guardian, 2020). As a consequence, Earth Overshoot Day – the point at which humanity's demand on nature exceeds what the Earth's ecosystem can renew in a year – was moved back by over three weeks from 29 July to 22 August 2020.

Human behavior is commonly accepted as a major contributor to environmental problems and climate change (Gifford et al., 2010; Lange et al., 2018; Stern, 1992; Swim et al., 2011; Wynes & Nicholas, 2017). The awareness that the required change for a sustainable future is not only initiated on a global, national or local, but to a large extent on an individual level, is increasing (e.g., Schultz, 2011; Wallen & Daut, 2018). However, the energy consumption of, for example, German households is rising according to the Environmental Awareness Study 2018, a representative population survey by the German Environment Agency (Umweltbundesamt, 2020), which is being published every two years and which involves around 4000 participants. In fact, despite increasingly efficient electrical appliances, more and larger appliances are being purchased per individual household. Further results of the survey show that environmental awareness is only moderately linked to greenhouse gas emissions ( $r = -.21$ ) with an explained shared variance of only 4.4 % (Umweltbundesamt, 2020).

The gap between verbal claims (i.e., intentions, attitudes) and actual behavior is a crucial problem in scientific research on what drives behavior (Kollmuss & Agyeman, 2002; Kormos & Gifford, 2014; Lavergne & Pelletier, 2015; Nielsen, 2017). In fact, this gap is even evident for instruments that intend to measure pro-environmental *behavior*: They suffer from serious methodological weaknesses and risk studying (only) verbal behavior that can be shown at no cost.

Thus, the current status quo of measuring PEBs in environmental behavior research is discussed in the following section.

### **1.1. Pro-environmental behavior**

With increasing environmental awareness, the scientific community has taken an interest in investigating pro-environmental behavior (PEB)<sup>1</sup>, generating a large variety of measurement instruments. These cover a range of specific behaviors that differ greatly regarding their effort, relative financial cost, knowledge and a variety of other factors (Heimlich & Ardoin, 2008). Research has found mixed evidence of consistency in PEBs in individuals (Thøgersen, 2004), concluding that one PEB does not necessarily elicit a spillover to another (Dolnicar & Grün, 2009; Thøgersen & Ölander, 2003): E.g., people concerned with climate change may change their purchase patterns to buying organic or seasonal products, but may still refrain from giving up a car for the sake of the environment (Heimlich & Ardoin, 2008).

#### ***1.1.1. Methodological issues of PEB scales***

Some studies found self-reported PEB measures accurately assess people's behavioral performances (Gamba & Oskamp, 1994) – particularly, when dichotomized response categories were used (e.g., “*I do*” / “*I don't*”; Kaiser et al., 2003).

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<sup>1</sup> Throughout this paper, I will broadly refer to behaviors that benefit the natural environment (e.g., recycling) as well as the omission of behaviors that harm the environment (e.g., avoid littering) as pro-environmental behaviors (PEBs).

However, findings for the limited validity of self-report measures are becoming increasingly prevalent: The gap between self- and objective PEB measurement instruments has accumulated lots of empirical evidence (Kormos & Gifford, 2014; Lange & Dewitte, 2019; Markle, 2013), e.g. an early study by Gatersleben et al. (2002) developed two different PEB measures, a short self-report scale and an objective measure (estimate of household energy consumption calculated on the basis of possession of certain household goods) and only found a moderate link between the two. Recent research regarding recycling skills and household food wastage show that both behaviors are weakly correlated with self-reports and household food wastage was underestimated if self-reported (Passafaro & Livi, 2017; van der Werf et al., 2020).

Self-report measures are an easy way to obtain information about an environmentally relevant behavior, for example by asking participants how often they engage in a specific behavior along a scale from “Never” to “Always”. However, the perception of how often for example the “often” is, varies between and even within individuals (e.g. pre- and post-intervention, Lange & Dewitte, 2019). In addition, self-report measures rely on the inherent assumption that each person is able to assess their *actual* pro-environmental behavior – retrospectively surveying one’s own behavior and aggregating it appropriately. Yet, this assumption has received quite conflicting empirical support. An highly referred meta-analysis investigated the validity of PEB self-report measures with a sample size of 6260 participants and 19 PEB measures (Kormos & Gifford, 2014): Despite a rather large positive effect size ( $r = .46$ ) between self-report and objective measures, 79% of the variance in self-reported measures remained unexplained by objective instruments, raising concerns about the construct validity of self-report PEB measures. To confirm that the relevant variable adequately represents the construct it purports to measure, an accurate measurement and assessment of the intended construct has to be a prerequisite (high construct validity; Lange & Dewitte, 2019). In this case, it means that the link between self-report and objective measures bears too much “noise” that

cannot be explained by the measure and is assumed to be due to misspecifications of the different behavioral measures as Levine and Strube (2012) suggest.

### ***1.1.2. Heterogeneity of PEB scales***

Amidst the previously discussed methodological weaknesses of self-reports, the heterogeneity of self-report PEB measures might also be a reason that the self-report instruments of PEB often do not translate very well into observed real-life behavior.

A review of 49 studies revealed 42 unique instruments to measure pro-environmental behavior (Markle, 2013), confirming the tendency of researchers to develop ad-hoc scales (Dono et al., 2010). Ad-hoc scales have mainly been developed as a purpose for a particular study - hence, their psychometric quality was not assessed, leading to a lack of validated and standardized instruments measuring pro-environmental behavior.

As a matter of fact, even just the terms used to describe PEBs are so heterogenous that it further adds onto the complexity of the research topic, e.g. “pro-environmental behaviors” (Bamberg & Möser, 2007; Steg et al., 2014), “responsible environmental behaviors” (Cottrell, 2003; Hines et al., 1987; Vaske & Kobrin, 2001), “environmentally responsible behaviors” (De Young, 2000; Thøgersen, 2004), “ecological behaviors” (Kaiser, 1998) , “conservation behaviors” (Chawla & Derr, 2012; Gosling & Williams, 2010; Monroe, 2003; for a review, see Larson et al., 2015).

The 42 instruments reviewed by Markle (2013) differed greatly regarding their number of behavioral items or indicators that were utilized, ranging from 6 to 97 items. Their reported internal consistency (Cronbach’s alpha) reached from  $\alpha = .63$  to  $\alpha = .92$ .) To further highlight the heterogeneity, studies reporting correlations among subscales highly varied in their consistency (for a review, see Markle, 2013, Table 1).

The behaviors selected for each instrument vary to a large extent regarding the following aspects: As Larson (2015) points out, the two most widely-used and established scales to measure PEB, the Environmentalism scale by Stern et al. (1999) and the General Ecological Behavior (GEB) scale by Kaiser et al. (1999), emphasize different PEB domains with almost no overlap and are thus not comparable: Whereas the Environmentalism scale includes consumer choices and environmental citizenship, but ignores lifestyle behaviors (as recycling, energy conservation), the GEB scale almost exclusively concentrates on lifestyle behaviors and groups the remaining behaviors into one factor called “other”.

Regarding their impact, scales have been criticized for including items that seem marginally relevant, e.g. *“I use an oven cleaning spray to clean my oven”*, *“I use a chemical air freshener in my bathroom”* (Kaiser et al., 1999). Regarding their specificity, items can refer to a general propensity to behave environmentally-friendly (e.g., *“I participate in pro-environmental behaviors.”*, Obery & Bangert, 2017) or be very specific (e.g., *“[I] personally wrote to or called a politician/government official about an environmental issue.”*, Alisat, 2015). Given that very specific items are more prevalent in PEB scales, these will only reflect a small portion of the overall propensity to behave pro-environmentally. For example, if a person had written to a politician about environmental protection, this specific behavior might not be generalizable or representative of the person’s entity of pro-environmental behaviors – in fact, the strength of political attitudes might determine the respective behavior. Therefore, measuring the overall propensity to behave pro-environmentally via such specific indicators will generate high levels of error variance in the prediction of pro-environmental behavior (Lange & Dewitte, 2019).

### ***1.1.3. Socially desirable responding in PEB research***

Another factor for the inaccuracies of self-reported PEB measures may be response bias: Given that individuals cannot observe their own behavior as an impartial party, the responses of self-report measures can be influenced by how respondents would like to behave (e.g., in accord with their intention; Chao & Lam, 2011), how they want to be seen by others (e.g. the researcher), or can depend on previous responses respondents gave in the study. In short, self-reported PEB might be vulnerable to socially desirable responding (SDR) bias.

SDR can be understood as a tendency to give seemingly socially accepted answers in a survey. Based on the analyses of Paulhus (1984), a distinction is made between two dimensions, self-deception (SDE) and impression-management (IM). SDE refers to an unconscious distortion of one's self-perception to an overly optimistic self-image as a means of self-protection and is regarded as a rather flexible construct that often depends on the question being asked. IM can be understood as deliberate, conscious deception with the goal of presenting the most favorable image of oneself to the outside world; it correlates highly with lying (Paulhus, 1991). IM is defined as a stable personality characteristic (Krumpal, 2013).

However, taken as an explanation for the over- or under-reporting of self-reported frequency of behaviors, SDR has received mixed empirical support: A meta-analysis found explicit evidence that social desirability (without differentiating between SDE and IM) appears to have small and non-significant correlations between self-reported PEB measures and social desirability scales (Kormos and Gifford, 2014). A recent meta-analysis confirmed the weak relations between social desirability and PEBs with a pooled correlation of  $r = .11$  ( $k = 26$ ; 95% CI=[.06, .16]; Vesely & Klöckner, 2020). Environmental attitudes ( $k = 21$ ;  $r = .06$ ; 95% CI=[.03, .10]) and environmental intention ( $k = 12$ ;  $r = .08$ ; 95% CI=[.00, .15]) had even lower associations with SDR. Investigating longitudinal national data from New Zealand (N=6518), Vilar and colleagues (2020) also found

SDR to be only weakly (and unreliably) correlated with environmental questions. In addition, the correlation between SDR and environmental questions after one year were weak and statistically non-significant. As a limitation of the study, SDE and IM were each measured with only one item.

These results are consistent with previous studies that have at best observed small to moderate effects of social desirability on PEBs (e.g., Cojuharenco et al., 2016; Kaiser et al., 2007; Lam & Cheng, 2002; Sörqvist et al., 2016). Correlational and moderated multiple linear regression analyses showed that social desirability had neither a significant direct effect on self-reported PEB, nor a moderating effect between environmental attitude and PEB (Milfont, 2009; Sintov & Prescott, 2011).

Although it seems as if SDR impacts PEBs only weakly, the literature found positive results of SDR that revealed conflicting empirical evidence between the SDR subdimensions IM and SDE: A study about self-reported organic food purchasing frequency (Wheeler et al., 2019) found that SDE had an effect on self-reported behavior frequency – leading to a significant overestimation of purchasing frequency. However, no direct or indirect effect of image management (IM) on purchasing frequency was evident. A previous similar study (assessing organic food consumption and using the same social desirability scale as Wheeler et al., 2019) also found a much higher prevalence of SDE than IM in the survey sample (Goetzke et al., 2014). This finding is in line with previous literature (Sörqvist et al., 2013, 2016; Sörqvist, Haga, Holmgren, et al., 2015; Sörqvist, Haga, Langeborg, et al., 2015). A recent study (Vilar et al., 2020) reported evidence for the reversed pattern. Here impression management (IM) had a significant, however, marginal impact on the longitudinal intention-behavior relation, meaning that the desire to seek approval from others combined with behaving pro-environmentally might be a driver of subsequent pro-environmental intention.

Despite the few studies that found evidence of SDR or, more specific, mostly for the SDE subscale, it seems as if the research field of environmental psychology suffers less from SDR than other fields of (psychological) research (Veseley & Klöckner, 2020).

## **1.2. Social desirability of PEBs**

Many of the studies that found significant results of social desirability only investigate one (objective) behavior, e.g. organic food purchasing (Sörqvist et al., 2016; Wheeler et al., 2019). Thus, it is not clear if the overreporting of the purchasing frequency is (a) a personal tendency to respond in a way that might be socially desired and is irrespective of the items / behaviors that should be evaluated or if (b) the overreporting is solely attributed to the characteristics of the specific behavior and is independent of the individual responding technique.

Results of Lam and Cheng (2002) have already indicated that SDR self-reports depend on the type of environmental behavior measured which is picked up by the authors of the recent SDR meta-analysis (Vesely & Klöckner, 2020) mentioned previously: They presume that SDR might especially concern PEBs, whose performance is strongly associated with social norms or sanctions (Brooks & Wilson, 2015). Taken together, as the behaviors differ greatly in their characteristics (e.g. domain, cost, specificity), they might also vary regarding their compliance with social norms.

Following the call of Vilar and colleagues (2020) to investigate potential subtle effects of social desirability on PEBs in more detail, we aim to shed a light on the conceptual confounding of (a) and (b) and hence, introduce in this study a new concept of social desirability besides socially desirable responding (SDR):

Social desirability is viewed as one context-specific characteristic of a specific environment-related behavior and is (contrary to SDR) independent of individual factors or traits: Social desirability (Schwartz & Howard, 1982; Thøgersen, 2006) is based on social norms which



are defined as the “unplanned, unexpected result of individuals' interactions...that specify what is acceptable and what is not in a society or group” (Bicchieri & Muldoon, 2014), as well as “the unwritten codes and informal understandings that define what we expect of others and what others expect of us” (Young, 2015; for an literature overview, see Farrow et al., 2017). Thereby, social norms can refer either to what is done by the majority, i.e. what is considered normal, or to what is commonly accepted, i.e. what is socially desired or sanctioned (Cialdini et al., 1991): Descriptive norms (beliefs about what other people would do) and injunctive norms (beliefs about what other people approve or disapprove of) respectively. In this study we will solely focus on the latter.

Studies confirmed the important role of social norms on behavioral intention, e.g. a meta-analytical structural equation model from Klöckner (2013) found that personal and social norms were among the direct predictors of behavioral intention (.22 and .15, respectively). In fact, aligning descriptive and injunctive norms lead to the strongest pro-environmental intentions in samples from UK and China (Smith et al., 2012). These results support the view that individuals act in accordance with social norms when deciding to perform pro-environmental behaviors.

The existence of norms about sustainability may lead people to judge one's own or other's behavior according to its environmental footprint and to create informal sanctions and rewards, like disapproval or approval (Bicchieri, 2016). In an experimental study, Vesely and colleagues (2020) even observed that people who behaved pro-environmentally were expected to be more cooperative, were preferred as interaction partners, and even achieved more cooperation with others. As customers in our society are respected by their peers when purchasing organic products, that specific behavior is seen as a very popular and heavily promoted socially desirable behavior (Prati et al., 2017). On the other hand, avoiding to fly short distances might have lower social desirability scores and is not as heavily promoted as purchasing organic products: As two studies (Jackson, 2005; Lorenzoni et al., 2007) examined, flying during holidays can be characterized as a

behavior that is socially accepted due to present norms and is therefore difficult to change. In general, social norms that foster symbolic-affective motives (like referring to cars as status symbols) lead to decreased pro-environmental behaviors (Blankenberg & Alhusen, 2019; Steg et al., 2001) – although the society’s perception and social norm of this specific behavior is in the process of changing already (e.g., promoting Hybrid and electric cars).

Taking a look to the future, if being sustainable and acting pro-environmental in all areas became a shared highly valued social norm in societies, the benefit of a pro-environmental self-image would easily multiply (Welsch & Kühling, 2018). As the importance of social desirability regarding environmental-related behaviors has been underestimated in environmental research (Farrow et al., 2017), I address the need to investigate the social norm – the perceived expectation of the society to show a particular behavior - separately for each pro-environmental behavior. To the best of my knowledge, studies have yet to investigate how high and low socially desirable pro-environmentally behaviors are promoted through a number of well-established determinants of PEBs.

### **1.3. Determinants of pro-environmental behavior**

Which factors determine the pro-environmental behavior of a person, is a complex question. Summarizing the individual and social factors that significantly influence one’s pro-environmental behavior, Gifford and Nilsson (2014) found 18 factors, e.g., childhood experience, knowledge and education, sense of control, political and world views, norms cognitive biases, urban-rural differences, chosen activities, proximity to problematic environmental sites as well as age and gender. Focusing on improving the predictive value and validity of self-reported PEB measurements, two of the best empirically evaluated determinants of PEB appear to be environmental attitudes (EA) and nature connectedness (NC). In addition, despite being widely

used in the environmental literature to explain different types of PEBs, environmental knowledge (EK) still has an inconclusive relationship with PEBs (Heimlich & Ardoin, 2008; Tam & Chan, 2018).

### ***1.3.1. Environmental attitudes***

Environmental attitudes (EAs) are considered a key predictor of pro-environmental behavior and have been a frequently studied subject of environmental research: Comparing publications in the major journals reveals that at least every second peer-reviewed article in the field of environmental psychology examined environmental attitudes (Milfont et al., 2010; Milfont & Schultz, 2016).

Following earlier definitions (e.g., Milfont & Sibley, 2012), Milfont and Schultz (2016) defined EA as evaluative beliefs, affects and behavioral intentions about environmentally related activities or issues. For example, EA includes the extent to which an individual agrees with resource conservation policies or views the natural environment as fragile and thus, needs to be protected, or as a resource for human beings to utilize and exploit for economic purposes (Gifford, 2014; Milfont & Duckitt, 2010).

Evidence has accumulated showing a low to moderate association between connection with nature and pro-environmental behavior (e.g., Bamberg, 2003; Gupta & Ogden, 2009; Levine & Strube, 2012; Morren & Grinstein, 2016; Rodríguez-Barreiro et al., 2013). The link has been questioned by Heimlich and Ardoin (2008) and a few studies found that EA does not reliably promote direct changes in environmental behavior (Arbuthnott, 2009; Szerényi et al., 2011; Zsóka et al., 2013). On the other side, meta-analyses indicate that EA is a reliable and important PEB determinant: Hines et al. (1987) found a correlation of  $r = .37$  ( $k = 9$ ) between attitude and PEB which is comparable with more recent results, e.g., by Bamberg and Moser (2007;  $r = .42$ , 95% CI

= [.26, .56],  $k = 17$ ), Milfont (2012;  $r = .48$ , 95% CI = [.42, .54],  $k = 5$ ) and Klöckner (2013;  $r = .36$ , 95% CI = [.28, .43],  $k = 30$ ). In addition, the effect sizes between attitudes and behavior in this field of environmental psychology seem to be larger than those usually obtained in social psychology (Milfont & Schultz, 2016).

However, in case of a weak relationship between environmental attitudes and PEB in a study, a common explanation is the mismatch between the measurement specifications for the two variables (Casaló et al., 2019; Levine & Strube, 2012), which is not surprising given that a multitude of EA concepts and scales have been provided over the last years.

According to Milfont and Schultz (2016), measurement instruments can be categorized – among other factors – if they assess the attitude towards a single environmental topic (e.g. recycling) or multiple topics (for an overview, see McIntyre & Milfont, 2015). The most widely used multiple-topic measures are the New Environmental Paradigm scale (Dunlap & Van Liere, 1978) and its revised version, the New Ecological Paradigm scale (Dunlap et al., 2000) as well as the Environmental Attitudes Inventory (EAI; Milfont & Duckitt, 2010). Both of the latter differ in regard to their number of items, structure and dimensionality: Whereas the NEP scale is unidimensional, contains 12 to 15 items and five facets, the EAI depicts a much broader range of attitudes with 72 items and 12 facets. Designed as a multidimensional construct, the EAI is composed by different bipolar dimensions that can be aggregated into one first-order factor (generalized environmental attitudes) or two second-order-factors (preservation and utilization). The orthogonal second-order factors are theoretically based on Blaikie (1992) who claimed that an individual is torn between the belief that the protection and preservation of nature and its diversity should be prioritized (Preservation) and the belief that the use of natural resources for human purposes is to some extent justified, appropriate and necessary (Utilization; Milfont & Duckitt, 2010).

According to Gatersleben et al. (2014), environmental attitudes are - contrary to identities and values - assumed to not be a stable construct that is independent of situational or contextual factors. Hence, to shed some light onto the attitude-behavior association in detail, a plethora of empirical research has looked at potential influencing factors.

As Kaiser et al. (2010) proposed, PEB is determined by the costs of the specific behavior (e.g., money, time) and the strength of the latent environmental attitude. Results from a study by Casaló and Escario (2018) revealed that pro-environmental behaviors were only related to strong environmental attitudes, highlighting the role of attitude strength as an explanation for the inconsistent results. Initially planning to investigate behavioral spillover (as attitude is said to be influenced by subsequent behaviors (e.g., Dolan & Galizzi, 2015), Brügger and Höchli (2019) found that participants mostly act in accordance with their attitude strength regardless if they recall previous behaviors. In case of behavioral spillover, a high pro-environmental attitude tends to work as a “behavioral stabilizer” that keeps the participants on track and in resistance against disengagement and self-complacency and, hence, increases PEB. Low pro-environmental attitudes occur to make participants vulnerable to behavior fluctuations like “moral licensing” or disengagement after recalling a goal-inconsistent behavior.

Given that pro-environmental behaviors vary to a large degree in their characteristics, the relationship between attitude and behavior may depend on the different types of PEBs as indicated by Casaló and colleagues (2019): A recent study using data from a representative nationwide survey of Spanish adults (Casaló et al., 2019) observed significant correlations with general environmental attitudes only for curtailment behaviors (e.g. separating trash, turning the light off when leaving a room) than efficacy behaviors (e.g. using an LED light bulb) – and in addition only for the highest levels of environmental attitudes.

### ***1.3.2. Nature Connectedness***

Apart from environmental attitudes, the importance of humans' connection with nature is one of the best empirically supported findings for explaining pro-environmental behavior: Nature Connectedness (NC) can generally be defined as the individual's sense of "oneness" with nature (Capaldi et al., 2014; Mayer & Frantz, 2004). Due to its recent popularity, at least 17 measurement instruments of NC have been developed (Tam, 2013). The theoretical understandings and operationalisation of scales diverge in regard to their cognitive, behavioral and affective focus: e.g. NC is defined as the extent to which he or she feels like being a part of the natural environment (affective focus; e.g., Connectedness with Nature scale (CNS): "*I often feel a kinship with animals and plants*", Mayer & Frantz, 2004), the role of nature in a person's identity or self-construal (cognitive focus; e.g., environmental identity scale (EID): "*Behaving responsibly toward the Earth - living a sustainable lifestyle - is part of my moral code*", Clayton, 2003) and expressed through "bonding activities" (Brügger et al., 2011, p. 326) with nature (behavioral focus; e.g., "*I get up early to watch the sunrise*", Brügger et al., 2011).

NC is assessed as a subjective experience which is embedded within the self and, thus, can be seen as a values-based attitude with qualities similar to personality traits (Brügger et al. 2011). It differs between individuals and groups and is relatively stable in regard to time and situational contexts, but can also be flexible enough to change (Mayer & Frantz, 2004; Nisbet et al., 2009). On the other hand, NC also have the characteristics to be seen as a state: Being exposed to nature and completing nature interventions lead to short-term increases of NC (Mayer et al., 2009).

The theoretical assumption that feeling connected to nature prompts people to engage in more PEBs, can be confirmed as an increasing amount of empirical work found strong positive associations between PEB and NC (e.g., Barbaro & Pickett, 2016; Brügger et al., 2011; Mayer & Frantz, 2004; Nisbet et al., 2009; Perkins, 2010) and replicated findings (e.g., Geng, et al, 2015;

Tam, 2013). For instance, individuals with higher NC are more likely to engage in energy- and resource-saving behaviors like recycling (e.g., Dong et al., 2020; Gkargkavouzi et al., 2018) and outdoor activities like camping (Pensini et al., 2016).

In a recent meta-analysis (Mackay & Schmitt, 2019) of correlational studies ( $k = 75$ ) revealed strong positive associations of NC with PEB ( $r = .37$ ; 95% CI = [.34, .40]). Across different operationalizations of nature connectedness, estimated effect sizes for each measure were significant and similar to the overall effect size, except for the implicit NC measure, which was lower correlated to PEB than the other instruments. Across different PEB measures, observed PEBs ( $r = .23$ , 95% CI = [.17, .28]) had lower correlations with NC than self-reported PEBs ( $r = .37$ ; 95% CI = [.33, .41]). In addition, private ( $r = .38$ ; 95% CI = [.33, .43]) and public sphere PEBs ( $r = .36$ ; 95% CI = [.29, .43]) had comparable results.

Another recent meta-analysis (Whitburn et al., 2020) confirmed the strong and robust link between nature connectedness and pro-environmental behaviors with a moderate effect size of .42 (95% CI = [.36, .47];  $k = 37$ ). Of interest, when the scale used to assess NC contained affect and behavior, or both combined with cognition, highest correlations between NC and PEB were observed ( $r = .52$  and  $r = .50$ , respectively). Across different PEB measures, the relationship ranged between  $r = .36$  and  $r = .51$  for self-reported instruments and  $r = .29$  for observed PEB. Both meta-analyses did not find moderating effects of participant mean age, age groups or the percentage of females in the sample.

Despite that the conceptualisation and operationalizations of NC differ to some extent, Tam (2013) revealed excessive empirical overlap among the various NC measures. The scales loaded on a single factor, intercorrelated highly (with  $r$  between  $r = .70$  to  $.88$  for non-graphical measures) and correlated similarly with criterion variables. Hence, these results suggest that different scales measure the same construct. However, some scales show (small) incremental validity: When

predicting self-reported PEB, the *Environmental Identity* scale (Clayton, 2003) and *Connectivity with Nature* scale (Dutcher et al., 2007) were incrementally important. When predicting support for environmental causes, only the *Love and Care for Nature* scale (LCN; Perkins, 2010) contributed beyond the common factor.

The evidence for the strong relationship between NC and PEB must, however, be interpreted with caution due to the fact that various NC measures include behavioral items and are thus confounded with pro-environmental behaviors (e.g., Alisat et al., 2014; Hedlund-de Witt et al., 2014; Perkins, 2010).

Explicitly focusing on the affective component of NC, Perkins (2010) developed the *Love and Care for Nature* scale. Results of a principal components analysis provide evidence that LCN is different from two established NC measures (CNS; Connectedness to Nature Scale; Mayer & Frantz, 2004; INS; Inclusion Of Nature in Self; Schultz, 2001) and almost exclusively loads on a different factor than the CNS and the INS that load on a common factor. This finding suggests that the LCN scale is distinct from two established NC measures and thus may measure a different construct or sub-dimension of NC - which is especially of interest, because the CNS scale claims to also measure the affective component of NC, which has already been questioned by Perrin and Benassi (2009). In line with the proposition put forward by Meneses (2010), the results indicate that NC might be closer related to emotions than cognition.

Taken together that (a) NC scales including behavioral items should be avoided, (b) NC measures that include affective components correlate higher with PEB (Whitburn et al., 2020) and that the LCN scale explicitly (c) has incremental validity (Tam, 2013), (d) has one of the strongest correlations with PEB (Tam, 2013) and (e) above average effect sizes in both meta-analyses (together with another affective scale:  $r = .44$ , Mackay & Schmitt, 2019; and  $r = .42$ , Whitburn et



al., 2020), this study will solely focus on the affective component of nature connectedness and hence, utilize the Love and Care for Nature (LCN) scale by Perkins (2010).

### ***1.3.3. Environmental knowledge***

Behavior-distal, environmental knowledge (EK) is seen as reliable and important determinant of pro-environmental behavior. In fact, EK was seen as one of the most potent predictors of PEBs in the classic meta-analysis of Hines et al. (1987). To deliberately act in pro-environmental ways, knowledge about the consequences of specific behaviors is required – especially as a means to overcome psychological barriers (e.g., misinformation, ignorance) that prevent performing PEBs.

Regardless that the amount of available information about environment-related topics has grown exponentially in the last years, the prevalent environmental knowledge of study samples seems to be on concerningly low levels: Depending on the employed knowledge scale, studies found that the percentage of knowledge questions answered right in an adult sample, ranged between 54% (Frick et al., 2004) and 68.6% (Geiger et al., 2019). The knowledge of adolescents is found to be very low with 17% (Liefländer et al., 2015) and 31% correct answers (Roczen et al., 2014). Taking into account that the PISA study (see OECD, 2009) suggests a response probability of a specific question above 62% in order to assume that the person possesses this specific respective knowledge, the empirical results (e.g., Frick et al, 2004) should raise concerns about the prevalent environmental knowledge in the German-speaking population. An US study (Robelia & Murphy, 2012) found that prevalent environment-related knowledge is to a large degree dependent on the topic.

Empirical evidence suggests a moderate positive relationship between EK and PEB, starting with findings from an early meta-analysis (Hines et al., 1987) and various replications since (Frick

et al., 2004; Geiger et al., 2018, 2019; Meinhold & Malkus, 2005; Roczen et al., 2014): Objective knowledge explains between 3% and 24% of behavioral variance of PEBs (e.g., Braun & Dierkes, 2019; Roczen et al., 2014; Geiger et al., 2018;). Two extensive meta-analyses (Bamberg & Möser, 2007; Hines et al., 1987) have found that EK plays an indirect role in predicting PEB and is mediated by intentions to act more environmentally friendly, moral norms and feelings of guilt. Several studies add onto that assumption, e.g., Frick et al. (2004) and Liu et al. (2020) found no significant direct effects on pro-environmental behaviors, but the EK-PEB link was fully mediated by environmental attitudes and environmental behavioral intentions. Thus, EK can be seen as a behavior-distal determinant.

Self-reported knowledge regarding sustainability showed weak to zero relations with objective ability measures (Effeney & Davis, 2013), problem awareness showed weak relations with general knowledge on climate change consequences and not at all with more specific knowledge on the topic (Ünal et al., 2018). However, Casaló et al. (2019) found that subjective EK was associated with all PEBs, whereas objective EK was only associated with specific PEBs, namely efficiency behaviors (e.g., using energy-efficient light bulbs) in a Spanish sample.

The only objective EK scale that is based, to my best of knowledge, on a Rasch model (which is the measurement model of choice when developing a knowledge scale, Frick et al., 2004), is the environmental knowledge scale (Frick et al., 2004; Kaiser et al., 2008; Roczen et al., 2014). It distinguishes between three different types of environmental knowledge: System-related knowledge, action-related knowledge, and effectiveness knowledge.

System-related knowledge relates to declarative knowledge about structures and functions of ecological systems and its underlying mechanisms and natural laws (e.g., *The “El Niño” phenomenon is a direct consequence of global warming. (true/false); In principle, today there is*

*enough food available worldwide to feed all the people on earth. (true/false)*; Frick et al., 2004; Roczen et al., 2014).

Action-related knowledge (AC) addresses procedural knowledge about possible actions to maintain a sustainable, pro-environmental lifestyle, for example how one can reduce household waste or conserve resources (e.g. (a) *In recycling, no energy is lost.* (false), (b) *How much water does it take to fill a bathtub?* (100 liters, 200 liters (true), 300 liters); Frick et al., 2004; Roczen et al., 2014). Although action-related knowledge explains that one is aware of pro-environmental behavioral options, for example, that water can be saved by showering instead of taking a bath, AC does not depict if one knows how effective this specific option is – that is measured by effectiveness knowledge:

Effectiveness knowledge (EF) comprises information about how to best (effectively) achieve a sustainable, pro-environmental lifestyle via evaluating and comparing behavioral patterns in regard to their effectiveness in promoting sustainability and protecting resources (e.g., *Non-returnable beer bottles are about as environmentally friendly as aluminum cans.* (false), *Energy-saving lamps consume about how much less energy than conventional light bulbs for the same amount of light? 20% less energy, 80% less energy* (true); Frick et al., 2004; Roczen et al., 2014). System-related knowledge and effectiveness knowledge both correlate weakly with action-related knowledge (Braun & Dierkes, 2019; Frick et al., 2004; Roczen et al., 2014).

Of note, the assumed structure of three subdomains of EK has only once been empirically tested against a model where all subdomains loaded on a single factor that reached a marginally better fit than the three-factor model (Frick et al., 2004). A recent study even found that EK might even be a subdimension of general knowledge factor (Geiger et al., 2019).

According to Roczen et al. (2014) and Frick et al. (2004), system knowledge is not directly related to PEB, whereas AC directly contributes to a person's behavioral performances with  $r = .15$  to  $r =$

.18. Hence, AC is a more proximal determinant of PEB. Together with environmental attitude, AC accounted for 34% of the variance in a person's PEB (Roczen et al., 2014). For the direct relationship between EF and PEB, the picture is still inconclusive: Frick et al. (2004) found significant correlations between EF and PEB only in two of five random subsamples (with  $r = .12$ ); in the study of Roczen and colleagues (2014) EF turned out to be insignificant; in a recent study EF yielded either nonsignificant or small positive effects on performed behavior ( $r = .10$ ; Braun & Dierkes, 2019). Taking into account that EF correlates with AC (see e.g. Frick et al., 2004), usually scores the lowest (Braun & Dierkes, 2019) and leads to the least knowledge accumulation after an intervention (see e.g., Liefländer et al., 2015), researchers propose that (a) AC can be seen as a precedent of EF as one needs to have different ecological options in mind before accumulating knowledge about the effectiveness of different behavior options and (b) EF appears to be more difficult to obtain in comparison to AC and system-related knowledge.

#### ***1.3.4. Subjective efficacy***

As discussed previously, knowledge-based approaches yield limited efficacy for explicitly and reliably explaining pro-environmental behavior and behavioral changes regarding PEB (e.g., Leiserowitz et al., 2005; McKenzie-Mohr, 2000; Stern, 2000): As a behavior-distant determinant, effectiveness knowledge (EF) fails to directly promote PEB by increasing its knowledge – hence, the relationship between these two factors is lacking a full understanding yet and might be influenced by other factors (McKenzie-Mohr, 2000; Simmons & Volk, 2002).

The knowledge regarding environmental impact is highly particular and subject to over- and underestimation– with especially large underestimates for high-energy activities (see e.g., Attari et al., 2010). A US study (Truelove & Parks, 2012) found that environmental impact of driving on global warming was judged accurately, adjusting the thermostat and eating meat was

underestimated and littering was overestimated. This is, however, not surprising given that education and governments often fail to recommend the most effective individual actions (e.g., Wynes & Nicholas, 2017).

For example, contrary to popular belief, turning off the lights is not the most effective PEB. However, one recent study (Lundberg et al., 2019) showed that it still remains the most frequent response in the United States since the 1980s - even in year 2019 (with 36.3% of the participants). Remarkably, lack of effectiveness knowledge might not be the reason for it: When asked to make a recommendation to a friend between turning off the lights or replacing incandescent bulbs with CFL or LED bulbs, the participants shifted their opinion towards replacing the bulbs (77%) which in fact is the more efficient behavior. As an explanation why turning off the lights still was the most common response, the participants predominantly stated that it was “easy to do” and they had been “taught to do this” (Lundberg et al., 2019). Thus, this indicates that the fast evaluation of the effectiveness of behaviors might not be an objective and knowledge-based process – in fact, it can be overridden by subjective factors like habitual use and cost of behavior.

In line with that, heuristics and cognitive biases also play a role in the evaluation process. Heuristics are used to simplify a person’s judgement, which is often the case, when an integration of uncertain data across multiple relevant criteria is needed, which is cognitively demanding. Recent findings reveal that twenty-four different heuristics were used in an energy-use judgement task (Broek & Walker, 2019). For example, when adding environmentally friendly items to a set of conventional items, participants report that the whole set has a lower environmental impact, although the impact in fact has increased (“negative footprint illusion”, e.g., Kim & Schuldt, 2018). The same also holds true for different object domains: While participants believed that buying a second conventional car would increase the environmental impact of a household, they did not believe that an additional hybrid car would do so (Kim & Schuldt, 2018). A recent study (Holmgren

et al., 2018) finds that this illusion is evident irrespective of the presence the necessary knowledge to make accurate evaluations. Research explains this illusion by the tendency to believe that the addition of environmentally-friendly objects can compensate for the negative impact of less sustainable objects (Holmgren, Andersson, et al., 2018).

The *subjective* effectiveness<sup>2</sup> of specific behaviors is subject to various factors that lead to misjudgements about the actual impact of a behavior. Yet, one study (Truelove & Parks, 2012) showed that this perceived – and therefore subjective - effectiveness might even be a more accurate predictor of PEB than objective environmental knowledge itself: Whereas effectiveness knowledge about global-warming mitigating behaviors were unreliably correlated with behavioral intention (with only one out of 12 correlations reaching statistical significance), the subjective effectiveness - whether correct or not - were strongly linked to the intention to perform that behavior ( $r = .67$ ,  $p < .001$ ). In detail, correlations between the belief that a behavior is effective in mitigating global warming and the intention to perform that behavior were especially high for adjusting the thermostat and reducing meat consumption ( $r = .66$  and  $r = .63$ ), but low for reducing driving and not littering ( $r = .35$  and  $r = .20$ ; Truelove & Parks, 2012). These results indicate that people act in accordance with how they perceive the environmental impact of behaviors, irrespective if they are factually incorrect.

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<sup>2</sup> Throughout this study, it will be referred to the subjective effectiveness of PEBs as *ePEB*.

## **2. Research goals and hypotheses**

### **2.1. Pilot study**

In the previous sections it was noted that the different characteristics of PEBs (e.g., cost of behavior) is often not systematically investigated and controlled for in the literature. Therefore, a pilot study aimed to shed light onto three different characteristics of environment-related behaviors: Regarding the gap between self-reported and objective behavior as well as methodological weaknesses in the PEB research, studies (e.g., Lange & Dewitt, 2020) indicate that the heterogeneity of the behaviors utilized to assess PEB might explain this gap. To further investigate the social desirability of PEBs, participants have been asked to determine the perceived social desirability of each item a list of PEBs in a pilot study (*PEB-SD*). In order to prevent PEBs from being too specific to explain a person's overall environmental behavior, it was also investigated which PEBs are perceived as representative of a person's "sum" of PEBs (*representativity*). As the behavioral cost of various PEBs is as wide-spread as their heterogeneity indicates, the participants were additionally asked to rate how difficult it is to implement the respective behavior in everyday life (*effort*).

All items as well as its descriptive statistics and psychometric properties are displayed in Table 2 in the appendix. As the same items were used in our main study, more information about the scales can be found in the subsequent section "Method and materials".

### **2.2. Main study**

#### **2.2.1. Social desirability**

This study responds to the call for more research of the subtle effects of social desirability (Vilar et al., 2020) and the results of the exploratory pilot study that we outlined previously: The first main objective of this study is to investigate if pro-environmental behaviors that are perceived

as highly socially desirable are predicted differently than low socially desirable pro-environmental behaviors. Hence, I will check for heterogeneity in the association between nature connectedness, environmental attitudes, environmental knowledge, subjective efficacy each with pro-environmental behavior and thereby determine if the social desirability of PEBs leads to significant differences of these prior predictors.

Beforehand, as the structural relationships between the variables EA, NC, EK and PEBs have been subject to various studies, we confirmatorily hypothesize:

*H1: PEB is moderately associated with environmental knowledge, environmental attitudes, nature connectedness, with the link between PEB and nature connectedness being descriptively the strongest. Action-related knowledge shows a higher correlation with PEB than effectiveness knowledge.*

As this study is, to our knowledge, the first to assess the social desirability of a list of PEBs, it is assumed that the determinants will predict the self-reported high or low socially desirable PEBs differently. Regarding the link between PEBs and environmental attitudes and environmental knowledge, a recent representative Spanish study has already found empirical evidence that EA and EK relate differently to specific types of PEBs. Casaló and colleagues (2019) found that objective EK was only associated with efficiency behaviors, whereas EA were only associated with curtailment behaviors. Contrarily, the effect of NC on different types of PEB has not been investigated yet. Hence, it is exploratorily proposed:

*H2: We hypothesize that the prediction of high socially desirable PEBs differs from low socially desirable PEBs in terms of (a) subjective efficacy, (b) environmental attitudes, (c) nature connectedness and (c) environmental knowledge.*

In the following, the cluster with the high socially desirable PEBs will be referred to as *PEB-SD-high*, the cluster with the low socially desirable PEBs as *PEB-SD-low*. In order to clarify that



the PEB frequency is not influenced by a personal tendency to respond in a way that might be socially desired and is irrespective of the items that should be rated – namely socially desirable reporting (SDR). Therefore, SDR will be included as a control variable.

### ***2.2.2. Objective pro-environmental behavior***

As discussed before (e.g., Geng et al., 2015), the gap between verbal claims of behavioral frequency and observed (objective) behavior has been a frequently studied subject of environmental research. As the predictive value of the independent variables only refers to self-reported PEBs so far in this study, it is yet unclear how they differ in predicting objective behavior. Hence, to shine a light onto potential differences in predicting subjective vs. objective PEB, a hybrid evaluation approach was employed by adding an objective PEB measure - namely, a raffle that will be provided at the end of the survey with an environmentally friendly or non-environmentally friendly winning option.

Three categories will be distinguished: (1) choosing the environmentally friendly raffle option, (2) choosing the non-environmentally friendly raffle option and (3) deciding to opt-out of the raffle. The goal is to investigate potential differences in predicting these three objective behaviors. Although opting-out of the raffle cannot directly be referred to as an environment-related behavior, it still might be an important source of information, e.g. how this group of subjects differs from (1) and (2) in regard to their environmental attitudes, nature connectedness, environmental knowledge and PEB frequency. Especially of interest will be the role of high and low socially desirable PEB frequency on the choice of raffle prizes or opting-out, since no study has yet investigated that relationship. Hence, to bridge that knowledge gap, we propose:

*H3: Subjects (1) who choose the environmentally friendly raffle prize option differ from subjects (2) who choose the non-environmentally friendly raffle prize option as well as from*

*subjects (3) who decide not to participate in the raffle, with regard to their (a) PEB frequency, (b) subjective efficacy, (c) environmental attitudes, (d) nature connectedness, (e) environmental knowledge and (f) SDR. In addition, we hypothesize that the subjects of each response group differ from each other in terms of their frequency of PEB-SD-high and PEB-SD-low.*

*Descriptively, the following is assumed:*

- *Participants who reported high PEB behavior are more likely to choose the WWF voucher.*
- *Participants who scored high in NC, EAPR and low in EAU are more likely to choose the WWF voucher.*
- *Participants who scored high in IM are more likely to choose the WWF voucher. There is no significant difference between the regression weight of high and low socially desirable PEB after controlling for IM.*

### **2.2.3. Subjective efficacy**

As a few studies (e.g., Kim & Schuldt, 2018; Truelove & Parks, 2012) indicate, people often misjudge the actual impact of behaviors on nature and resources. In particular, Truelove and Parks (2012) found that people intend to act in accordance with how they perceive the environmental impact of behaviors, irrespective if they are factually incorrect. Hence, the subjective efficacy might be a potentially more accurate determinant of self-reported PEBs than the level of objective knowledge of an individual itself.

To my knowledge, no empirical research has been conducted yet to test whether the subjective efficacy of a list of behaviors relate to their frequency, not just behavioral intention. Hence, in this study a list of pro-environmental behaviors should be rated regarding how often they are performed (frequency of PEBs) and how much positive or negative impact the behaviors have on nature,

environment and climate - in the participants' opinion. This allows for a direct comparison of PEB frequency and estimated efficacy of PEB. Therefore, we propose:

*H4: Subjective effectiveness and PEB frequency as well as effectiveness knowledge are positively correlated. In addition, we hypothesize that highly socially desirable PEBs will be perceived as more impactful regarding the environment.*

In line with Truelove and Parks (2012), we assume that a subjective impact evaluation is applied without resorting to objective effectiveness knowledge. To rule out that effectiveness knowledge influences the relationship between subjective efficacy and PEB frequency, we thus propose the following:

*H5: Effectiveness knowledge moderates the relationship between subjective effectiveness and PEB frequency.*

#### **2.2.4. Associations of socio-economic characteristics with PEBs**

Prior research identifies age and gender as important socio-economic characteristics of PEBs (for a review, see Gifford & Nilsson, 2014):

On one hand, age is found to be positively correlated with PEB in a multitude of studies (e.g., Casaló & Escario, 2018; Diamantopoulos et al., 2003; Olli et al, 2001; Van Liere & Dunlap, 1981). Using data from studies between 1970 and 2000, a meta-analysis (Wiernik et al., 2012) observed small, but robust relationships between age and PEBs: When individuals grow older, they become more likely to exhibit environment-related behaviors of different domains, including engaging with nature, avoiding harm, consuming sustainably and educating others. On the other hand, however, there are few studies that found the opposite effect of age onto PEB frequency (e.g., Hines et al., 1987): Age was negatively correlated with purchasing fair trade products (McCluskey et al., 2009), environmental concern (Shen & Saijo, 2008) and PEBs that require active

involvement like outdoor activities (Johnson et al., 2004). Explanations for this apparent paradox may be provided by Otto and Kaiser (2014), who compared age groups of two large German samples assessed in 2001 and 2010 and found participants below 30 years and between the age of 60 to 69 to have increased their ecological performance the most compared to their initial reported PEBs in 2001. As Blankenberg and Alhusen (2019) propose, this may advocate for PEBs to follow a life-circle.

Empirical research identifies gender as a crucial influencing factor of PEB frequency as women tend to have more pro-environmental attitudes (e.g., Franzen & Vogl, 2013), higher environmental concern (Casalò & Escario, 2016) and exhibit more PEBs than men (e.g., Luchs & Mooradian, 2012, Scannell & Gifford, 2013). This finding was found to be consistent across 14 nations and age (Zelezny et al., 2000). This may be explained through a stronger ethic of care and higher sense of social responsibility (Zelezny et al., 2000). Of interest, however, women have less factual environmental knowledge compared to men, but express higher environmental concern (Arcury & Christianson, 1993; Gambro & Switzky, 1999; Levine & Strube, 2012). Therefore, two hypotheses are proposed:

*H6: There is a positive correlation between the age of the subjects and the frequency of PEBs and environmental knowledge.*

*H7: Women report a higher frequency of PEBs and have lower environmental knowledge scores than men.*

### 3. Method and materials

#### 3.1 Study design

To detect small bivariate associations, e.g., a small one-tailed correlation of  $r = .13$  between effectiveness knowledge and PEB (Frick et al., 2004) with 80% power and an alpha of 5%, a sample size of approximately 400 ( $N = 391$ ) is required.

##### 3.1.1. Sample and procedure

The online survey was implemented using SoSci Survey (Leiner, 2019) and made available to the participants via [www.soscisurvey.de](http://www.soscisurvey.de). The data acquisition started at 7<sup>th</sup> of February and ended at 8<sup>th</sup> of March 2020, when the threshold of the minimum number of participants needed had been reached ( $N = 400$ ), resulting in  $N = 411$  participants who completed the survey and choose to participate in a subsequent raffle or opt-out of it. Of note, the choice of the two possible raffle prizes was made available only after choosing to opt-in or out of the raffle. Therefore, it did not reach the minimum number of needed participants ( $N = 391$ ).

The first page of the survey was accessed 772 times, whereas the last page of the questionnaire (at which the decision to opt-in or -out for the subsequent raffle has to be made) was completed by 414 participants. The sample of  $N = 414$  was comprised of 76.0% female, 22.6% male and 1.5% participants that assigned themselves as a third gender. The mean age at the time of the survey participation was  $M = 28.04$  years ( $N = 410$ ,  $SD = 9.68$ ), ranging from 18 (required minimum age) to 86. Regarding country of residence, the sample was composed of 65.5% participants living in Austria, 32.4% in Germany and 2.2% in another country. With respect to education the median highest qualification was a Bachelor University degree with 42.7% of the sample ( $N = 412$ ,  $SD = 1.98$ ). 65.5% of the participants were students and 22.6% occupied as employees. In regard to the preferred choice of transportation, 62.6% of the participants report to

mainly use public transport, 15.3% majorly go by bike and 15.0% by car. Asked to rate their residence in a range between rural (0) and urban (100), a right-skewed distribution with a mean of  $M = 80.51$  indicates that the sample perceives their place of residence as quite urban.

Thus, the distribution of gender, age and education is not representative of the general Austrian population, but can be considered a representative student sample due to the data collection procedure which mainly proceeded via Facebook groups or university-internal emails to students.

The chairperson of a university lecture series on climate change of the University of Vienna distributed the survey link to the assigned students at my request. The lecture series was held from October 2019 to February 2020 and was open to all students of the University of Vienna as well as to the wider public. Approximately 130 students of this course took part in the survey (course participation was not logged in the survey; this number was deduced from the timing of incoming data). Four professors at the Vienna University of Business and Economics were contacted as well. One professor from the Change Management and Management Development department sent the request to students assigned to the courses of his department, resulting in a survey participation of approximately 130 of his assigned students (again, deduced from the timing of incoming data).

In addition, the survey was distributed to either personal contacts or Facebook groups about topics similar to the current research themes (e.g., Students for Future Austria), university studies that include environmental and sustainable issues in their curricula (e.g., UBRM Master at University of Natural Resources and Life Sciences, Vienna – a Master programme Environment and Bio-Resources Management) or Facebook Groups that are unrelated to the research topics (e.g. a group for students at the University of Vienna). The online research platforms SurveyCircle (SurveyCircle, 2020) and PoolPoll (PoolPoll, 2020) were further used for the recruitment of participants, resulting in 18 datasets from SurveyCircle and 5 from PoolPoll.

The survey participation was voluntary and fully anonymous. Participants were required to be at least 18 years of age and provided an informed consent in order to proceed with the survey. The survey took approximately 15 minutes and ended with an optional raffle of six vouchers each worth €20. Participants could choose between a pro-environmental (donation for a rainforest conservation project by WWF) and a non-pro-environmental option (Amazon gift voucher).

### **3.2. Measurement Instruments**

Of note, in the current study the 7-point response format of the environmental attitudes scale (EA; Sutton & Gyuris, 2015), the nature connectedness scale (NC; Perkins, 2010), and the socially desirable responding scale (SDR; Winkler, Kroh & Spiess, 2006) were changed to 5-point response formats, as was used in the PEB measure (Arnold et al., 2018; Kaiser & Wilson, 2004; 5-point Likert scale from 1 = *strongly disagree* to 5 = *strongly agree*) for reasons of comparability, simplicity, and uniformity in the online survey.

As Cronbach's alpha underestimates the true reliability of a scale unless the items are tau-equivalent (Deng & Chan, 2017; McNeish, 2018) and is not suitable for binary coded items as in the environmental knowledge scales EF and AC (e.g., Gadermann et al., 2012), the ordinal coefficient of McDonald's Omega ( $\omega$ ; McDonald, 1999) was employed to determine the internal consistency of the scales (Elosua & Zumbo, 2008; Gadermann et al., 2012). The point estimate for the ordinal Omega total coefficient have been calculated with the `scaleStructure` function in the `userfriendlyscience` package in R (Peters, 2014, 2018) which uses the MBESS function `ci.reliability` (Dunn et al., 2014).

As discussed in the section "Analysis", a few items were removed from the scales. Hence, the internal consistency (Omega) refers to the final set of items.

### **3.2.1. Pro-environmental behaviors**

PEBs were measured using two item sets of 15 behaviors – each set with either the highest or lowest values for social desirability (and moderate to high values for representativity). These 30 items have been selected in a prior pilot study: A list of 64 PEBs was sent as an online survey to a sample of Psychology master students ( $N = 14$ ). The participants were asked to rate how socially desirable the respective behavior is (*PEB-SD*), how representative it is to predict the overall environmental behavior of a person (*representativity*) and how difficult it is to implement the respective behavior in everyday life (*effort*). To note, the frequency of these behaviors was not subject of the pilot study and therefore has not been asked.

A two-mean cluster analysis was employed to detect systematic group differences of the items. Representativity had the greatest impact as a predictor (1.0), followed by social desirability (0.9). With approximately 0.55, effort contributed the least in predicting changes of item values.

As a next step, a short form of the PEB scale was generated with 30 items that differ greatly regarding their social desirability, albeit still being estimated as being above average in terms of their representativity. Effort was not taken into account since it had the least predictive impact. Hence, 15 behaviors for each cluster were selected for the current study. In an overview, the descriptive statistics of the social desirability, representativity and effort of the full (64 PEBs) and short (30 PEBs) item set are displayed in Table A1 in the Appendix. The selected 30 items and their social desirability, representativity and effort values are found in detail in Table A2 in the Appendix.

22 of the 30 selected items had been taken from the German version of the *General Ecological Behavior Scale*, a 50-item measure of pro-environmental behavior (Kaiser & Wilson, 2004) and two items were added from the adapted German scale for adolescents (Kaiser et al., 2007). Both scales can be considered Rasch scales and have been found to aggregate into



unidimensional scales even when the self-reported PEBs are from different domains are used in various sociocultural contexts (Kaiser & Wilson, 2000; Scheuthle et al., 2005). Evidence for the GEB measure's criterion validity as well as test-retest validity was provided by Arnold et al. (2018) and Kaiser et al. (2014).

With the GEB mostly focussing on lifestyle behaviors, behaviors from distinct domains (e.g., environmental activism) have been neglected. To broaden the range of potential PEBs, five supplementary items have been self-generated by the author and one item was taken from a new multi-dimensional measure of PEB by Gkargkavouzi et al. (2019).

**Frequency of PEBs.** The participants were asked to rate the frequency of their pro-environmental behaviors with responses given on a 5-point Likert scale (1 = *never*, 5 = *always*) as is used in the *General Ecological Behavior Scale* (Arnold et al., 2018; Kaiser & Wilson, 2004). One item (“*I refrain from owning a car for the sake of the environment.*”) had a yes/no response format. Negatively keyed items were reverse-coded for analysis. In case of behaviors that require specific qualifications or conditions (e.g., having a driver's license to drive a car), the alternative response category “*I cannot assess*” was added as had been suggested by Kaiser and Wilson (2004).

In the current sample, internal consistency for the complete PEB scale was  $\omega = .84$ . This is comparable to the recent assessment of the GEB scale (Arnold et al., 2018). Omega of the PEB item sets were  $\omega = .78$  for PEB-SD-high and  $\omega = .67$  for PEB-SD-low (with each 15 items).

**Subjective efficacy of PEBs.** The participants were asked to estimate the efficacy of each of the 30 PEBs with “Please indicate the extent to which you think this behavior has a positive or negative impact on nature, the environment and the climate”. The items were scored in a 5-point Likert scale (-2 = *strong negative impact*, +2 = *strong positive impact*) with negatively keyed items

being reverse-coded. The internal consistency for the complete subjective efficacy scale ePEB-SD was  $\omega = .90$ . ePEB-SD-high items has an Omega of  $\omega = .91$ , whereas the internal consistency of ePEB-SD-low items is  $\omega = .87$ .

### **3.2.2. Nature connectedness**

To strictly distinguish between EA and NC, an NC scale was included that supposedly focussed exclusively on the affective component of nature relatedness: NC was measured using the unidimensional 15-item scale Love and Care for Nature (LCN) introduced by Perkins (2010). The LCN scale was developed through factor analysis of five existing NC questionnaires and aims to assess the affective component of nature connectedness (e.g., “*I often feel a sense of awe and wonder when I am in unspoilt nature*”). It was translated into German by the author given the fact that up to the date of data collection, no validated German scale was available. Internal consistency in the present sample was  $\omega = .96$ , which is comparable to previously published results for the LCN scale (Perkins, 2010).

### **3.2.3. Environmental attitudes**

To avoid a conceptual overlap of environmental attitudes with PEBs, any EA scale should refrain from including behavioral items to measure EA. Therefore, a recently developed short form of the multidimensional *Environmental Attitudes Inventory* (EAI; Sutton & Gyuris, 2015; Milfont et al., 2010) was selected for this study. The EAI is hierarchically organized with 12 first-order factors and two opposing second-order order factors: Preservation (P; e.g.: “*It makes me sad to see forests cleared for agriculture.*”) and Utilization (UT; e.g.: “*Human beings were created or evolved to dominate the rest of nature.*”).

Due to the length of the inventory, the EAI had been adapted by other researchers: Sutton and Gyuris (2015) developed a new short form with 37 items, because the original short 24-item form of the EAI (Milfont & Duckitt, 2010) contained a large amount of redundancy, due to reversed pairs of items. A more recent study by Domingues and Gonçalves (2020) tested a Portuguese 36-item version and found it to be also more adequate than the 24-item version in terms of reliability and validity.

As the Portuguese version still included reversed pairs of items, the current study used items from the reduced 37-item short form established by Sutton and Gyuris (2015) – but only from 7 of the 12 subscales to address particular environmental topics. A similar approach to item selection has already been adopted by previous studies (Delhomme & Gheorghiu, 2016; Hoffarth & Hodson, 2016). The following subscales have been selected for the current study: Of the six subscales that comprise the second-order factor Preservation, Scale 2 (Support for interventionist conservation policies), 6 (Environmental fragility) and 11 (Eco-centric concern) have been included in this study. Four of the six subscales aggregating into the second-order factor Utilization have also been selected - with high composite scores describing high utilization of nature and hence, non-compliance with pro-environmental attitudes: Scale 4 (Conservation motivated by anthropocentric concern), 7 (Altering nature), 9 (Human dominance over nature) and 10 (Human utilization of nature). The questionnaire was translated into German by the author of this study.

The internal consistency of the second-order factor Preservation was moderate with  $\omega = .77$  and the second-order factor Utilization reached an Omega of  $\omega = .83$ . The overall internal consistency of the complete 37-item EA scale was  $\omega = .88$ . Whereas these results are comparable to previously published results by Sutton and Gyuris (2015), the internal consistency of the 7 first-order factors resume below the results of prior research: Except one Preservation subscale, the Omega values range between  $\omega = .63$  and  $\omega = .77$  for both second-order factors. On average, the

Preservation scales have lower Omega values than the Utilization subscales with all three subscales below  $\omega = .70$  and one scale with an insufficient internal consistency of  $\omega = .35$ .

### ***3.2.4. Environmental knowledge***

For the use of the current study, environmental knowledge was assessed with a two-dimensional 40-item environmental knowledge scale that is a combination of the original German environmental knowledge scale (Frick et al., 2004), which was developed as a Rasch scale, and its adapted and renewed version (Roczen et al., 2014). Environmental knowledge differentiates between action-related (AC), effectiveness (EF) and environmental system knowledge (see Introduction section for detailed information). For the current study, the subscale environmental system knowledge was excluded. The response categories were either dichotomous (true/false statements), in a single-choice format or in a multiple-choice format with partial credit for partially correct responses.

Due to restricted access of the German version of the renewed scale (Roczen et al., 2014), the items of the AC and EF subscale were taken from the questionnaire of Frick and colleagues (2004), compared to the more recent study (Roczen et al., 2014) and adjusted to new answer options or a different response format, if necessary. If no item match could be found between both studies, a content-related item of the recent item version (Roczen et al., 2014) was chosen and translated into German by the author. As a result, both subscales each comprised 20 items. Each item was recoded, so that it could respectively reach the value 1, if all correct responses were chosen (with  $1 = correct$ ,  $0.5 = partially\ correct$ ,  $0 = incorrect$ ). The composite score of each subscale was used for statistical analysis, resulting in a maximum score of 20 points each.

For the analysis of internal consistency, the recoded items were chosen. The binary coded AC subscale reached an Omega value of  $\omega = .49$ , whereas the internal consistency of the ordinal

EF subscale, recoded as a three-point scale, was highly insufficient with  $\omega = .07$ . As a consequence, it was abstained from investigating EF (effectiveness knowledge) further and was, thus, excluded from the analyzes.

### **3.2.5. Socially Desirable Responding**

To measure personal tendencies towards socially desirable responding (SDR), the German *Balanced Inventory of Desirable Responding* (BIDR) short scale (Winkler et al., 2006) was employed. It is a two-dimensional 6-item measurement instrument based on Paulhus' BIDR scale (1991) and includes the subscales Self-Deceptive Enhancement (SDE; e.g., "*I always know why I like things.*") and Impression Management (IM; e.g. "*I am always honest with others.*"). Compared to the results of the original study (Winkler et al., 2006), the internal consistency is lower for the IM subscale ( $\omega = .53$ ) and similar for the SDE subscale ( $\omega = .70$ ).

### **3.2.6. Raffle prize choice**

After completing the survey, the participants could decide between opting in or out of a raffle while the prize options were already displayed. Aiming to analyse the participants regarding their choice, this approach was used to ensure that the raffle prize options were chosen deliberately and not for lack of alternatives. Six vouchers, each valuing €20, could be won with two possible options: a pro-environmental (donation for a rainforest conservation project by WWF) and a non-pro-environmental option (Amazon gift voucher). The donation for the rainforest conservation project comes along with a personalized certificate. It will be referred to WWF *voucher* in the following, even though, strictly speaking, it is a donation. Six names were drawn by lot. Hence, the chances of winning were irrespective of the selected prize option, which was communicated to the participants. The variable is binary coded (0 = Amazon voucher, 1 = WWF voucher).

### 3.3. Methodological framework

This study will investigate two Research questions:

For Research question 1, structural equation modelling (SEM) was employed. As a modeling technique that allows the combination of factor analytic and path analytic Research questions (Kline, 2011), two hypotheses were tested via SEM:

First, measurement models of the latent constructs NC, EA, PEB and ePEB (subjective efficacy of PEBs) have been specified to test or confirm the hypothesized factor structure of the scales. Additionally, as splitting PEBs into two groups that differ in regard to their social desirability as well as the subjective efficacy of both groups have never been tested before, a new model needs to be generated and tested with the current data. Given that the alternative response category “*I cannot assess*” of the PEB frequency led to increased missing values, the sample size would decrease to a great extent for ( $N < 200$ ) for the PEB scales due to list-wise deletion and, hence, lose its representative power. This would be especially important to prevent as the factor structure of the exploratory scales of PEB frequency (PEB-SD) and subjective efficacy (ePEB-SD) need to be investigated. Thus, a dataset that includes incomplete cases ( $N = 772$ ) was utilized for the measurement models as both scales were at the beginning of the survey and hence, have a high completion rate. For the rest of the analyzes, the main sample of  $N = 411$  is used.

Second, the path or regression analytic approach of SEM is of interest to investigate H2 (this study’s main objective) and further analyses (H3): Multiple linear regression will be used to determine whether the independent variables (including subjective efficacy here as well) predict the high and low socially desirable PEBs significantly. Since the addition of the alternative response category of PEB frequency resulted in a higher percentage of missing values, the sample size would be reduced to  $N = 239$  by deleting listwise when models on item-level are employed in

a multiple linear regression analysis. As a consequence, a multiple linear regression analysis based on mean scores of the scales has been conducted.

For Research question 2 multinomial logistic regression analysis will be used to determine the predictors of the raffle prizes choice (H3): To investigate whether the prediction of the choice of the raffle prize is dependent on the social desirability of PEBs, a multinomial logistic regression was performed. Contrary to the originally planned procedure (a logistic regression between WWF and Amazon voucher), non-participation will be additionally included to get an insight into different response outcomes – especially, how the predictors of choosing to opt-out of the raffle differ from the WWF and Amazon voucher choice.

## **4. Research question 1**

### **4.1. Statistical analysis**

#### ***4.1.2. Structural equation modelling***

All SEM model specifications are tested confirmatorily. SEM was conducted using the R package lavaan (Rosseel, 2012), whereas the remaining analyses utilized SPSS (version 27).

The outlined SEM estimates the relationships between the latent dependent variables of (a) PEB frequency and (b) the subjective efficacy of PEBs, and the latent independent variables of (c) NC, (d) EA, (e) AC and (f) SDR. Due to the ordinal metric of the independent variable “raffle prize choice”, it was excluded of SEM analysis and will be discussed subsequently in Research question 2.

**Model estimation and specification.** To confirm the proposed structure of the scales, confirmatory factor analyses (CFA) were performed. In order to account for the ordinality of the data, item-level models were estimated using diagonally weighted least squares (DWLS), as it uses polychoric correlation matrices. Models based on mean scores of the scales were estimated using

maximum likelihood with robust standard errors (MLR). Both DWLS and MLR are unbiased under non-normality.

Model fit was assessed using four main fit indices to test the validity of the scales: Comparative Fit Index (CFI), Tucker-Lewis-Index (TLI), Standardised Root Mean Square Residual (SRMR) and Root Mean Square Error of Approximation (RMSEA). For interpretation, the standard benchmarks of by Hu and Bentler (1999) were used: CFI and TLI, good fit  $\geq .95$  and acceptable fit  $\geq .90$ ; SRMR, good fit  $< .05$  and acceptable fit  $< .08$ , RMSEA, good fit  $< .06$  and acceptable fit  $< .08$ . Benchmarks were the same for all SEMs. RMSEA values were reported including its 90% confidence interval.

**Model specification of PEB.** To account for the differentiation of PEBs regarding their social desirability, a two-factor model for PEB frequency (PEB-SD-high vs. PEB-SD-low) as well as PEB subjective efficacy (subjective efficacy for either PEB-SD-high or PEB-SD-low) was proposed. In addition, the possibility that the PEBs were derived from a single latent factor and thus, do not differentiate between two clusters, was investigated.

## 4.2. Results

### 4.2.1. *Latent variable measurement and structural analysis of the variables*

Descriptive statistics and correlations of the investigated variables are shown in Table 1 and fit statistics of the CFA models are presented in Table 2. If the resulting solutions of the CFAs diverged from the factor structures proposed by the literature, models encompassing the expected solutions are shown as well.

Partially nested data was used with approximately 260 students being recruited from two university courses – with one subject-related course about climate change. Thus, to assess the extent of context effects, intraclass correlations for all variables were employed on a subscale level.



Both courses were clustered separately and compared with the remaining participants. The intraclass correlations for all variables ranged from .002 for PEB subjective efficacy of PEB-SD-low to .072 for PEB frequency of PEB-SD-high and were hence, trivial.

Data were screened to confirm that the data structure did not reveal substantial deviations from the assumption of normality. Except for environmental knowledge (which will be discussed later), the values for skewness ( $<|2.2|$ ) and kurtosis ( $<|6.1|$ ) of all variables did not exceed the values that assume a departure from normality (West et al., 1995). Histograms and boxplots did not reveal any significant distributional abnormalities of the data. Standardized residuals were mostly normally distributed. Four cases were excluded due to a standardized residual above  $|3|$ , resulting in a final sample size of  $N = 403$ .

**PEB frequency.** Due to the binary metric of one item of PEB frequency in PEB-SD-high, it was excluded from factor and path analysis. Apart from a small proportion of missing values (0.7 to 1.0 %), the additional alternative answer category “*I cannot assess*” led to lower item frequencies: For three items, “*I cannot assess*” was selected with a percentage above 20%, while for the remaining items, the alternative response category was selected by up to 12%. The items with the highest percentage were about cars or driving as well as owning a TV and hence, required specific conditions (e.g., having a driver’s license to drive a car). The items of the PEB-SD frequency scale, their means values and percentage of alternative response categories are displayed in detail in Table 2 in the Appendix.

Exploratorily, the factorial structure of each cluster was assessed separately resulting in two models which differ greatly in their fit measures: For PEB-SD-high the model fitted very well (see Table 2) and all items were highly significant ( $p < .001$ ) – although they loaded on the factor with somewhat moderate values and 5 items below .40. After excluding one item that did not reach significance ( $p > .05$ ), the model fit of PEB-SD-low improved to good RMSEA and acceptable

SRMR values, but still can be deemed as not sufficient due to CFI and TLI below .81. The factor loadings confirmed the insufficient construct validity of the scale with 10 items below .40.

Results of the CFA and fit statistics supported the hypothesis that the frequency of PEBs is best measured with a two-factor model. All fit indexes of the two-factor model reproduce the data better than the one-factor model (see Table 2: PEB-SD (1-factor model)), albeit the fit indexes indicated that the two-factor model did not reproduce the observed covariances well (see Table 2: PEB-SD (2-factor model)). Modification indices suggest adding covariance paths between the errors associated with items within and between both PEB factors: The strongest four links were almost exclusively between items within a factor and would improve the fit of the model substantially ( $\chi^2 = 601.21$ ,  $df = 345$ ,  $p < .001$ ,  $CFI = .917$ ,  $TLI = .909$ ,  $SRMR = .084$ ,  $RMSEA = .054$  [.047, .061]). Possible cross-loadings on the other factor were negligible, except one link between a PEB-SD-high and PEB-SD-low items that both refer to recycling behaviors. It was abstained from allowing for intercorrelations.

The items of the 2-factorial model loaded on their proposed factor with somewhat low values. Thereby, all items of PEB-SD-high had higher loadings than the items of PEB-SD-low on their expected factor: Comparing factor loadings below |0.4|, 3 items of PEB-SD-high and 10 items of PEB-SD-low were identified. Both factors were significantly and highly positively intercorrelated with  $r = .78$ .

The insufficient loadings on the factor of PEB-SD-low might be an indicator that the items are not suitable to measure low socially desirable PEB adequately as a factor loading is a supposed causal effect of a latent variable and an observed indicator. A principal component analysis confirmed the lack of internal consistency: To determine the minimum number of principal components that account for most of the variation in PEB-SD-low, a parallel analysis was

employed. Four components could be extracted, confirming the need to investigate the factorial structure of PEB-SD-low in further research.

For both clusters, the most often reported frequency option was “*often*” (median) with - to the author’s surprise - almost no difference between high and low socially desirable PEBs ( $M_{\text{PEB-SD-high}} = 3.74$ ,  $M_{\text{PEB-SD-low}} = 3.76$ ). The mean values measured in the sample are comparable to previous studies (e.g., Gkargkavouzi et al., 2019; Larson et al., 2015). The intercorrelations of the PEB clusters exceeded the majority of studies that mostly found moderate relationships (for an overview see Markle, 2013). On the other hand, the correlations of all determinant variables with both PEB clusters will be discussed for each predictor separately subsequently – however, they were overall smaller than suggested by literature.

**PEB subjective efficacy.** The factorial structure of the subjective efficacy of each PEB cluster was also assessed separately (see in Table 2: ePEB-SD-high, ePEB-SD-low). For the subjective efficacy of ePEB-SD-high, the model fitted the data well and all items were significant with high factor loadings from 0.44 to 0.72. For ePEB-SD-low, after recoding two items that had negative loadings and excluding two non-significant items, the fit indices showed a very good fit of the model. All items showed high loadings on the respective factor with values ranging between .46 and .74 except for two items that loaded onto the factor with .21. The model fit showed very good CFI, TLI and RMSEA values and an acceptable SRMR.

When assessed together, the one-factor model (see in Table 2: ePEB: *1-factor model*) was not deemed acceptable due to insufficient values of all fit indexes. Fitting a two-factor model (see in Table 2: ePEB: *2-factor model*) to the data resulted in a significant improvement of the model fit with very good CFI, TLI and RMSEA values and SRMR showing an acceptable fit.

Table 1: Descriptive results, internal consistency and zero order bivariate correlations for all variables

Variable	<i>N</i>	<i>M (SD)</i>	$\omega$	1	2	3	4	5	6	7	8	9	10	11	12
1. PEB-SD-high	407	3.74 (0.48)	.78	—											
2. PEB-SD-low	407	3.76 (0.45)	.67	.49**	—										
3. ePEB-SD-high	406	3.96 (0.63)	.91	.36**	.17**	—									
4. ePEB-SD-low	406	3.54 (0.64)	.87	.08	-.03	.23**	—								
5. NC	407	3.79 (0.83)	.96	.40**	.23**	.17**	-.05	—							
6. EA - UT	404	4.03 (0.51) <sup>a</sup>	.83	-.44**	-.34**	-.22**	-.09	-.39**	—						
7. EA - P	404	4.36 (0.48)	.77	.33**	.34**	.24**	.09	.22**	-.48**	—					
8. AC <sup>b</sup>	410	12.00(2.71)	.49	.14**	.25**	.11*	.02	.10	-.11*	.26**	—				
9. EF <sup>b</sup>	404	10.72(2.09)	.07	.07	.14**	.08	.05	.05	-.12*	.21**	.22**	—			
10. SD - SDE	404	3.37 (0.76)	.70	.10*	.00	-.05	-.09	.13**	-.04	.05	-.02	.00	—		
11. SD - IM	404	3.40 (0.83)	.53	.18**	.20**	.07	.03	.11*	-.12*	.09	.05	.02	.24**	—	
12. Raffle Prize <sup>c</sup>	281	0.70 (0.46)		.31**	.27**	.21**	.09	.22**	-.33**	.33**	.16**	.06	.05	.05	—

*Note.* PEB-SD-high= frequency of high socially desirable PEBs, PEB-SD-low = frequency of low socially desirable PEBs, ePEB-SD-high = subjective efficacy of PEB-SD-high, ePEB-SD-low = subjective efficacy of PEB-SD-low, NC = nature connectedness, EA-UT = utilization of nature, EA-P = preservation of nature, AC = action-related knowledge, EF= effectiveness knowledge, SD-SDE = self-deception, SD-IM = impression management. \* $p < .05$ . \*\* $p < .01$

<sup>a</sup> Recoded mean into positively keyed subscale for better comparability with the EA Preservation factor.

<sup>b</sup> Mean composite scores can reach a maximum of 20 points.

<sup>c</sup> 0 = Amazon voucher and 1 = WWF voucher

Surprisingly, the factor loadings highly exceeded the ones observed for the two-factor model of PEB frequency and almost exclusively ranged between .51 and .88 for both factors. Two items of PEB-SD-low had factor loadings of .11 and .14. Both factors are moderately positively correlated with  $r = .29$ . Notably, the items of PEB-SD-low, which are identical for PEB frequency and subjective efficacy, performed worse in all CFAs. Hence, as the results indicate a multidimensionality of the items of PEB-SD-low, the results of this regression analysis should be interpreted with care. Further research should especially investigate the factorial structure of the

Table 2: Fit Statistics for CFA Models

Model	<i>N</i>	$\chi^2$	df	CFI	TLI	SRMR	RMSEA [90% CI]
<b>PEB-SD: 2-factor model</b>	<b>254</b>	<b>689.41</b>	<b>349</b>	<b>.889</b>	<b>.880</b>	<b>.090</b>	<b>.062</b> <b>[.055, .069]</b>
PEB-SD: 1-factor model	254	720.36	378	.879	.870	.092	.065 [.058, .071]
PEB-SD-high	389	198.34	77	.947	.938	.073	.064 [.053, .075]
PEB-SD-low	342	176.41	77	.808	.773	.081	.062 [.050, .074]
<b>ePEB: 2-factor model</b>	<b>442</b>	<b>668.60</b>	<b>349</b>	<b>.955</b>	<b>.952</b>	<b>.071</b>	<b>.046</b> <b>[.040, .051]</b>
ePEB: 1-factor model	440	2578.91	405	.717	.696	.137	.111 [.107, .115]
ePEB-SD-high	500	136.68	77	.983	.980	.068	.039 [.028, .050]
ePEB-SD-low	524	76.23	65	.996	.995	.049	.018 [.000, .033]
EA: 7-factor model	461	324.16	149	.974	.967	.066	.051 [.043, .058]
EA: hierarchical model	461	367.06	163	.953	.945	.067	.052 [.045, .059]
EA: 1-factor model with intercorrelations)	521	365.33	166	.954	.947	.067	.051 [.044, .058]
<b>EA: 2-factor model with intercorrelations</b>	<b>461</b>	<b>409.55</b>	<b>165</b>	<b>.964</b>	<b>.958</b>	<b>.075</b>	<b>.057</b> <b>[.050, .064]</b>

*Note.* Solutions assumed for further analyses are shown in boldface.

items of PEB-SD-low more closely in an exploratory factor analysis. On average, the efficacy of high socially desirable PEBs is perceived as more positively impactful towards environment than of low socially desirable PEBs ( $M_{\text{ePEB-SD-high}} = 3.96$ ,  $M_{\text{ePEB-SD-low}} = 3.54$ ). The subjective efficacy of all PEB items can be found in Table 2 in the appendix.

**Nature Connectedness.** On average, the participants agreed with the statements of the LCN scale and rated their attachment to nature with  $M = 3.79$  which is comparable to Tam (2013). When analysed separately for PEB-SD-high and PEB-SD-low, correlation of NC with high socially desirable PEBs ( $r_{\text{PEB-SD-high}} = .40$ ) was similar to results suggested by two recent meta-analyses ( $r = .37$ , Mackay & Schmitt, 2019;  $r = .42$ , Whitburn et al., 2020), but smaller for low socially desirable PEBs ( $r_{\text{PEB-SD-low}} = .23$ ).

**Environmental attitudes.** As the 7-factor model and the originally proposed hierarchical structure with 12 first-order factors and two opposing second-order order factors (Milfont et al., 2010) would contradict the author's aim for parsimony, both models were not taken into consideration for the following multiple linear regression analysis. For reasons of completeness, however, the model fit of both models have also been investigated (see Table 2: *EA: 7-factor model*, *EA: hierarchical model*). For the hierarchical model a solution was only found after excluding an item of subscale 2 (Support for interventionist conservation policies) of the Preservation factor.

The remaining EA versions, the 1- and 2-factor models, demonstrated insufficient model fit when intercorrelations were not allowed: With both second-order factors, Preservation and Utilization, the 2-factor model ( $\chi^2 = 848.20$ ,  $df = 188$ ,  $p < .001$ ,  $CFI = .902$ ,  $TLI = .891$ ,  $SRMR = .095$ ,  $RMSEA = .087$  [.082, .093]) reproduced the data equally worse than the 1-factor

model ( $\chi^2 = 619.51$ ,  $df = 189$ ,  $p < .001$ ,  $CFI = .901$ ,  $TLI = .890$ ,  $SRMR = .083$ ,  $RMSEA = .070$  [.064, .077]) which had been assessed as well as both second-order factors Preservation and Utilization intercorrelate highly ( $r = -0.83$ ). After also excluding the item of subscale 2, that had no covariances above .15 in the 1- and 2-factorial EA model, and allowing for the four strongest covariance paths between the errors associated, the fit of both models improved to an overall good fit (see Table 2: *EA: 1-factor model*, *EA: 2-factor model*). Still, fit indices, as well as the  $\chi^2$  test statistic, indicate that neither the 1- nor the 2-factor model is clearly favourable. Hence, for reasons of explanatory power, the 2-factor model was chosen to represent the factor structure of EA for subsequent analyses.

All parameters of the 2-factor model were statistically significant. Only 11 of the 20 items had factor loadings above .50 on their expected first-order factor: Overall, the Preservation items loaded higher onto their factor with 3 out of 8 items below 0.50, whereas 6 out of 12 of the Utilization items resided below .50. The highest loadings for each subscale were .72 for Preservation and .76 for Utilization. The Preservation and Utilization subscales are highly intercorrelated with  $r = -0.82$ .

As prior studies mostly employed 7-point Likert scales, the mean level of agreement was for Preservation predominantly “*Somewhat agree*” and for Utilization “*Somewhat disagree*” (Domingues & Gonçalves, 2020; Milfont & Duckitt, 2010; Sutton & Gyuris, 2015). Thus, it is descriptively comparable to this study’s mean responses of “*Agree*” for Preservation ( $M_{\text{Preservation}} = 4.36$ ) and “*Disagree*” for Utilization ( $M_{\text{Utilization}} = 4.03$ ). Zero order correlations of both PEB clusters with the factors Preservation and Utilization found a heterogenous pattern that is only partially comparable with previous research that found correlations between  $r = .36$  and  $.48$  (Bamberg & Möser, 2007; Klöckner, 2013; Milfont, 2012): Whereas Utilization resume close to

mentioned studies for PEB-SD-high only with  $r_{\text{PEB-SD-high}} = -.44$  ( $r_{\text{PEB-SD-low}} = -.34$ ), Preservation overall had lower associations of  $r_{\text{PEB-SD-high}} = .33$  and  $r_{\text{PEB-SD-low}} = .34$  with both PEB item sets.

**Environmental knowledge.** The highest possible composite score of Effectiveness Knowledge and Action-related Knowledge each is 20. On average, the participants were capable of correctly answering 11 ( $M = 10.72$ ) out of 20 Effectiveness Knowledge (EF) questions and 12 ( $M = 12.00$ ) out of 20 Action-Related Knowledge (AC) questions. Mean item difficulty (i.e., average solving probability) was at 53,9% for EF and 55,3% for AC which is similar to the results obtained by Frick and colleagues (2004), but exceeded the results from Roczen and colleagues (2014). Respectively, the level of knowledge was on an average level. EF usually appears to be more difficult to accumulate and consequently has the lowest baseline knowledge in comparison to AC, which is in accord with the results of this study.

Whereas both EF and AC on sustainable consumption are quite common in the sample (e.g., *“Meat is equally harmful to the environment as the equivalent amount of vegetables in terms of calories.”*, dichotomized and reverse coded), EF about recycling is least prevalent (e.g., *“Reusable beer bottles are on average [10x/30x/60x] recycled.”*; *“During the production of an aluminium can, the [2x/10x/20x] of energy is used in the production of an aluminium can than in the production of a glass bottle.”*) Likewise, AC of the greenhouse effect and “grey energy” of products were the most difficult AC items. Both EF and AC correlate marginally with PEB-SD-high and just slightly higher with PEB-SD-low (see Table 1).

Considering skewness (S) and kurtosis (K) for the EF scale, the results indicated that both values ( $S = -0.11$ ,  $SE(S) = .11$ ,  $K = 0.21$ ,  $SE(K) = .23$ ) are assumed as acceptable in order to prove normal univariate distribution (George & Mallery, 2010). Response distributions of the AC scale tended to be skewed towards higher composite scores ( $S = -1.13$ ,  $SE(S) = 0.11$ ), which might be



explained by the fact that partial credit for partially correct responses was given for six items of the AC scale. The kurtosis is 2,54 ( $SE(K) = 0.23$ ), suggesting distortion of the distribution through outliers. Ceiling and flooring effects of AC were non-existent. Calculated by percentage frequency of the lowest or highest possible scores in a range of one standard deviation, they each resumed below 15%.

**Socially desirable responding.** IM correlated significantly and higher with both PEB-SD-high ( $r = .17$ ) and PEB-SD-low ( $r = .18$ ), whereas SDE showed either lower or even non-existing associations ( $r_{\text{PEB-SD-high}} = .10$  and  $r_{\text{PEB-SD-low}} = .01$ ). Compared with the recent meta-analysis of Vesely and Klöckner (2020), who found a pooled correlation of  $r = .11$  (95% CI = [.06, .16],  $k = 26$ ), the results of SDR in this study are on average in the same range – although with interesting differences between PEB-SD-high and PEB-SD-low. IM reached higher correlations than SDE, which is contradictory to previous literature (e.g. Goetzke et al., 2014), but in compliance with theoretical assumptions: Participants who generally tend to present themselves better, would equally have higher mean scores of IM and the frequency of PEB-SD-high, as PEB-SD-high depicts highly socially desirable behaviors.

#### ***4.2.2. Multiple linear regression analysis***

**Testing the equality of standardized regression coefficients in SEM using likelihood ratio tests.** The relation of our newly developed PEB scale with two item sets was evaluated with established predictors of PEB (NC, EA and AC), using mean scores of the respective inventories. In a SEM, shown in Figure 1, a structural regression model with NC, EA, AC each predicting high and low pro-environmental behavior, were tested altogether. No additional pathways between the

coefficients have been added, as the values of these coefficients are already automatically corrected in SEM for the presence of correlated predictors.

To note, opposed to the originally planned analyses, the environmental knowledge subscale EF (effectiveness knowledge) was excluded due to highly insufficient internal consistency. It was additionally planned to compare the prediction of subjective efficacy on PEBs with the interaction of subjective efficacy with EF on PEBs. The aim of this hypothesis (H5) was to rule out that EF moderates the link between subjective efficacy and PEBs. However, in the current study this hypothesis could not be investigated.

**$\chi^2$ -difference test.** To test whether high and low socially desirable PEBs are predicted differently, a likelihood ratio (LR) test was employed. In the current study, a L-R-test was conducted as a two-stage procedure: In the first stage, an unrestricted model is estimated. In the second stage, the pathways of each predictor were tested on the PEB clusters for equality - by imposing equality constraints on the regression parameters separately, one predictor per model: These so-called *constrained* models were then tested against the respective unconstrained model via an  $\chi^2$ -difference test.

**Unconstrained model estimation.** First, the *unconstrained* model including all variables of interest was estimated. Considering that the sample was not representative in age and sex and regression effects might be influenced by social desirability responding (SDE and IM) as well, the regression model was for controlled for these variables. Since coefficients are corrected for the presence of correlated predictors in SEM, a common cause model was assumed and therefore age, sex, SDE and IM were included as predictors of both PEB groups.

In general, the paths of individual predictors are identical, regardless of whether they refer to high or low socially desirable PEB. However, the subjective effectiveness of each cluster clearly

relates to a specific cluster, since the same pool of items is evaluated: subjective efficacy of PEB-SD-high (ePEB-SD-high) and PEB-SD-high share the same item pool and, thus, should theoretically only be related to each other and not to PEB-SD-low items. However, so-called cross-over paths (e.g., ePEB-SD-high to PEB-SD-low) were included to rule out that the significant result of the former “customized model” are not just an artefact: As impact scores would easily correlate with agreement scores of the same items and thus produce artificial links due to the high degree of similarity. Therefore, the final unrestricted model also includes the subjective effectiveness of the other cluster via cross-over coefficients.

For the unconstrained model, the explained variance of the dependent variable resumes at moderate levels ( $R^2_{\text{PEB-SD-high}} = 0.340$ ,  $R^2_{\text{PEB-SD-low}} = 0.244$ ). The model without constraints is saturated ( $df = 0$ ), yielding a perfect fit. However, as imposing equality constraints leads to over-identification, fits can be interpreted for all constraint models.

**Likelihood ratio  $\chi^2$  tests.** In a second step, after imposing equality constraints separately on the regression parameters, these so-called constrained models were compared with the unconstrained model which is typically conducted through testing the constrained model against the unconstrained model separately via  $\chi^2$ -tests.

However, given that the unconstrained model is saturated, the  $\chi^2$ -test of the respective constraint models can be interpreted as L-R-test. Significant p-values of this test would show that the constrained model differs significantly from the saturated (“perfect”) unconstrained model, indicating worse fit. In this case, equality of regression paths could not be assumed.

The results of the likelihood ratio  $\chi^2$ -tests are shown in Table 3. Together with the results of the multiple linear regression, they will be discussed per predictor subsequently.

Table 3:  $\chi^2$ -Difference Test Results for the unconstrained vs. constrained models ( $N = 404$ )

	NC	EA-P	EA-UT	EK-AC	ePEB-SD-high	ePEB-SD-low	customized ePEB
$\chi^2$ difference	6.506	1.465	1.560	4.184	6.338	3.012	10.014
<i>df</i> difference	1	1	1	1	1	1	1
Significance	0.011*	0.226	0.212	0.041*	0.012*	0.083	0.002**

*Note.* *df*=degrees of freedom. \* $p < .05$ , \*\* $p < .01$ . customized ePEB: ePEB-SD-high to PEB-SD-high vs. ePEB-SD-low to PEB-SD-low

**Multiple linear regression analysis.** In a final SEM, the parameters for which equality of the regression coefficients could be assumed were included with their respective constraints. Thus, the specified model freely estimated regression coefficients onto both PEB clusters if the respective  $\chi^2$ -test indicated significantly different paths. For all other predictors, equality of both paths was assumed. The final results of the multiple linear regression are displayed in Table 4 and the model is shown in Figure 1.

The final regression model had a very good fit ( $\chi^2(21) = 292.37, p < 0.001$ ; CFI = 0.992, TLI = 0.947, SRMR = 0.008, RMSEA = 0.044 [.000, .106]) and explains the variance to a moderate degree ( $R^2_{\text{PEB-SD-high}} = 0.336, R^2_{\text{PEB-SD-low}} = 0.242$ ).

Table 4: Multiple linear regression analysis of the final model

Model	Estimate	Std. Err	P (>  z )	Std. all
<b>PEB-SD-high ~</b>				
ePEB-SD-high	0.172	0.053	0.001	0.225
ePEB-SD-low (a1*)	-0.021	0.029	0.471	-0.027
Nature Connectedness	0.131	0.027	0.000	0.225
EA: Preservation (b1*)	0.113	0.042	0.007	0.112
EA: Utilization (c1*)	0.190	0.041	0.000	0.201
Action-related Knowledge	0.215	0.163	0.187	0.053
SD: Impression Management	0.050	0.026	0.056	0.087
SD: Self-Deception	0.036	0.031	0.244	0.057
Age	-0.003	0.002	0.254	-0.057
Sex	-0.063	0.044	0.151	-0.061
<b>PEB-SD-low ~</b>				
ePEB-SD-high	0.035	0.034	0.301	0.049
ePEB-SD-low (a2*)	-0.021	0.029	0.471	-0.029
Nature Connectedness	0.052	0.026	0.043	0.094
EA: Preservation (b2*)	0.113	0.042	0.007	0.119
EA: Utilization (c2*)	0.190	0.041	0.000	0.212
Action-related Knowledge	0.717	0.172	0.000	0.188
SD: Impression Management	0.082	0.026	0.001	0.150
SD: Self-Deception	-0.040	0.030	0.185	-0.067
Age	0.002	0.002	0.376	0.039
Sex	-0.090	0.042	0.033	-0.092

Note. \* equality constraints

**Nature Connectedness.** In support of hypothesis H2, the regression pathways of NC significantly differ in dependence of predicting high or low socially desirable PEBs (see Table 3). The standardized regression weights between NC and high as well as low socially desirable PEBs show signs of heterogeneity: For PEB-SD-high, NC was the strongest predictor ( $\gamma(\text{NC})_{\text{PEB-SD-high}} = 0.225, p < .001, 95\% \text{ CI}_{\text{PEB-SD-high}} = [0.137, 0.313]$ ), together with the subjective efficacy of PEB-SD-high. As a significant predictor of low socially desirable PEBs, NC played a subordinate role ( $\gamma(\text{NC})_{\text{PEB-SD-low}} = 0.094, p = .043, 95\% \text{ CI}_{\text{PEB-SD-low}} = [0.003, 0.185]$ ). However, the results should be interpreted with caution as the confidence intervals of the standardized regression weights of PEB-SD-high and PEB-SD-low overlap.

**Environmental attitudes.** The paths from each of both EA subscales, Preservation (P) and Utilization (UT) to high and low socially desirable PEBs were not statistically different due to non-significant results of the  $\chi^2$  difference test (see Table 3). Hence, there is not enough evidence to suggest that the social desirability of PEBs influences the predictive values of EAs. However, the results of the multiple linear regression analysis indicate that Utilization is the strongest predictor of low socially desirable PEBs (with  $\gamma(\text{EA-UT})_{\text{PEB-SD-low}} = 0.212, p < .001$ ) and the third strongest predictor of high socially desirable PEBs (with  $\gamma(\text{EA-UT})_{\text{PEB-SD-high}} = 0.201, p < .001$ ). Preservation, on the other hand, has lower regression weights of both high and low socially desirable PEBs:  $\gamma(\text{EA-P})_{\text{PEB-SD-high}} = 0.112, p = .007$ ;  $\gamma(\text{EA-P})_{\text{PEB-SD-low}} = 0.119, p = .007$ .

**Environmental knowledge.** Due to insufficient measurement reliability of the subscale EF (effectiveness knowledge) mentioned prior, only the EK subscale AC (action-related knowledge) has been included and found to significantly differ between PEB-SD-high and PEB-SD-low (see Table 3): AC played a (surprisingly) important role when predicting low socially desirable PEBs (with  $\gamma(\text{AC})_{\text{PEB-SD-low}} = 0.188, p < .001, 95\% \text{ CI}_{\text{PEB-SD-low}} = [0.103, 0.272]$ ) – especially in

comparison to the high socially desirable PEBs ( $(\gamma(AC))_{PEB-SD-high} = 0.053, p = .187, 95\% CI_{PEB-SD-high} = [-0.026, 0.132]$ ). In fact, the standardized regression weights of AC were apart from Utilization the highest for low desirable PEBs. However, the confidence intervals of the regression weights of both PEB groups overlap, raising concerns about the validity of the assumed significant difference between the relationship of AC to PEB-SD-high and to PEB-SD-low.

*Subjective efficacy.* As explained prior, cross-over coefficients were added in the final regression model to exploratorily investigate subjective efficacy of both PEB groups separately as predictors. In total, three  $\chi^2$  difference tests were executed (see Table 3) of which two tests yielded significant results: It was hypothesized that both ePEB-SD-high and ePEB-SD-low would predict the frequency of each PEB group differently - with higher regression weights and, thus, a stronger prediction of the PEB group referring to the same item pool. E.g., ePEB-SD-high should predict PEB-SD-high better than PEB-SD-low. This could be confirmed (see Table 3). ePEB-SD-low, on the other hand, did not predict PEB-SD-low significantly differently than PEB-SD-high (see Table 3). Finally, although one would theoretically assume that the regression weights of subjective efficiency equally predict the frequency of the respective PEB group - ePEB-SD-high to the frequency of PEB-SD-high and ePEB-SD-low to the frequency of PEB-SD-low should assumingly have similar regression weights -, the  $\chi^2$  difference test of the customized model shows otherwise (see Table 3): The regression path of ePEB-SD-high to PEB-SD-high significantly differed from the paths of ePEB-SD-low to PEB-SD-low.

Together with NC, ePEB-SD-high is the strongest predictor of PEB-SD-high ( $(\gamma(ePEB-SD-low))_{PEB-SD-high} = -0.027, p = .471$ ), whereas ePEB-SD-low played a negligible role for both PEB groups in the multiple linear regression ( $(\gamma(ePEB-SD-low))_{PEB-SD-low} = -0.029, p = .471$ ). The significant difference found by ePEB-SD-high in the prediction of both PEB groups might not held

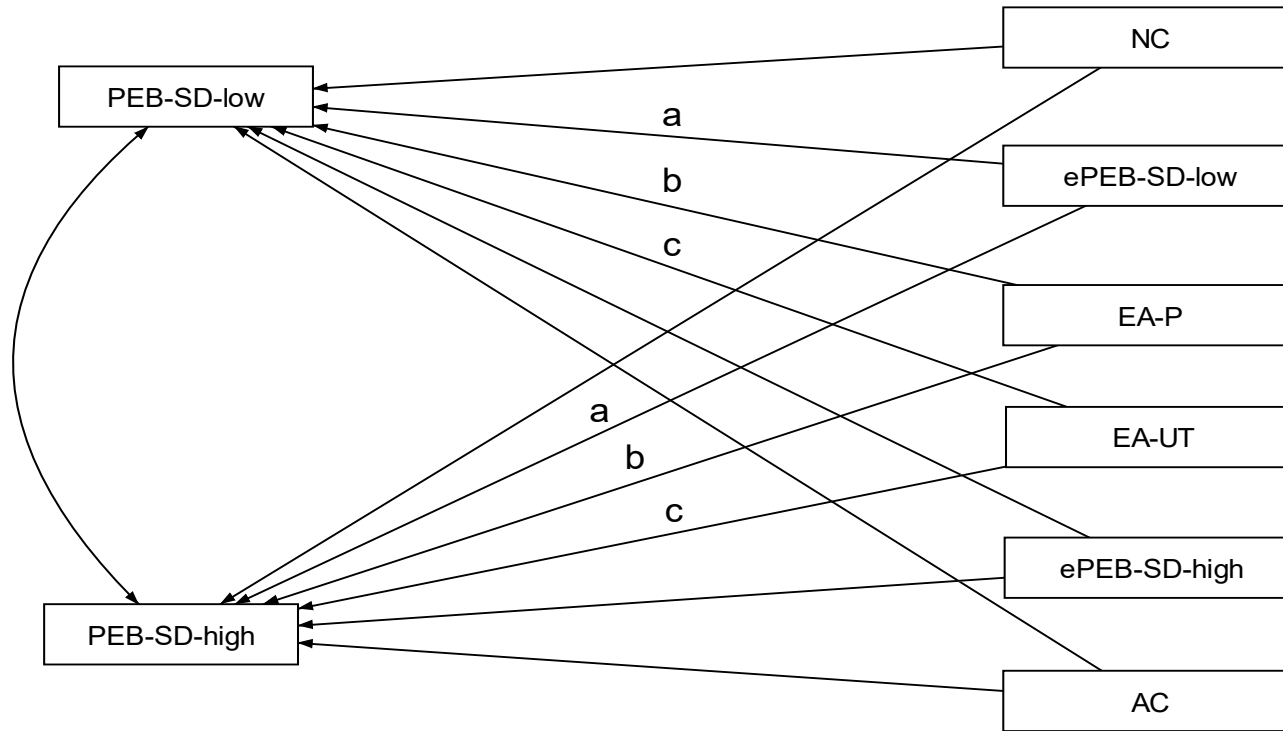
true, as indicated by the overlapping confidence intervals ( $\gamma(\text{ePEB-SD-high})_{\text{PEB-SD-high}} = 0.225, p = .001, 95\% \text{ CI}_{\text{PEB-SD-high}} = [0.090, 0.360]$ ;  $\gamma(\text{ePEB-SD-high})_{\text{PEB-SD-low}} = 0.049, p = .298, 95\% \text{ CI}_{\text{PEB-SD-low}} = [-0.043, 0.141]$ ). Thus, it can be concluded that solely the subjective effectiveness of PEB-SD-high adds predictive value - and that only to the frequency of PEB-SD-high.

**Control variables.** All control variables were unrelated in the prediction of PEB-SD-high - namely sex, age as well as the socially desirable responding subscales SDE (Self-Deception) and IM (Impression Management). The latter finding is particularly surprising as it was assumed that participants who scored high in IM would also report performing high socially desirable PEBs more frequently than PEB-SD-low items. However, it should be noted that IM, with  $p = .056$  may nevertheless be a variable of interest for further research.

On the other hand, IM had a significant positive effect on PEB-SD-low ( $\gamma(\text{SDE-IM})_{\text{PEB-SD-low}} = 0.150, p = .001$ ). In fact, IM is the third strongest predictor of low socially desirable PEBs, meaning that participants who attempted to present themselves in an overly positive light also reported performing low socially desirable PEBs more often than participants with low IM scores. In addition, sex significantly predicted PEB-SD-low with a small negative effect ( $\gamma(\text{Sex})_{\text{PEB-SD-low}} = -0.092, p = .033$ ): Participants who are female were more likely to have higher frequency means of low socially desirable PEBs. Age and SDE remain non-significant as control variables of PEB-SD-low.



Figure 1: Final SEM. Paths labelled with the same letter denote equality constraints. Control variables are not depicted.



## 5. Research question 2

### 5.1. Method

The prior multiple linear regression provided us with information about predictors of self-reported PEB frequency. To investigate whether objective PEB is predicted differently than PEB-SD-high and PEB-SD-low, multinomial logistic regressions were performed using IBM SPSS Statistics 27 for Windows. The WWF voucher was chosen as the reference category.

In a first step, we specified the regression model as follows: All predictors used in the SEM were included as main effects via stepwise backwards selection method, namely backwards elimination. This approach is rendered superior to a forced entry and forward procedure in exploratory research due to fewer type 2 errors (i.e., excludes fewer predictors that should have been retained; Field, 2017). In this case, PEB-SD-high and PEB-SD-low acted as predictors as well.

As most of the independent variables in this study are commonly known to predict (objective) PEB - except high vs. low socially desirable self-reported PEBs - I was particularly interested in potential interactions. Hence, in a second step, a model was customized based on results of the prior multinomial logistic regression of the main effects: In a backwards elimination procedure these significant regressor variables have been included together with potential interactions between them.

Derived from prior research, interactions between the following variables were hypothesized: the interaction of NC, both EA subscales, as well as SDR with PEB-SD-high and PEB-SD-low. To account for the rather high correlation between both EA subscales, an interaction between both would be required. It was initially planned to further investigate the relation between

EF with the subjective efficacy of PEB-SD-high and PEB-SD-low by adding interaction terms. Due to the reliability issues of the EF scale, they have not been taken into consideration.

### ***5.1.1. Assumptions of multinomial logistic regression***

As we majorly have continuous variables, it is necessary to test for their linearity. Given that multinomial logistic regression assumes a linear relationship of the variable to its logit, an interaction term between each continuous predictive variable and the logit of itself was created: Age ( $p = .041$ ), AC ( $p = .032$ ) and the SDR subscale SDE ( $p = .024$ ) showed significant interactions and hence, violate the assumption of linearity.

Testing for multicollinearity of the predictors, the variance inflation factor (VIF) and tolerance statistics ( $1/VIF$ ) are above and below their respective cut offs with  $VIF > 2$  (cut offs:  $VIF > 10$ , tolerance  $< .01$ ). To look at the residuals two binary logistic regressions were employed with the WWF voucher as the reference category. Both fitted well onto the data (Hosmer-Lemeshow test:  $\chi^2_a = 10.89$ ,  $\chi^2_b = 11.24$ ,  $df = 8$ ;  $p > .05$ ). For both analyses Cook's distance resumed below 1 and leverage stayed close to the calculated expected values (of 0.128 and 0.113 respectively). Standardized residuals were distributed rather normally. Overdispersion is not given as the values are close to 1 for the final regression.

## **5.2. Results**

From the totality of participants who completed the survey ( $N = 414$ ), 398 participants provided us with information regarding the raffle participation and choice. The sample was distributed as follows: 118 (29.6%) chose not to participate at the raffle, 83 (20.9 %) opted for the Amazon voucher and 197 (49.5%) for the WWF voucher as their prize of choice.

### 5.2.1. Multinomial logistic regression

The results of the multinomial regression only employing the main effects are presented in Table 3 in the appendix. The backwards stepwise analysis suggested that a regression model including the predictors age, PEB-SD-high, Preservation and Utilization significantly improved the model’s ability to explain the variation in the outcome compared to the original model ( $\chi^2(8) = 66.22, p < .001$ ). To gain further insights about the associations, a more exploratory multinomial logistic regression analysis was employed including the centered variables that had become significant in the prior analysis. Descriptive statistics of the significant predictor variables of each “participation group” are shown in Table 5, the results of the final multinomial logistic regression are presented in Table 6.

The model explains the variation in the outcome significantly better than the original model ( $\chi^2(10) = 75.65, p < .001$ ) and is a good fit to the data ( $\chi^2_{\text{Pearson}}(784) = 790.44, p = .43; \chi^2_{\text{Deviance}}(784) = 748.58, p = .81$ ). The likelihood-ratio tests indicate that PEB-SD-high, both EA subscales Preservation and Utilization, age as well as an interaction between PEB-SD-high and age significantly improve the prediction of the participation groups.

Table 5: Descriptive statistics of significant predictors of the raffle participation groups

	PEB-SD-high	EA: Preservation	EA: Utilization*	Age
No raffle participation ( <i>N</i> = 118)	3.73 (0.51)	4.35 (0.46)	3.99 (0.49)	31.01 (12.53)
Amazon voucher ( <i>N</i> = 83)	3.52 (0.48)	4.12 (0.59)	3.79 (0.58)	26.16 (5.23)
WWF voucher ( <i>N</i> = 197)	3.84 (0.43)	4.47 (0.40)	4.16 (0.43)	26.96 (8.91)

*Note.* Utilization is keyed positively for better comparability with Preservation.

**No raffle participation.** Deciding to opt-out of the raffle significantly depended on the participant's attitude towards Utilization of nature ( $b = -0.65$ , Wald  $\chi^2(1) = 4.73$ ,  $p = .030$ ): Participants whose Utilization score increased one unit were more likely to opt-out of the raffle than participating and choosing the WWF voucher. The odds ratio of 1.92 indicates that for every one-unit-increase on Utilization, the odds of opting out of the raffle changes by a factor of 1.92 – and are hence increasing. (Keep in mind that Utilization is negatively keyed with low values indicating high pro-environmental attitudes.)

Age also predicted whether a person takes part in the raffle in comparison to choosing the WWF voucher with a highly significant  $p$ -value ( $b = 0.05$ , Wald  $\chi^2(1) = 11.90$ ,  $p = .001$ ): As age increases one year per unit, the participants tend to become 1.05 times more likely to drop out of the raffle, which is a rather small effect.

Choosing to not participate at the raffle also significantly depended on the interaction between PEB-SD-high and age ( $b = 0.08$ , Wald  $\chi^2(1) = 6.94$ ,  $p = .008$ ). With a one-unit increase of this interaction, the participants tend to become 1.09 times more likely to opt-out of the raffle than participating with the WWF raffle choice. Although this effect is small, it is even more surprising that it is directed oppositely to the non-significant effect of PEB-SD-high on non-participation: While a one-unit increase in PEB-SD-high score would lead to a decreased chance of opting-out of the raffle, the interaction term is positive and, thus, would lead to an increased probability of non-participation. Since the focus of this regression is particularly on the differences between participants who opted for the Amazon and the WWF voucher, no further investigation of the interaction, e.g., by means of a slope analysis, was carried out.

Table 6: Multinomial logistic regression with a backwards selection method

	<i>B</i>	<i>SE</i>	95% CI for Odds Ratio		
			Lower	Odds Ratio	Upper
<i>No raffle participation vs. WWF voucher</i>					
Intercept	-0.44***	(0.12)			
PEB-SD-high	-0.12	(0.30)	0.50	0.89	1.58
EA: Preservation	-0.22	(0.31)	0.44	0.81	1.48
EA: Utilization	0.65*	(0.30)	1.07	1.92	3.47
Age	0.05**	(0.14)	1.02	1.05	1.08
PEB-SD-high x Age	0.08**	(0.03)	1.02	1.09	1.16
<i>Amazon voucher vs. WWF voucher</i>					
Intercept	-0.96***	(0.15)			
PEB-SD-high	-0.75*	(0.34)	0.24	0.47	0.92
EA: Preservation	-0.89**	(0.33)	0.22	0.41	0.79
EA: Utilization	0.82*	(0.34)	1.17	2.27	4.44
Age	-0.01	(0.02)	0.95	0.99	1.03
PEB-SD-high x Age	0.08	(0.05)	0.98	1.08	1.18

Note.  $R^2 = 0.17$  (Cox-Snell), 0.20 (Nagelkerke). Model  $\chi^2(10) = 75.65, p < .001$ . \* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$ .

Albeit included in the model, PEB-SD-high could not significantly predict if participants decided to opt-out of the raffle or opted-in and selected the WWF voucher ( $b = 0.30$ , Wald  $\chi^2(1) = 0.17, p = .681$ ). As well, Preservation ( $b = 0.31$ , Wald  $\chi^2(1) = 0.48, p = .488$ ) remained non-significant in predicting the non-participation of the raffle.

**Amazon voucher.** In the respective analysis, the self-reported frequency of high socially desirable PEBs significantly distinguished solely between the choice of Amazon vs. WWF voucher: Per one unit that a participant scored lower on the self-reported PEB-SD-high scale, the probability of him or her choosing the Amazon voucher is approximately 2.1 times ( $1/0.47 = 2.11$ ) higher than deciding for the WWF voucher ( $b = 0.34$ , Wald  $\chi^2(1) = 4.82, p = .028$ ).

For the Utilization subscale, the odds of choosing the Amazon instead of the WWF voucher increased by a factor of 2.3 when the participants scored one unit higher ( $b = 0.82$ , Wald  $\chi^2(1) = 5.80$ ,  $p = .016$ ). A new finding is that Preservation also significantly improved the model's ability to predict the WWF raffle choice: Participants who had higher Preservation scores were 2.4 times ( $1/0.41=2.4$ ) less likely to opt for the Amazon voucher than the WWF voucher ( $b = -0.89$ , Wald  $\chi^2(1) = 7.12$ ,  $p = .008$ ) - and, therefore, is of equal effect size as the Utilization subscale.

As variables that predicted whether participants would choose the Amazon over the WWF voucher, neither age ( $b = -0.01$ , Wald  $\chi^2(1) = 0.22$ ,  $p = .643$ ) nor the interaction of PEB-SD-high with age ( $b = 0.08$ , Wald  $\chi^2(1) = 2.60$ ,  $p = .107$ ) had significant effects.

When comparing observed with predicted probabilities, the WWF voucher is correctly predicted at 86.3%, whereas the prediction of the Amazon voucher (36.1%) and raffle non-participation (13.6%) resume at rather low levels. Of the totality of cases, 58% of the Amazon voucher and 72% of non-participation are wrongly classified as WWF vouchers.

To gain a more in-depth insight into the association between PEBs and the raffle prize choice, a backward regression similar to the final multinomial logistic regression was conducted using PEB frequency as one factor without distinguishing between high and low social desirability. The results, displayed in Table 4 in the appendix, show that the self-reported PEB frequency significantly improved the model (LR:  $\chi^2(10) = 71.82$ ,  $p < .001$ ) and also predicted choosing the Amazon voucher: Participants who reported to behave pro-environmentally less often were more likely to opt for the Amazon voucher than the WWF voucher ( $b = -0.96$ , Wald  $\chi^2(1) = 5.34$ ,  $p = .021$ ). However, the model fit, explained variance and Odds Ratio (OR = 0.38 [0.17, 0.86]) decreased to a small extent when using the one-factorial PEB frequency, suggesting the high socially desirable PEBs to be superior in predicting the raffle prize choice.

## 6. Discussion

### 6.1. Research question 1

In order to investigate the much discussed heterogeneity of pro-environmental behaviors and bridge the gap between self-reported and objective PEBs, recent work has called for research on the subtle effects of social desirability (Vesely & Klöckner, 2020; Vilar et al., 2020). The present study introduced a new approach of incorporating effects of social desirability by subjecting items of PEBs to cluster analysis in order to distinguish items with low and high social desirability respectively.

First, the hypothesized structural relationships between the variables EA (Preservation and Utilization), NC, EK (AC: action-related knowledge; EF: effectiveness knowledge) and PEBs can partly be confirmed (H1): The correlations between PEB-SD-high were moderate to high for EA and NC, but weak for EK and SDR. The correlations with PEB-SD-low, however, were - compared with PEB-SD-high - weaker and resumed at moderate levels for EA and NC, but higher for EK with weak to moderate correlations. Albeit somewhat heterogenous, these findings are in line with previous literature (e.g., Bamberg & Möser, 2007). Utilization has higher correlations with PEB-SD-high and PEB-SD-low than NC and is followed by Preservation. Thus, the hypothesis, that NC is the strongest predictor cannot be confirmed. The very weak correlations of both EK subscales to both PEB item sets are in accordance with prior literature (e.g., Frick et al., 2004). In fact, only the link between AC and PEB-SD-low were as strong as assumed, namely at an almost moderate level. Nevertheless, as suggested, AC correlated higher with PEB-SD-high and PEB-SD-low than EF.



The primary aim of this study was to investigate whether high and low socially desirable PEBs are predicted differently by nature connectedness, environmental attitudes, environmental knowledge and subjective efficacy (H2).

This hypothesis has partially been confirmed, as the predictive value of NC, the environmental knowledge subscale AC as well as subjective efficacy of PEB-SD-high significantly depends on the social desirability of PEBs. More specifically, the main finding of the first Research question lies in the significant difference of NC predicting high vs. low socially desirable PEBs, whereas the prediction of the EA subscales preservation as well as utilization did not differ significantly between PEB-SD-high and PEB-SD-low.

It is important to note, however, that the confidence intervals of the standardised regression weights of those predictors whose  $\chi^2$ -test became significant overlap, namely NC, AC and ePEB-SD-high. Due to these limitations, implications of the findings should be considered with caution.

As this is an explorative study and the social desirability of PEBs has never been examined before, the conclusions of these findings remain preliminary and will require further validation. However, potential explanations for the predictive differences will be given subsequently.

### ***6.1.1. Nature Connectedness***

With a significant  $\chi^2$ -test, NC predicted the self-reported PEB frequency better for high socially desirable PEBs than for low socially desirable PEBs: Where NC was the strongest predictor for PEB-SD-high, it was the weakest for PEB-SD-low and barely reached significance.

A potential explanation for the significant difference in prediction is the sole focus on the affective component that the scale with which NC has been assessed has. By employing the LCN scale, it was planned to investigate a different NC component than the majority of the scales which

focus on the cognitive aspect of the construct (Perkins, 2010; Tam, 2013). As a potential consequence, the affective NC may have been more strongly associated with the underlying social desirability of the PEBs which are also driven by emotion and not mainly by cognitive processes (as environmental attitudes or the cognitive aspect of NC). Consequently, as only partial aspects of the construct NC are measured in this study, future research should include the cognitive aspects of the construct to be able to draw valid conclusions. On another note, since the scale showed an internal consistency of  $\omega = .96$  and factor loadings above .80 for 7 out of 15 items, potentially indicating redundancy of the items, future research should consider using a short form of the LCN scale.

Nature connectedness is associated with pro-social behavior or social connectedness which might be associated with a higher frequency of socially desirable PEBs. Previous research consistently observed relationships between cooperation and EA as well as PEBs (Kaiser & Byrka, 2011; Sussman et al., 2016). Two experimental studies (Zelenski et al., 2015, Joye & Bolderdijk, 2015) found that the effect of nature exposure on willingness to behave pro-environmentally was mediated by pro-social or cooperative behavior. This was especially the case when watching extraordinary natural scenes. In other words, nature directly promoted and enhanced PEB, especially when it relates primarily to cooperative contexts or situations that require pro-social behavior. Whether this causal relationship, however, can be transferred to self-reported and retrospective feelings towards nature instead of an experimental exposure remains unclear.

Further studies (e.g., Soutter et al., 2020) suggested that the NC-pro-sociality association might be explained through a shared underlying personality trait: Honesty-Humility. Honesty-Humility can be defined as reciprocal altruism which is based on the principle of fairness, i.e. the tendency to not take advantage even when the respective counterpart is vulnerable. Honesty-

Humility not only promotes pro-social behavior, but also is the strongest negative predictor of environmental harmful actions. A recent meta-analysis (Soutter et al., 2020;  $k = 38$ ) found Honesty-Humility as well as Openness as the strongest correlates of environmental attitudes ( $r = .22$  and  $.20$ ) and PEBs ( $r = .21$  and  $.25$ ). In fact, Kaiser and Byrka (2011) revealed that 90% of their participants that were highly pro-environmental also had high pro-social scores, whereas that was only the case for 65% of the less environmentally engaged subjects.

This personality trait is not only associated with PEBs, but also with NC, leading to a potential explanation. The feeling of “connectedness” may represent a common underlying construct of both NC and high socially desirable PEBs. A study proposed that Connectedness to Humanity and Connectedness to Nature (Lee et al., 2015) share a sense of oneness, albeit in two different entities, and found a high correlation between both ( $r = .44$ ). Advocating for common underlying personality traits, both connectedness constructs shared Openness to Experience and Honesty–Humility as their main personality correlates. As both personality traits showed only weak direct relationships to pro-environmental attitudes and behaviors, NC explains most of the associations as a mediator (Lee et al., 2015). In addition, people’s affective feelings towards nature changed (in the short term) as a response to increasing or decreasing feelings of social connectedness. However, a few studies have reported negligible correlations between social connectedness and connectedness to nature (Moreton & Tiliopoulos, 2019; Nisbet et al., 2011; Zelenski & Nisbet, 2014). Nonetheless, as a measure that solely and strongly focusses on the emotional connection towards nature, the LCN scale may elicit similar emotions as when thinking about close friends and family and hence, share an underlying sentiment.

As it remains unclear whether pro-sociality and the feeling of social connectedness is “implemented” in both PEB-SD-high and PEB-SD-low and can advocate for the significant finding of NC, further research should investigate their potential mediating influence.

### ***6.1.2. Environmental attitudes***

Following the study from Casaló and colleagues (2019) that found heterogeneous relations of EA with different PEBs (curtailment behaviors like turning the light off when leaving a room, vs. efficacy behaviors like using an LED light bulb), this study cannot confirm that social desirability accounts for respective heterogeneity. Both EA subscales Preservation (P) and Utilization (UT) predicted PEBs irrespective of their social desirability.

Nonetheless, Utilization was one of the strongest predictors of PEB, especially of PEB-SD-low, which is comparable to previous research (Milfont & Schultz, 2016). Surprisingly, Preservation was a less meaningful predictor than expected. This finding is opposed to Milfont (2012) who meta-analysed environment-related variables among others and found ecological behavior as well as sustainability attitudes to be stronger related with Preservation than Utilization. The difference in the number of items (P: 8 items, UT: 12 items) and internal consistency between Preservation and Utilization might potentially account for the lower estimates of Preservation and the non-significant  $\chi^2$ -difference test in general. Two of the three Preservation first-order factors had an Omega below  $\omega = .70$  and one scale had  $\omega = .35$ . The Preservation first-order factors had almost no inter-item- correlation ( $r < .10$ ). Approximately half of the items of both second-order factors had factor loadings below .50. The rather mediocre model fit of the 2-factor model (and in fact, also of the 1-factor model) can be seen as a confirmation of the insufficient validity of the scale.

In view of these results and the fact that the factorial structure of this respective short form has not yet been evaluated by Sutton and Gyuris (2015), the validity of this EA short form should be questioned. In another study (Domingues & Gonçalves, 2020), which also developed a short form of the original EA scale (Milfont & Duckitt, 2010), it was shown that the Preservation subscales used here already suffers from internal consistency (average variance explained  $\leq 0.5$ , composite reliability  $\leq 0.7$ ). As solely 3 out of 7 first-order factors of Preservation, but 4 out of 5 first-order factors of the Utilization subscale have been employed in the current study, the Preservation factor might have not been represented adequately. Therefore, a comparison with the results of other studies is not fully possible.

Taken together, the fact that NC predicted the frequency of PEBs in dependence of their social desirability, while this is not the case for either EA subscale is the key finding of this study. On one hand, it shows a possible heterogeneous pattern of NC being an important predictor of high socially desirable PEBs, but negligible as a predictor of low socially desirable PEBs. NC thus appears to be sensitive to normative desirable behavior, which is not only important for item selection of PEB scales in future research, but also to shed more light on and explore self-reporting bias of PEBs. On the other hand, the importance of EA as a robust and reliable predictor is confirmed - especially for a wide range of PEBs. The EA subscales, however, are surprisingly quite different in importance, considering the difference in the regression weights of Preservation and Utilization. These findings indicate that EA might be robust towards social norms and, hence, might be a more universal predictor of PEBs than NC. This is in fact confirmed by Research question 2 in which both subscales of EA also significantly predicted the choice of the WWF voucher against the Amazon voucher.

### ***6.1.3. Environmental knowledge***

Action-related environmental knowledge (AC) contributed a surprisingly substantial amount in predicting low socially desirable PEBs. The  $\chi^2$ -difference test yielded significant results which is reflected in the results of the multiple linear regression. AC was not a significant predictor of PEB-SD-high, but a highly significant and second strongest predictor of PEB-SD-low. Given that previous literature suggests that EK generally plays an indirect role in predicting PEBs, often leading to no direct or rather small effects, the significant moderate effect in this study is rather unexpected. Nonetheless, previous research found AC to be the more consistent and stronger determinant of PEBs than the other two EK subscales EF and system-related knowledge (Frick et al., 2004; Roczen et al., 2014).

Theoretical implications for the higher values of AC in predicting low socially desirable PEBs are discussed subsequently. Behavior that is socially undesirable could to a greater extent be based on knowledge, as other factors that would play a role in more socially desirable PEBs (e.g., attitudes and normative influences) would fall short or disappear. In other words, participants who report that they often react to environmentally friendly and socially undesirable behavior are likely to need more environmental knowledge, as this behavior is not publicly known or promoted to the same extent as PEB-SD-high behaviors. These individuals could even be regarded as "true" environmentalists who consistently behave in an environmentally conscious manner regardless of the social norm.

This study is not the first to discover that objective EK relates differently to specific PEBs. Casalo and colleagues (2019) already found significant effects of EK only for efficiency behaviors (e.g., using energy-efficient light bulbs) and not for curtailment behaviors. This study further adds onto potential heterogeneity in the relationship between EK and PEBs and indicates that

environmental knowledge is a more important and behavior-proximal PEB determinant than literature assumes. Especially when it comes to behaviours that are not considered socially desirable, AC is a surprisingly strong regressor (with moderate regression weights) and might reveal a genuine interest in behaving environmentally-friendly which is not triggered or influenced by existing social norms. In line with that, for the raffle prize choice in Research question 2 no effect of AC was found – probably because choosing the WWF voucher can be assumed to be a high socially desirable behavior.

#### ***6.1.4. Subjective efficacy***

In accordance with hypothesis H4, high socially desirable PEBs are perceived as more impactful regarding the environment than low socially desirable PEBs. This might be evidence of a biased perception: What is seen as socially normative is perceived as being more efficient in sustaining nature and environment (or the other way around, as no assumptions on causality can be made). However, further research with two groups of PEBs that differ in their social desirability but are similar in their mean environmental impact, is required, as it has not been controlled for in this study.

The effect of the subjective effectiveness knowledge of the PEB items on their respective frequency was inconsistent: Whereas the subjective efficacy of PEB-SD-high was, apart from NC, the strongest predictor of PEB-SD-high, it was deemed non-significant in predicting PEB-SD-low. The subjective efficacy of PEB-SD-low did not reach significance as a regressor for either PEB-SD-high and PEB-SD-low. It can be interpreted as reported PEB frequencies are positively predicted through perceiving PEBs as highly environmentally impactful – but only if these behaviors meet the social norm and are thus socially desirable.

Taken the findings of environmental knowledge and subjective efficacy together, they partially confirm the results of Truelove and Parks (2012): The tendency of people to act in accordance with how they perceive the environmental impact of PEBs was found to be true only for high socially desirable PEBs. They further suggested subjective efficacy to promote self-reported PEBs more strongly than objective knowledge itself. This also only applies for high socially desirable PEBs, as for low socially desirable behaviors the reverse pattern is evident: Subjective efficacy remains a non-significant regressor, whereas AC strongly predict PEB-SD-low. This finding is essential as it adds a potential explanation for the inconclusive findings of the link between EK and PEB: EK presumably only determines the self-reported frequency of PEBs as long as they are not particularly socially desirable - because if this is the case, the perceived rather than the "true" efficacy of PEBs determines their reported frequency. Whether this is because subjective efficiency is the determining factor of PEB-SD-high - as Truelove and Parks (2012) assume - or simply because impact and frequency of highly desirable behaviors are equally overestimated, is unclear. Prior literature (Kim & Schuldt, 2018) shows that the environmental impact of green products that might also have been perceived as socially desirable, like purchasing a hybrid car in the respective study, is overestimated and seen in an overly positive light. Against the latter argument, however, speaks the fact that the self-reported mean of PEB-SD-low is equal to PEB-SD-high.

#### ***6.1.5. Control variables***

Except the participant's gender and Impression Management (IM), the remaining control variables did not significantly affect the frequency of high and low socially desirable PEBs. In fact, no control variable significantly predicted PEB-SD-high – not even the socially desirable



responding subscales Impression Management or Self-Deception (SDE), which is against the assumption: In particular, the non-significant result of IM is somewhat unexpected, as it represents a conscious need to present the best possible image of oneself to others, which was thought to occur especially with highly socially desirable behaviors. It has to be mentioned, however, that IM is very slightly above  $p = .05$ .

Moreover, this study could show quite the opposite of what was hypothesized: IM explained a substantial amount of variance in predicting PEB-SD-low as the third strongest regressor. Thus, in order to detect SDR (socially desirable responding) this study suggests to not focus on the highly desirable behaviors, but instead on the ones that are not considered as very desirable in society. These findings are new in literature, e.g., they contradict Brooks and Wilson (2015) and Vesely and Klöckner (2020) who proposed high socially desirable or highly sanctioned PEBs to be especially vulnerable to SDR.

In general, this finding is opposed to research that predominantly found SDE to effect purchasing frequency (e.g., Goetzke et al., 2014; Wheeler et al., 2019) and was only recently complemented by a study that found small effects of IM in an interaction with intention (Vilar et al., 2020). The current study finds further evidence of IM in the self-reporting of PEB frequency - and in fact, the findings are more distinct and less subtle than expected. Further studies should focus on more-in-depth research regarding PEBs that are not socially desirable.

However, as the mean frequency of both PEB-SD-high and PEB-SD-low are almost identical and PEB-SD-low has been presented after PEB-SD-high, a question order bias may also account for the found effect, instead of consciously over-reporting PEB-SD-low items.

Sex also had a small significant effect on PEB-SD-low, with female participants reporting a higher frequency. This is in accordance with literature that reliably found women to exhibit more

PEB, across time, nationalities and sample characteristics (e.g., Longhi, 2013; Sundström & McCright, 2014). It further implies that women behave pro-environmentally regardless of existing societal norms. Furthermore, studies support this assumption, finding that women are more socially responsible (Zelezny et al., 2000) and care more about nature and quality of life than men (Casaló & Escario, 2016). Another possible explanation could be provided by the construct of social dominance orientation, defined as a person's belief about whether a group, preferably their own, should dominate others (Sidanius & Pratto, 1999): As women show lower levels of social dominance orientation, they may not primarily act in an environmentally friendly way in order to increase their own social status by complying with prevailing environmental norms. An alternative explanation for the finding could also be that higher PEB frequencies might be related more strongly to women, as they are more prone to overreporting due to the significant finding of IM mentioned prior.

## **6.2. Research question 2**

In order to investigate the much discussed heterogeneity of PEBs and, at best, bridge the gap between self-reported and objective PEBs, Research question 2 was conducted: As PEB self-reports risk studying verbal claims about one's behavior that can be shown at no cost, a raffle was included with a pro-environmental and non-pro-environmental prize option.

The personal cost of the raffle prize choice was that by choosing the environmentally friendly option, one forgoes a personal gain, as the WWF voucher is a 20 € donation for a rainforest project, while the Amazon voucher, which is worth the same amount, can be used for own purposes. In addition, Amazon does not promote sustainability and protection of the environment what is publicly known. Hence, the raffle prize choice can be seen as a moral dilemma– where

personal gain would go hand in hand with support for an environmentally damaging company, namely Amazon, while the environmentally friendly option would be without personal gain (as the amount would be donated for a WWF preservation rainforest project). The non-participation of the raffle was included as a third response category. However, the results between Amazon vs. WWF voucher are the main objective of Research question 2.

Thereby, two questions have been of particular interest: Whether the significant predictors and control variables between self-reported and objective behavior differ (especially if there are personal costs involved) and whether self-reported PEBs and the social norm of these behaviors predict the objective behavior. Results of the multinomial logistic regression found PEB-SD-high, Preservation, Utilization, age and the interaction between PEB-SD-high and age to significantly predict whether a participant chose the WWF voucher opposed to either selecting the Amazon voucher or opting-out of the raffle in general.

Compared to the predictors in the analysis of Research question 1, only both EA subscales were also significant regressors in Research question 2:

### ***6.2.1. Environmental attitudes***

An individuals' Utilization mean score significantly distinguished between all three raffle participation behaviors: The higher the Utilization score, the higher the probability of him or her of either opting out of the raffle or opting for the Amazon voucher. Utilization had the second largest OR in both reference categories, with a greater effect for predicting the choice of the WWF voucher against the Amazon voucher, than against the non-participation.

Compared to Utilization, Preservation was a more specific predictor as it only significantly differentiated between choosing the Amazon or WWF voucher – though with higher significance,

of equal effect size as Utilization and directed opposedly: A decrease of the Preservation score increased the chance that a participant opted for the Amazon voucher instead of the environmentally friendly raffle prize option, the WWF voucher.

This in accordance with hypothesis 3b and previous literature (Milfont & Duckitt, 2004, 2006) that found Utilization to predict economic liberalism and Preservation to predict pro-environmental behavior:

In detail, Utilization expresses the belief that it is appropriate and necessary to dominate, utilize and alter nature and species for human purposes (e.g. *The question of the environment is secondary to economic growth.*, Milfont & Duckitt, 2010) and economic liberalism is defined as an economic-political philosophy based in particular on strong support for the market economy. It thus, perfectly explains the significant result of Utilization as economic liberalism significantly overlaps with Amazon's corporate philosophy: A few non-profit groups assessed the climate impact of the world's largest companies – and Amazon consistently ranked at the bottom of the lists (Carbon Disclosure Project, 2021).

The odds ratio of Preservation in the analysis of Research question 2 was the highest in the regression, which may be somewhat unexpected questionable internal consistency of the Preservation scale and rather mediocre influence of Preservation on both PEB-SD-high and PEB-SD-low. However, given that protecting nature and its diversity would predict donating for a rainforest reservation project - which is exactly what the WWF voucher is about -, this particular voucher option was rather customized towards the Preservation items.

As to why Utilization also significantly differentiated between participants who opted out of the raffle and those that chose the WWF voucher, whereas Preservation did not, a potential explanation is given here: Due to the fact that a high score in the anti-environmental worldviews

is a clear indicator for the rejection of not only the environmentally friendly but also the other non-sustainable raffle option, this may perhaps be due to a response tendency of the participant.

### ***6.2.2. Pro-environmental behavior***

First, it was hypothesized that a high frequency of self-reported PEBs should significantly predict choosing the WWF voucher (H3a). The results of this study supported the hypothesis as a positive effect between PEB frequency and the WWF voucher was found – only for PEB-SD-high as well as PEB frequency as one factor. The results confirm this study’s proposition that the self-reported frequency of PEBs is a predictor of the raffle choice. This finding adds to the base of evidence that has investigated the consistency between self-reported and objective PEBs and found a modest association (Gatersleben et al., 2002; Kormos & Gifford, 2014).

Second, the main aim of Research question 2 was to investigate whether the social desirability of self-reported PEBs plays a role in predicting objective PEB. This study is, to the author’s knowledge, the first that found evidence of predictive differences of self-reported PEBs depending on their social desirability: While neither high nor low socially desirable PEBs are regressors in predicting the non-participation of the raffle, only PEBs that are highly desirable significantly predicted the choice of raffle prize. To note, however, as a predictor of the WWF voucher, PEB-SD-high was of equal importance than both EA subscales Preservation and Utilization with a similarly sized Odds Ratio.

In addition, social desirability also had an effect in predicting whether a participant opted out of the raffle or chose the WWF voucher - with a significant interaction of PEB-SD-high and age. However, the effect is less straightforward: The interaction means that the effect of PEB-SD-high is different for a different age - or the effect of age varies depending on the PEB-SD-high

frequency. Albeit causality remains unclear, the latter explanation seems favorable given the positive main effect of age and the non-significant negative odds ratio of PEB-SD-high.

It was additionally hypothesized that Impression Management (IM) would control potential differences between the regression weights of PEB-SD-high and PEB-SD-low. However, as IM did not significantly improve the model fit in the preliminary regression that included all main effects, it was excluded for the final multinomial logistic regression – together with PEB-SD-low. Therefore, the respective hypothesis cannot be answered directly. Nevertheless, it can be concluded that since neither IM nor PEB-SD-low are important predictors of raffle participation and prize choice, the predictive differences between PEB-SD-high and PEB-SD-low cannot be explained by SDR but by the social desirability of PEBs.

An alternative explanation for the significant association between PEB-SD-high and the WWF voucher may be that the objective behavior itself is perceived as a highly desirable behavior. Participants who comply with the social norm will probably also choose the WWF voucher. The rather high percentage (49.5 %) of people opting for the WWF voucher (and hence foregoing a personal gift) in comparison to the Amazon voucher (20.9 %) seems to support that claim. To get a more in-depth insight of this finding, further research is needed, e.g., adding a pro-environmental raffle prize that ranks low on social desirability.

In addition, it cannot be ruled out that the lack of internal consistency of the PEB-SD-low scale is responsible for the non-significant result of PEB-SD-low: Since the factor loadings for PEB-SD-low items are 80% below  $|0.40|$  and a preliminary confirmatory factor analysis suggested 4 factors as a best fit (instead of 1), the question is raised to what extent the items of low socially desirable PEBs are markers of a common, broader construct. As the internal consistency and

convergent validity of low socially desirable PEBs resume at insufficient levels, it might hence account for the insignificant results.

Moreover, Research question 1 found IM to be a significant predictor of PEB-SD-low. Thus, the chance that the mean frequency of PEB-SD-low is overreported and, hence, does not depict the genuine environment-related behavior of a participant is high, which in turn may explain that no association between PEB-SD-low and WWF voucher could be found.

That the predictive power of PEBs to objective PEB is indeed dependent on their social desirability has never been investigated before and is therefore a key finding of this study. Further in-depth research would be needed to validate the results found here and to help close the gap between self-reported and objective PEBs.

This is an important implication for future research, as the current status quo of PEB measurement instruments are "ad hoc" scales (developed solely for the researchers' own study) with a range of PEBs that vary widely in number of items, domains and other characteristics: This study draws attention to the fact that when using PEB items or scales, the social desirability of the respective behaviors would need to be controlled for in order to make valid and reliable statements.

### ***6.2.3. Nature Connectedness***

Opposed to hypothesis H3b, NC did not significantly predict choosing the WWF voucher. This contradicts literature as meta-analyses found strong and reliable associations between NC and observed PEBs with  $r = 0.23$  to  $r = .29$  (Mackay & Schmitt, 2019; Whitburn et al., 2020). This non-significant finding is especially unexpected as the WWF voucher is actually a donation for a rainforest reservation project – hence, it represents caring for nature in its quintessence. In general, literature suggests that people who feel a genuine connection to nature, would want to protect it,

e.g., Tam (2013) even found the LCN scale to specifically predict support for environmental causes which this study cannot confirm. By assessing NC exclusively through an affective point of view in this study, the construct of NC might not be captured in its entirety. As the majority of NC scales (also) measure the cognitive component of NC, further research should test for possible predictive differences of affective and cognitive NC.

#### **6.2.4. Control variables**

Age emerged as a relevant predictor of the WWF voucher compared to non-participation in the direction of older participants being more likely to opt out of the raffle. On average, participants who choose the WWF voucher were 27 ( $M = 26.96$ ,  $SD = 8.91$ ) years old, whereas participants who decided to drop out of the raffle were 31 ( $M = 31.01$ ,  $SD = 12.53$ ) years of age. Of interest in Research question 1, age did not yield significant direct effects, although tendencies for a positive effect on PEB-SD-low have been detected ( $p = .078$ ). Both findings of Research question 1 and 2 are contradictory to research as small positive influences of age on PEBs have been observed (Gatersleben et al., 2002; Geiger et al., 2019; Gilg et al., 2005; Wiernik et al., 2013). In fact, as the younger participants tend to opt for the pro-environmental raffle option, quite the opposite is found. However, as this sample is much younger than the average Austrian population, research with a representative sample is necessary to draw distinct conclusions.

Opposed to the hypothesis, neither IM – in which the author was especially interested in – nor SDE significantly predicted choosing the WWF voucher. As impression management particularly depicts a deliberate need to present the best possible image of oneself to another person, the non-significant result is theoretically surprising - but nonetheless in line with recent research, that found marginal or unreliable SDR in environmental behavior research (Milfont &



Duckitt, 2010; Sintov & Prescott, 2011; Vilar et al., 2020; Wheeler et al., 2019). However, as discussed subsequently, tendencies to react in accordance with previous items (priming effects) or avoiding cognitive dissonance cannot completely rule out the possibility that there may be methodological or normative factors that distort the results.

### **6.3. Limitations**

As this study is based on the results of the pilot study, the validity and reliability of the obtained results plays a substantial role for this study. Due to the complex and abstract questions of social desirability and generalizability, the author aimed for an expert sample of Master psychology students. Resulting in a sample size of  $N = 14$ , it might not be a representative sample in many aspects: Gender and age distribution, place of residence as well as specific characteristics of Psychology students may have influenced the social desirability ratings of PEBs. Further validation of the results of the pilot study is needed with a bigger, more representative sample.

Vesely and Klöckner (2020) suggested to adapt the SDR scales, namely IM and SDE in this study, to the specific context as they presumably are too broad to capture normative environment-related responses. In order to clearly distinguish whether the self-reported PEB-SD-high frequency is a true reflection of reality or still (despite negligible SDR values) distorted by socially desirable responses, context-specific SDR items would be necessary.

It is advised for future research to employ validated inventories with the complete set of items to ensure comparability of the results. In this case, this would mean to include all subscales of a validated short form of the *Environmental Attitudes Inventory* (EAI; Milfont et al., 2010) and to use the original Environmental knowledge scale (Roczen et al., 2014). Assessing the social desirability of items of already validated (and popular) PEB scales, e.g., *General Ecological*

*Behavior Scale* (Arnold et al., 2018; Kaiser & Wilson, 2004) may help to gain further insights about the heterogeneity of PEB items.

For Research question 2, a hierarchical procedure was conducted: First, a multinomial logistic regression solely with main effects was employed using backwards elimination. Second, all significant predictors were selected for a new regression model in which potential interactions between the variables have been added. Thus, a method of analysis was chosen that emphasises the aspect of parsimony and usability of the data more than the inclusion of all influencing variables and thus loses its exploratory character. Further research with a more explorative design would be necessary.

In general, the final SEM model of Research question 1 as well as the multinomial logistic regression model of Research question 2 have lots of unexplained behavioral variance unaccounted for: Both models explained the variance of the outcome in a low to moderate degree. Hence, it backs up the notion that several potential influencing factors have not been administered. It is advised to include other psychological determinants that are known to predict PEB, such as (explicit) social norms or behavioral intention.

As the raffle prize choice can be regarded as very specific, it will only reflect a small portion of the overall propensity to behave pro-environmentally. Therefore, to measure the overall propensity to behave pro-environmentally via such specific indicators will generate variance that can primarily explained by error variance (Lange & Dewitte, 2019). As the choosing of a raffle prize is a conscious decision-making process, it probably differentiates to the circumstances in which objective PEB is typically assessed in environmental research, e.g. field observations or situational simulation experiments like accepting a plastic bag after study participation (Geng et al., 2015). Albeit studies found dichotomized response categories (in this case the two raffle prize

options) to accurately predict one's objective PEB (Gamba & Oskamp, 1994), whether a person would behave similar in a real-life situations cannot be answered adequately in this study.

The order in which the PEB frequency and raffle prize choice had been presented, could also account for the findings of this study: As the self-reported PEB frequency has to be answered before the raffle prize choice, it can lead to priming effects (Salancik, 1984; Salancik & Pfeffer, 1977): Being asked to report the frequency of environment-related behaviors and subsequently being offered to participate in a raffle with two options, with only one being pro-environmental, the participant may be more likely to opt for the WWF voucher - using information made salient by the former responses about the PEB frequency. According to the cognitive dissonance theory (Festinger, 1957), the participant could be tempted to choose the WWF voucher in order to maintain a consistent (pro-environmental) behavior regardless of own preferences.

#### **6.4. Conclusion**

Reflecting on implications of the findings for future research, this study is, to the author's knowledge, the first, that investigated the social desirability of PEBs. Social norms and SDR have been subject of research in environmental research before, but the social desirability has never been evaluated separately for each pro-environmental behavior before. Two recent studies already suggested that subtle effects of social desirability for specific PEBs may have gone undetected in research yet (Vesely & Klöckner, 2020; Vilar et al., 2020) which this study can partially confirm: The predictors NC, AC and ePEB-SD-high seemed to be sensitive for the social desirability of PEBs. This might be a crucial finding as it brings a new, to date unknown, factor into the field of environmental psychology.

It implies that social norms might be a factor that could explain potential heterogeneous patterns of PEB predictors and need to be taken into account in order to not only reliably and validly assess the PEB of an individual but also to correctly interpret and compare the results of a study. Thus, this study contributed to the field of environmental psychology with three key findings and resulting implications:

First, there is a larger than expected discrepancy between two of the most established and most reliable determinants of PEB, NC and EA, in predicting self-reported and objective PEB, which brings to light possible strengths and weaknesses of the two variables (and of their subscales) as PEB predictors:

Utilization was a consistently and equally strong predictor of each assessment of PEB (PEB-SD-high, PEB-SD-low, WWF voucher), whereas Preservation was found to be a less distinct and meaningful regressor for high or low socially desirable self-reported PEBs, but more specific for objective PEB compared to Utilization. On one hand, it further confirms the substantial role of EA in promoting and explaining environment-related behaviors, irrespective, if the PEBs comply with social norms or are assessed subjectively or objectively. On the other hand, the predictive validity of both subscales seem to differ in regard to the type of PEB asked – whether it is assessed per self-report or via a decision-making process to win a raffle prize.

Nature connectedness, which is established as an equally strong predictor as EA, showed a less robust relationship with the different forms of PEBs: Only the effect on PEB-SD-high was as strong as known from previous studies. It yielded negligible predictive value for PEB-SD-low and even remained non-significant in predicting the WWF raffle voucher. This is a key finding as this study is the first to provide potential evidence that social desirability of PEBs may lead to predictive differences – even with well-established determinants like NC. As the predictive value

of NC might be underestimated when PEB is only measured by low socially desirable PEBs and thus, might not reflect the NC-PEB association adequately in its entirety, further research should be conducted.

Second, this study found evidence of a heterogeneous pattern between objective and subjective environmental knowledge in predicting self-reported PEBs: Truelove and Parks (2012) suggested the perceived environmental impact (subjective efficacy) of PEBs to be a better indicator of PEB frequency than objective environmental knowledge itself. This study found evidence only for high socially desirable PEBs: ePEB-SD-high was - together with NC - the strongest regressor of PEB-SD-high, whereas objective action-related knowledge (AC) remained non-significant. For PEB-SD-low the reverse pattern emerges: AC substantially contributed to predicting PEB-SD-low as the second strongest predictor, apart from Utilization, while ePEB-SD-low had no effect. Since literature (e.g., Braun & Dierkes, 2019) found unreliable and mostly small effects of environmental knowledge to PEB, the moderate effect of AC in this study is somewhat unexpected.

Thus, this study found two mechanisms of evaluating specific PEBs that diverge depending on the social desirability of PEBs. It is proposed that if a PEB is socially desirable, people may be vulnerable to biased perception and overestimate its environmental impact and report higher frequencies of the respective PEB, without resorting to objective knowledge. On the other hand, when it comes to PEBs that are not considered socially desirable, AC might reveal a genuine interest in behaving environmentally-friendly which is not triggered or influenced by existing social norms. Especially in regard of the low levels of prevalent practical environmental knowledge across nations (e.g., Roczen et al., 2014) and the found tendency to act according to the subjective impact of a socially desirable PEB that may be factually incorrect, future research

should further investigate these postulated mechanisms in order to educate about the efficacy of PEBs and foster impactful pro-environmental choices and habits.

Third, addressing the gap between self-reported and objective PEBs, this study is the first to provide evidence that self-reported PEBs predict objective PEBs depending on their social desirability. Thus, only high socially desirable PEBs are moderate and positive predictors that participants chose the environmental-friendly raffle prize, rendering a potential explanation for the low levels of association in literature. However, as the objective behavior employed in this study is a rather conscious and verbal behavior that can be shown at (almost) no cost, further research in a more experimental setting is advised.

All in all, as the current status quo of PEB measurement instruments are "ad hoc" scales (developed solely for the researchers' own study) with a range of PEBs that vary widely in number of items, domains and other characteristics, the current study may add another factor to disentangle the noncumulative state of PEB research: This study draws attention to the fact that when assessing PEBs via specific inventories or through observation or experiments, the social desirability of the respective behaviors is indeed an influencing factor which would need to be controlled for in order to make valid and reliable statements. Further studies are needed to investigate the social desirability of PEBs and validate the findings of the pilot and main study with a larger and more representative sample. Nevertheless, this study is a first step in the direction of integrating social norms, that are specifically measured for each PEB, into the field of environmental psychology, which should be pursued further: After all, the effects of social desirability are less subtle than assumed by Vesely and Klöckner (2020) and Vilar et al. (2020) and could thus make a valuable contribution to bridging the gap between self-reported and objective PEB.

## 7. References

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## 8. Appendix

Table A1: Means and standard deviations of the full and short form PEB item sets.

	<i>n</i>	<i>Social desirability</i>		<i>Representativity</i>		<i>Effort</i>	
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
all items ( <i>k</i> = 64)							
PEB-SD-high	39	3.56	.57	3.66	.29	2.74	.64
PEB-SD-low	25	2.58	.39	2.99	.38	2.02	.26
selected items ( <i>k</i> = 30)							
PEB-SD-high	15	3.80	.90	3.87	.96	2.64	1.00
PEB-SD-low	15	2.42	1.00	3.15	.97	2.03	.97

Table A2: N, means of PEB frequency and subjective efficacy of the Main Study and values of social desirability and representativity of the Pilot Study

		Main Study (N = 414)			Pilot Study (N = 14)		
	N	"I cannot assess" (percentage)	PEB Frequency M (SD)	PEB Subjective efficacy M (SD)	Social Desirability M (SD)	Representativity M (SD)	
<b>PEB-SD-high</b>							
PB1_01	I keep my consumption of animal products low.	409	0.5%	3.65 (1.15)	3.87 (1.36)	3.79 (0.98)	4.43 (0.76)
PB1_02	I refrain from owning a car for the sake of the environment.*	321	21.5%	1.48 (0.50)	3.89 (1.36)	3.79 (0.89)	4.07 (0.83)
PB1_03	I turn the lights off when I leave a room.	410	0.2%	4.35 (0.72)	3.90 (0.81)	4.36 (0.84)	4.00 (1.04)
PB1_04	I recycle paper, glass and aluminum packages.	410	0.2%	4.34 (0.87)	4.10 (1.02)	4.43 (0.76)	3.93 (1.00)
PB1_05	I buy food from my region.	409	0.5%	3.53 (0.79)	4.23 (0.98)	4.43 (0.51)	3.93 (1.00)
PB1_06	I buy seasonal produce.	407	1.0%	3.45 (0.91)	4.18 (1.04)	3.93 (0.92)	3.93 (0.83)
PB1_07	I wait until I have a full load before doing my laundry.	402	2.2%	4.56 (0.69)	4.14 (0.75)	3.29 (0.91)	3.50 (1.09)
PB1_08	I buy meat and produce with eco-labels.	408	0.7%	3.61 (0.88)	3.94 (0.90)	4.21 (0.80)	3.86 (1.03)
PB1_09	I buy products with little or no packaging.	407	1.0%	3.45 (0.86)	4.12 (1.00)	4.21 (0.80)	3.86 (1.03)
PB1_10	I vote a political party that support stronger environmental laws.	372	9.4%	4.25 (1.01)	3.99 (0.94)	3.64 (0.93)	3.86 (0.86)
PB1_11	In winter, I turn down the heat when I leave my apartment for more than 4 h or at night.	387	5.8%	3.47 (1.46)	3.79 (1.01)	3.79 (0.98)	3.79 (0.98)
PB1_12	I have electronic devices repaired instead of buying new ones.	391	4.8%	3.21 (1.10)	4.00 (1.10)	3.14 (1.03)	3.71 (0.83)
PB1_13	I have pointed out unecological behavior to someone.	405	1.4%	3.09 (1.08)	3.55 (0.92)	2.71 (1.07)	3.71 (0.91)
PB1_14	I inform myself about environmental problems (e.g., in books, magazines, internet).	408	0.7%	3.76 (1.06)	3.73 (0.85)	3.50 (1.16)	3.79 (1.25)
PB1_15	I buy beverages and other liquids in returnable bottles.	382	7.0%	3.77 (1.06)	4.01 (0.94)	3.71 (0.91)	3.64 (1.01)



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**PEB-SD-low**

PB2_01	<i>I eat in fast-food restaurants, such as McDonalds and Burger King.</i>	411	0.0%	4.20 (0.71)	3.89 (1.04)	2.00 (0.78)	2.79 (1.19)
PB2_02	<i>In the winter, I air rooms while keeping on the heat and leaving the windows open, simultaneously.</i>	407	1.0%	4.09 (1.14)	3.74 (1.06)	2.00 (1.04)	3.71 (1.14)
PB2_03	<i>I put dead batteries in the garbage.</i>	403	1.9%	4.66 (0.85)	3.86 (1.30)	2.14 (1.17)	3.57 (1.09)
PB2_04	<i>For longer journeys (more than 6h by car), I take an airplane.</i>	402	2.2%	3.72 (1.09)	4.13 (1.25)	2.64 (1.01)	3.43 (1.16)
PB2_05	<i>If I am offered a plastic bag in a store, I take it.</i>	410	0.2%	4.02 (1.00)	3.77 (1.05)	2.14 (1.41)	3.36 (0.75)
PB2_06	<i>If I have to wait with the car for a short time (e.g., before red lights or at closed railway gates), I leave the engine running.</i>	323	21.3%	3.83 (1.30)	3.63 (1.00)	2.64 (1.15)	3.29 (0.91)
PB2_07	<i>I use power strips to turn off electronics between uses.</i>	380	7.5%	3.00 (1.27)	3.04 (1.04)	2.64 (1.15)	3.29 (1.07)
PB2_08	<i>After one day of use, my sweaters or trousers go into the laundry.</i>	410	0.2%	3.57 (1.08)	3.52 (0.91)	2.38 (0.96)	3.08 (0.64)
PB2_09	<i>I wash dirty clothes without prewashing.</i>	364	11.4%	4.28 (1.19)	3.47 (0.95)	2.93 (1.07)	3.07 (1.00)
PB2_10	<i>I turn the oven off early to finish cooking with the captured heat.</i>	387	5.8%	2.72 (1.42)	3.37 (0.88)	2.71 (0.91)	3.07 (1.21)
PB2_11	<i>I leave my cell phone charger plugged in when not in use.</i>	410	0.2%	2.49 (1.57)	3.45 (0.82)	2.29 (1.07)	3.07 (0.92)
PB2_12	<i>I buy convenience foods.</i>	411	0.0%	3.82 (0.97)	3.42 (0.88)	2.43 (0.85)	2.71 (0.61)
PB2_13	<i>I let warm foods cool down to room temperature before placing them in the fridge.</i>	401	2.4%	4.43 (0.99)	3.55 (0.90)	2.86 (1.10)	3.00 (1.00)
PB2_14	<i>I buy beverages in cans.</i>	409	0.5%	3.93 (0.98)	3.54 (1.09)	2.64 (0.63)	2.93 (1.00)
PB2_15	<i>I leave my TV in standby mode.</i>	308	24.9%	3.46 (1.61)	3.56 (0.91)	1.93 (0.73)	2.93 (1.14)

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Table A3: Multinomial logistic regression of main effects in a backwards selection method

	<i>B</i>	<i>SE</i>	95% CI for Odds Ratio		
			Lower	Odds Ratio	Upper
<i>No raffle participation vs. WWF voucher</i>					
Intercept	-1.63	(2.09)			
PEB-SD-high	-0.09	(0.29)	0.52	0.92	1.61
EA: Preservation	-0.20	(0.31)	0.45	0.82	1.50
EA: Utilization	0.65*	(0.30)	1.07	1.92	3.44
Age	0.04**	(0.01)	1.01	1.04	1.06
<i>Amazon voucher vs. WWF voucher</i>					
Intercept	4.86*	(2.30)			
PEB-SD-high	-0.82*	(0.33)	0.23	0.44	0.84
EA: Preservation	-0.87**	(0.33)	0.22	0.42	0.80
EA: Utilization	0.81*	(0.34)	1.16	2.26	4.38
Age	-0.02	(0.02)	0.94	0.98	1.02

Note.  $R^2 = 0.15$  (Cox-Snell), 0.18 (Nagelkerke). Model  $\chi^2(8) = 66.22, p < .001$ . \* $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$ .

Table A4: Multinomial logistic regression using one-factorial PEB in a backwards selection method

	<i>B</i>	<i>SE</i>	95% CI for Odds Ratio		
			Lower	Odds Ratio	Upper
<i>No raffle participation vs. WWF voucher</i>					
Intercept	-0.47***	(0.12)			
PEB-SD	0.16	(0.36)	0.58	1.18	2.39
EA: Preservation	-0.25	(0.31)	0.42	0.77	1.44
EA: Utilization	0.71*	(0.30)	1.13	2.03	3.66
Age	0.04**	(0.13)	1.02	1.04	1.07
PEB-SD x Age	0.09*	(0.04)	1.00	1.09	1.18
<i>Amazon voucher vs. WWF voucher</i>					
Intercept	-1.01***	(0.16)			
PEB-SD	-0.96*	(0.42)	0.17	0.38	0.86
EA: Preservation	-0.82*	(0.33)	0.23	0.44	0.85
EA: Utilization	0.83*	(0.34)	1.18	2.28	4.42
Age	-0.02	(0.02)	0.94	0.98	1.02
PEB-SD x Age	0.03	(0.06)	0.92	1.03	1.15

Note.  $R^2 = 0.17$  (Cox-Snell), 0.19 (Nagelkerke). Model  $\chi^2(10) = 71.82, p < .001$ . \* $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$ .