1 Introduction

Human survival critically depends on the resources provided by the natural environment, such as clean air and water, food, and habitat. It is therefore essential that these resources are used in a sustainable way in order to guarantee their availability in the long run. However, industrialization, urbanization, and population growth have resulted in ever-increasing demands on the environment, which exceed the capacity of the global ecosystem (Dunlap & Jorgenson, 2012). In recent decades, this has become manifest in various environmental problems that pose a threat to both nature and humans, including pollution of air, water, and soil, depletion of natural resources, deforestation, and loss of biodiversity. One major environmental issue of our time is the global climate change problem. Since the 1950s, an unprecedented global warming of the climate system has been observed, as evident from increased air and water temperatures, diminished amounts of snow and ice, and rising sea levels (IPCC, 2013). These changes are largely driven by substantially increased emissions of greenhouse gases (especially carbon dioxide and methane), attributable to the burning of fossil fuels, agriculture, and forestry (Bernauer, 2013). The resulting higher temperatures, in turn, increase the risk of extreme weather events, such as heavy precipitation, droughts, heat waves, and tropical cyclones (IPCC, 2007).

Due to the serious global implications of climate change and other environmental problems, finding adequate solutions is of high political and economic relevance. Considering that most of the present environmental issues originate in human behaviors, they can often be managed by changing those behaviors (IPCC, 2013; Steg & Vlek, 2009; Vlek & Steg, 2007). While global policy making constitutes a key component of this problem solving process (reviewed in Bernauer, 2013), interventions that target behavior at the individual level also offer great potential for mitigating negative human impact on the environment. This initially requires a thorough understanding of the factors that predict individual environment-friendly behavior, hereafter referred to as *pro-environmental behavior (PEB)*. Since the 1970s, environmental psychologists

have therefore attempted to explain when and why individuals act in pro-environmental ways. A variety of influencing factors have been identified, including demographic variables (e.g., age, gender), social-psychological constructs (e.g., attitudes, social norms), and situational factors (e.g., infrastructure, incentives). Nevertheless, these factors often predict only a small amount of variance or are limited to specific forms of behavior and are thus not able to sufficiently explain the large interindividual variability in PEB.

The aim of the present work was to contribute to the explanation of PEB by exploring the, as yet unexamined, predictive value of psychobiological factors. In particular, the effects of basal testosterone and cortisol as well as of acute stress and associated increases in cortisol were investigated in two separate empirical studies. Baseline testosterone and cortisol levels reflect relatively stable individual differences, which have been conceptualized as traits by several authors (Liening & Josephs, 2010; Newman & Josephs, 2009; Sellers, Mehl, & Josephs, 2007). The two hormones have been found to critically influence various forms of human social behavior and might therefore also contribute to the prediction of PEB as a special form of prosocial behavior. By contrast, acute stress and associated hormonal fluctuations represent transient states that may vary rapidly within an individual. A large body of research demonstrates that stress affects behavior across numerous areas, including eating behavior, sexual behavior, cognitive performance, decision-making, and social behavior. Since stress, at least in its more minor forms, is a common part of everyday life, many of the daily decisions on whether to act pro-environmentally or not (e.g., Should I take the car or train? Should I donate to an environmental organization?) are likely to be made under stress at times.

All in all, the present research intends to provide a new perspective on PEB by focusing on more basal or distal psychobiological predictors in the form of relatively stable baseline hormone concentrations and more transient states of psychosocial stress. A more profound understanding of the psychobiological determinants of PEB may ultimately contribute to the development and tailoring of efficient interventions aimed at promoting sustainable actions.

This thesis consists of three main parts. The first part provides a theoretical background to the research questions under study. It introduces and defines the key concepts of PEB and stress, explains the functioning and mechanisms of the examined endocrine systems, and reviews previous empirical findings that are of relevance to the present hypotheses. Since testosterone, cortisol, and stress have not been explored in association

with PEB before, the literature review focuses on related research from the larger field of social and particularly prosocial behavior. The first part ends with an integration of the theoretical and empirical findings and the derivation of the study hypotheses. In the second and core part of the thesis, the results of the two empirical studies are presented. Finally, the thesis concludes with a summary and critical discussion of the main findings and an outlook for future research.

PART I: THEORETICAL BACKGROUND

2 Pro-Environmental Behavior

This first chapter is concerned with the construct of pro-environmental behavior (PEB), which serves as the main dependent variable in the two empirical studies described in the second part of the thesis. The chapter starts with a definition of the construct and a discussion of different methods commonly employed to measure PEB. After that, the focus lies on the important question of what factors determine an individual's propensity to act in pro-environmental ways. Key theoretical frameworks are presented, along with a review of the literature on various intrapersonal and external predictors of PEB.

2.1 Definition

In the present work, PEB is defined as behavior that is intended to minimize one's negative impact on the natural environment (cf. Steg & Vlek, 2009). This definition explicitly focuses on behavior that is performed with the intention of protecting the environment and does therefore not include "unintentional" forms of PEB that originate from non-environmental motivations such as saving money or improving one's health. Furthermore, the present definition encompasses all intentional forms of PEB regardless of their actual benefit, notwithstanding that some behaviors (e.g., driving) have a considerably higher impact on the environment than others (e.g., recycling) (Gardner & Stern, 1996; Gifford, 2014; Steg & Vlek, 2009). With regard to terminology, *pro-environmental behavior* is commonly used throughout the literature, but a considerable number of synonyms are also prevalent, including environmental, ecological, eco-friendly, climate-friendly, sustainable, and conservation behavior or action.

Examples of PEB are diverse and include recycling, reuse of products, reduction of waste production, use of non-toxic substances, purchase of energy-efficient appliances, reduced driving and flying, buying seasonal and local foods, reducing room temperature, limiting hot water use, eliminating standby electricity, supporting environmental organizations (e.g., via membership or donations), and political activism. One major

area of PEB with great potential for reducing carbon dioxide emissions and mitigating climate change is energy conservation in the household and private travel domains (Dietz, Gardner, Gilligan, Stern, & Vandenbergh, 2009; Gardner & Stern, 2008). Energy-saving behavior can be further divided into curtailment and efficiency behaviors (Stern & Gardner, 1981). While actions based on curtailment (e.g., reduce standby electricity) need to be consistently repeated and maintained in everyday life, efficiency behaviors entail the one-time adoption of a more efficient technology (e.g., solar panels).

From a conceptual perspective, PEB can be understood as a form of prosocial behavior. The latter is defined as intentional and voluntary behavior aimed at benefitting others (Eisenberg & Miller, 1987). It typically does not entail direct benefits for the acting individual and is often even associated with a cost to the self. PEB constitutes a form of prosocial behavior insofar as it primarily serves long-term collective interests at the cost of short-time individual interests (Joireman, Lasane, Bennett, Richards, & Solaimani, 2001). In other words, the individual contributes to the greater good and produces benefits for future generations by performing personally costly actions, such as restricting energy consumption or donating money to an environmental organization. Accordingly, several authors in the environmental psychology literature have integrated PEB into the general framework of prosocial behavior (e.g., Geller, 1995; Stern, Dietz, Abel, Guagnano, & Kalof, 1999), as discussed in more detail below. This approach is further supported by findings showing that individuals who act more pro-environmentally display generally higher levels of prosocial behavior, also in areas not related to environmental conservation (Cameron, Brown, & Chapman, 1998; Kaiser & Byrka, 2011). It has therefore been argued that PEB might constitute an indicator of a general prosocial trait (Kaiser & Byrka, 2011).

2.2 Measurement Methods

The most valid assessment of PEB arguably is the direct observation of actual behavior, such as recycling, energy consumption, or purchasing behavior, in the field (for a review of field studies, see Abrahamse, Steg, Vlek, & Rothengatter, 2005). However, this approach is often not feasible since it requires a lot of resources, especially if the researcher aims to measure PEB across multiple areas. Consequently, PEB is most commonly assessed using self-report questionnaires. Several scales have been de-

veloped, with most of them combining behaviors from different behavioral domains to obtain a composite measure of general PEB (e.g., Dutcher, Finley, Luloff, & Johnson, 2007; Kaiser, 1998; Maloney & Ward, 1973; Markowitz, Goldberg, Ashton, & Lee, 2012; Schultz & Zelezny, 1998; Sia, Hungerford, & Tomera, 1986; Sütterlin, Brunner, & Siegrist, 2011). Although self-report measures in general are susceptible to effects of social desirability, self-reported PEB has been shown to be, at most, marginally affected by social desirability concerns (Kaiser, Ranney, Hartig, & Bowler, 1999; Milfont, 2009; Schahn, 2002). Further evidence for the validity of self-reported PEB also comes from studies examining the correspondence between subjective and objective PEB. For example, the correlation between self-reported and actual household energy consumption has been shown to be high (Warriner, McDougall, & Claxton, 1984). Similarly, in a Swiss study 14 exemplary self-reported pro-environmental behaviors from different domains (e.g., recycling, purchasing behavior) were verified by visiting participants at home (Kaiser, Frick, & Stoll-Kleemann, 2001). The results suggested that self-reports are fairly stable and valid indicators of actual PEB. On the other hand, correlations between self-reported and observed re-use and recycling behavior have been reported to be low in an earlier study (Corral-Verdugo, 1997). All in all, although effects of social desirability and other response biases cannot be completely eliminated, self-reports are generally accepted as valid and reliable indicators of PEB.

While self-report measures are usually applied in the context of survey-based research, environmental psychologists have also used experimental designs, for example to investigate the influence of specific interventions on PEB in a more controlled laboratory setting. Such studies often attempt to increase objectivity and reduce effects of social desirability by observing PEB more directly. For instance, the propensity to make a spontaneous donation to an environmental organization has been used as an indicator of PEB in the laboratory (Holland, Verplanken, & Van Knippenberg, 2002; Verplanken & Holland, 2002). Furthermore, a series of studies have focused on pro-environmental consumer behavior by asking participants to rate or choose between actual or hypothetical products differing in their eco-friendliness (Biel, Dahlstrand, & Grankvist, 2005; Cornelissen, Pandelaere, Warlop, & Dewitte, 2008; Fritsche, Jonas, Kayser, & Koranyi, 2010; Grankvist, Dahlstrand, & Biel, 2004; Griskevicius, Tybur, & Van den Bergh, 2010; Verplanken & Holland, 2002). Further examples of more objective PEB measures include observing participants‘ littering behavior in the laboratory (Kallgren, Reno, &

Cialdini, 2000) or their propensity to volunteer for conservation activities (Davis, Green, & Reed, 2009).

2.3 Theoretical Frameworks

Two of the most influential theoretical frameworks for the explanation of PEB at the individual level are the theory of planned behavior (TPB; Ajzen, 1991) and the value-belief-norm theory (VBN; Stern, 2000; Stern et al., 1999). The TPB suggests that a relevant behavior (e.g., PEB) is most proximally predicted by the intention to perform this behavior (see Figure 1). A strong behavioral intention, in turn, is determined by three predictors. First, the personal attitude towards the particular behavior must be positive. Second, perceived social norms must support the behavior, and third, the individual must believe to have actual control over the behavior (e.g., opportunities and resources). Thus, the TPB explains behavior based on factors that are specific to the behavior under study, rather than on the basis of more general dispositions or traits. The TPB has been shown to successfully predict different pro-environmental behaviors, such as transportation choice, recycling, environmental organization membership, and energy conservation (e.g., Bamberg & Schmidt, 2003; Heath & Gifford, 2002; Kaiser & Gutscher, 2003; Laudenslager, Holt, & Lofgren, 2004).

The second commonly used theoretical framework, VBN theory, is a modified version of Schwartz's (1973, 1977) moral norm activation theory of altruism, which Stern and colleagues (2000, 1999) adapted to explain PEB. The VBN theory proposes a causal chain which culminates in the activation of personal norms – a feeling of personal obligation – to take pro-environmental action (see Figure 2). The chain starts with three distinct types of personal values that influence environmental beliefs. Altruistic values (concern for other humans) and biospheric values (concern for other species and the biosphere) are considered to be self-transcendent, that is, they focus beyond an individual's immediate own interests (Stern, 2000). While these two types of values positively predict environmental beliefs, egoistic (or self-enhancing) values affect them negatively. Environmental beliefs, in turn, comprise the awareness that the personally valued natural environment is threatened and the belief that the individual can reduce this threat through personal action. Both beliefs stem from an ecological worldview which acknowledges that human actions have substantial negative effects on the nat-

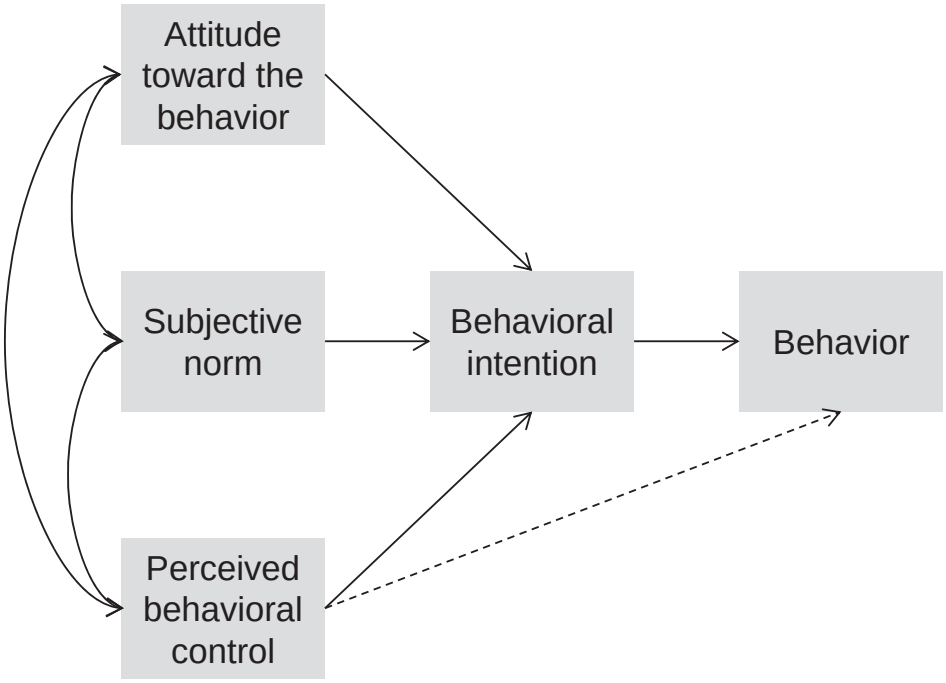

Figure 1: The theory of planned behavior (adapted from: Ajzen, 1991).

ural environment (Stern et al., 1999). The VBN theory has been applied to different pro-environmental behaviors and seems most successful at explaining behavioral intentions or low-cost PEB (for an overview, see Steg & Vlek, 2009). In particular, altruistic, biospheric or self-transcendent values have been shown to positively predict pro-environmental action, whereas egoistic or self-enhancing values have been found to be negatively related to PEB (e.g., Nordlund & Garvill, 2002; Schultz et al., 2005).

While the two described frameworks have been widely applied and empirically supported, both models cannot sufficiently explain PEB, as evidenced by the generally weak associations between the proposed constructs (Gifford, Kormos, & McIntyre, 2011; Kollmuss & Agyeman, 2002). Other authors have therefore included further predictors, such as environmental knowledge, personal sense of responsibility, and situational factors (e.g. Hines, Hungerford, & Tomera, 1987), or habits and past behavior (Gifford et al., 2011; Kollmuss & Agyeman, 2002; Steg & Vlek, 2009). However, all in all it appears that PEB is a highly complex and heterogeneous construct depending on a variety of factors which are difficult to integrate into a single framework (Kollmuss & Agyeman, 2002). Accordingly, different lines of research have explored various other influencing factors of PEB, independently of a specific theoretical framework. These factors will be reviewed in the following section.