Environmental competence : the interplay between connection with nature and environmental knowledge in promoting ecological behavior

Environmental competence

The interplay between connection with nature and environmental knowledge in promoting ecological behavior

Nina Roczen

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CHAPTER 1

General introduction

Physicians should be able to cure people from diseases and not only shine with excellent results in their exams. In just the same way, we expect a car mechanic to fix and to reassemble a broken engine properly, and not only to know the theory behind engine types, assemblies, and their workings. These two examples illustrate what the ultimate goal of education is, or at least should be: to provide students with abilities that enable them to attain real life achievements (McClelland, 1973; OECD, 2003). To put it another way, the purpose of education is to advance *competences*, and not just abilities such as acquiring and retrieving factual knowledge. Competences describe abilities that allow people to cope successfully with real-life tasks (e.g.,Weinert, 2001).

Transferred to the field of environmental education, the ultimate goal obviously is to advance people's ecological behavior. Those abilities and propensities have to be identified, which are both behavior effective with regard to ecological behavior and that are accessible by educational interventions. To effectively and sustainably promote ecological behavior, environmental education, thus, should focus on environmental competence. Unfortunately, most approaches in environmental education focus either on changing single specific behaviors (see Kyburz-Graber, 2004) or on abilities that are not empirically confirmed to be strongly correlated with ecological behavior (e.g., de Haan, 2006). The objective of this thesis is the development and empirical test of an environmental competence model that is conceptualized as the interplay of motivational and cognitive dispositions and abilities in promoting ecological behavior. Several environmental competence conceptualizations are found in the literature. However, only very few describe competence models in a narrower sense, that is, approaches that aim at modeling the structure of environmental competence. Although both models we will present address important aspects of competence, they also have significant shortcomings which we aim to overcome with our environmental competence model. The first model does not properly differentiate competences from abilities. That is, one essential determinant of

competence, the effect on behavior, is not integrated into the competence structure (see Corral-Verdugo, 2002). In the second model, only intellectual abilities are considered (see Gräsel, 2001). However, these abilities are empirically confirmed to only have a moderate effect on ecological behavior (e.g., Hines, Hungerford, & Tomera, 1986/87; Stern, 2000a), whereas motivational dispositions strongly impact on ecological behavior (see Roczen, Kaiser, & Bogner, 2010). Furthermore, in this model, the ecological impact of a person rather than the behavior itself represents the target dimension. As we will see, however, this leads to underestimating the actual influence of psychological dispositions as many factors that cannot be influenced by a person affect a person's ecological impact.

In contrast to existing approaches, we propose an environmental competence model which includes cognitive and motivational propensities and in which the target criterion is conceptualized as people's overall ecological behavior. The cognitive propensity environmental knowledge does not have a strong influence on ecological behavior; it is however seen by many as a necessary precondition. By following Frick and colleagues (Frick, Kaiser, & Wilson, 2004), we distinguish three forms of environmental knowledge: knowledge about nature and about environmental problems (system knowledge), knowledge about ecological behaviors (action-related knowledge), and knowledge about these behaviors' effectiveness (effectiveness knowledge). In addition and as the motivational source behind a person's ecological behavior, we propose people's connection with nature. With our model, we conceptualize environmental competence as the interplay between environmental knowledge and connection with nature in promoting ecological behavior. While the knowledge-behavior structure had already been analyzed with a representative sample of adults (Frick et al., 2004), to our knowledge, no study has explored the relationship between connection with nature and environmental knowledge and how they are conjointly advancing ecological behavior.

While for ecological behavior and environmental knowledge, instruments have already been developed and established, the existing instruments assessing connection with nature were not fully satisfying, especially for our target group of adolescents[1].

[1] In view of possible further studies and a longitudinal analysis of environmental competence, we decided to analyze our anticipated model with a sample of adolescents as the acquisition of environmental competence presumably takes place during childhood and adolescence (Müller, Kals, & Pansa, 2009).

Therefore, the first step was the development and validation of a new measure for connection with nature. Most of the existing connection with nature measures require a demanding intellectual performance: Participants have to assess their own extent of connection with the natural world, which we think is a very difficult task, especially for children and adolescents and which may lead to response biases. Therefore, we have developed a measure in which connection with nature is indirectly derived from behaviors and statements that are easy to assess.

An environmental competence model can only be useful for promoting ecological behavior if the precedents of ecological behavior included in the model can be targeted effectively by means of education. Knowing how a propensity arises and develops provides information about how to address it by educational interventions. There is a consensus among researchers that somehow experiences in nature play a certain role in this development. Up to now, however, hardly any research has been done to investigate *how* these experiences lead to a higher connection with nature. For this reason, we undertook studies to gain further knowledge about the processes behind the development of connection with nature.

Thesis outline. This thesis is organized in seven chapters. This first chapter introduced a general definition for competences and a more specific one for competences in the field of environmental conservation and pointed out the importance for education to focus on competences rather than on mere abilities without linking them to the desired outcome. Further, it described our conceptualization of competence as the interplay between ecology-specific abilities and dispositions on the one hand and ecological behavior on the other and contrasted it with existing approaches. Chapter 2, 3, and 4 constitute the first part of the dissertation and deal with one of the prime motives for ecological behavior: connection with nature. The chapters address its theoretical conceptualization, its measurement, as well as its origins. Chapters 5 and 6 focus on environmental competence and form the second part of the dissertation. Existing approaches are reviewed, the single constituents of our environmental competence model are presented as well as the empirical test of the theoretically anticipated model. Chapter 7 contains a review of the main findings, a discussion of implications of our studies and directions for future research as well as for environmental education programs.

Chapter 2 reviews the literature concerning the motivational constituent of our environmental competence model: Connection with nature. Although it is conceptualized differently, by some authors cognitively, as part of a person's self

concept, and by others with regard to emotion, as emotional affinity towards nature, it can be shown that all concepts reflect the same psychological phenomenon. Despite the variety in the theoretical conceptualizations, the different authors agree on the behavior effectiveness of connection with nature. A growing body of research recognizes it to be one of the prime motives for ecological behavior.

In Chapter 3, we present the development and validation of an indirect measure for connection with nature which is also better suited for children and adolescents than the existing measures. We conceptualize connection with nature as attitude which we derive indirectly from simple behavioral and evaluative statements which are indicators for higher or lower levels of attitude toward nature. Examples are collecting mushrooms or considering animal watching as exiting. Although our new connection with nature measure is conceptualized differently from the existing instruments as it derives connection indirectly, we expect it to converge with other connection with nature measures. Furthermore, we hypothesize our instrument to be technically equivalent or even superior with regard to reliability as well as to discriminant and predictive validity.

Chapter 4 deals with the origins of connection with nature. We present two studies that were conducted to gain further insights into the acquisition and development of connection with nature. In the first study, based on interview data from students high and low in their connection with nature, we analyzed whether students with high levels recalled more enjoyable and relaxing experiences in nature than students with low levels of connection with nature. In the second study, based on survey data, we further explored the processes behind the development of connection with nature. We hypothesize enjoyable, gratifying experiences to mediate the relationship between contact with nature and living environment on the one hand and connection with nature on the other hand.

In Chapter 5, we present the concept of competences and their significance for the field of educational psychology. We describe two existing environmental competence models and contrast them with our newly developed model. Among the existing competence models in the literature, only our model comprises the interrelations between ecological behavior as target dimension and its prerequisites and, at the same time, includes cognitive as well as motivational propensities. While the three forms of knowledge, environmental system knowledge, action-related knowledge, and effectiveness knowledge are understood as necessary prerequisites, connection with nature is expected to be the crucial motivational source behind the ecological behavior of individuals. Regarding the knowledge-behavior relationship, we expect system

knowledge to only indirectly influence ecological behavior, whereas action-related and effectiveness knowledge are hypothesized to have a direct impact. Connection with nature is not only anticipated to motivate ecological behavior, but also to motivate the search for information about ecological behaviors (action-related knowledge) and their effectiveness (effectiveness knowledge).

In Chapter 6, we present a study which we undertook with a large sample of adolescents to empirically confirm our theoretically anticipated environmental competence model. First, we report descriptive results concerning the five scales employed for environmental system knowledge, action-related knowledge, effectiveness knowledge, connection with nature and ecological behavior. These results include the reliabilities, fit statistics and descriptions of the respective person estimate distributions. Second, we describe the empirical test of the postulated competence model. Specifically, (1) we aim to confirm the structure between different forms of knowledge and ecological behavior for adolescents, which has already been corroborated for a representative sample of adults before. Furthermore, (2) we anticipate connection with nature, which we included as a motivational source, to be the strongest predictor for ecological behavior within our model, compared with the influence of environmental knowledge, which is only expected to be moderate. (3) Regarding the relationship between environmental knowledge and connection with nature, we investigate whether connection with nature is a significant predictor for action-related and effectiveness knowledge.

Finally, in Chapter 7, we summarize our results concerning the measurement of connection with nature, concerning its development, and the interplay of knowledge, connection with nature, and ecological behavior. We discuss theoretical implications concerning the concept of connection with nature, its development, its measurement as well as implications for environmental competence models. We furthermore explicate practical implications for intervention programs regarding their effectiveness, their evaluations and their content. For future research, we propose longitudinal studies to examine the acquisition of connection with nature as well as the development of the environmental competence structure. Moreover, further research into the nature of the phenomenon connection with nature is recommended.

PART I

CONNECTION WITH NATURE

CHAPTER 2

Motivational source for ecological behavior – connection with nature

People's motives behind ecological behavior have been studied in psychology for over thirty years now. In several studies, numerous possible motivational sources for ecological behavior have been investigated. Those motives have been examined in the framework of behavior explanation models such as the theory of planned behavior (Harland, Staats, & Wilke, 1999) or the value-belief-norm theory (Stern, 2000b; Stern, Dietz, Abel, Guagnano, & Kalof, 1999). In other studies, motives for ecological behavior have been investigated as a rather heterogeneous set of predictors retrieved from different environmental psychological approaches (e.g., Sia, Hungerford, & Tomera, 1985; see Kals, 1996). These predictors are a person's worldview (Dunlap, Van Liere, Mertig, & Jones, 2000), empathy with nature (Schultz, 2000), values (Dietz, Frisch, Kalof, Stern, & Guagnano, 1995; Inglehart, 1990; Stern, 2000b), altruistic motives (e.g., Guagnano, Stern, & Dietz, 1995), and beliefs (Stern et al., 1999), just to name a few.

Overall, it can be stated that the most important class of motivational sources for ecological behavior are formed by different moral norms and values (Kals, 1996). Although the behavior effectiveness of moral motives is undisputable (Bamberg & Möser, 2007), we believe another motive to be a more appropriate constituent of an environmental competence model: connection with nature. A growing body of research corroborates it to be a similar strong force behind ecological behavior.

In the following, we will review some results concerning the behavior efficacy of moral motives. We discuss the arguments for why, in spite of their behavior effectiveness, moral motives might be less suitable as a competence constituent and therewith, less suitable for being addressed by environmental education interventions than connection with nature, which we propose as an alternative. Subsequently, we present different conceptualizations of connection with nature and summarize the

research confirming its behavior effectiveness. Two aspects within the research into connection with nature still require further research: The measurement of connection with nature as well as the developmental processes of connection.

2.1 Why connection with nature rather than other motivational sources?

In this section, we argue for connection with nature as a motivational source of a competence model rather than moral norms and values, which are the most prominent motives for ecological behavior to date. Next, we provide a short overview of two different research traditions that corroborate people's morality to be vital for ecological behavior, before we examine potential problems with moral values and thoughts.

Many current environmental problems can structurally be described as social dilemmas (Hardin, 1968). In social dilemmas, people are confronted with a conflict between their prosocial propensity to cooperate with each other and their inclination to compete for the resource. By and large, people compete rather than cooperate. In other words, the pursuit of self-interest is commonly found to be the dominant strategy. Nevertheless, people differ in their propensity to cooperate with one another in social dilemmas (Kramer, McClintock, & Messick, 1986). Predictably, personality, that is, one's social value orientation (e.g., Van Lange, 1999), was one factor that was repeatedly recognized to influence behavior in social dilemmas, in a way that "prosocials" cooperate rather than "individualists" or "competitors". Social value orientation was also recognized to be relevant for ecological behavior outside the laboratory, for example in the field of mobility and transportation (Joireman, van Lange, Kuhlman, van Vugt, & Shelley, 1997).

In environmental psychology, the search for motives behind ecological behavior likewise led to moral considerations, particularly, to a person's moral norms and values (e.g., Bamberg & Möser, 2007; Stern, 2000b). In their meta-analysis, Bamberg and Möser (2007) report a mean correlation between moral norms and behavior of about $r = .40$. In their extended version of the planned behavior framework, they estimate moral norms to explain about 10% of people's intention to act ecologically even above and beyond the other determinants of intention (see also Harland et al., 1999). In Kaiser's research (2006), moral norms not only form the essence of a person's attitude and, thus, a person's intention to act ecologically but also substantially materialize in ecological activities of various sorts (see also Kaiser & Scheuthle, 2003). Likewise, Lindenberg and Steg (2007) also speak of a most critical role of normative goals for

ecological behavior. Furthermore, much research in environmental psychology has so far been conducted within some variant of the norm-activation framework by Schwartz (1973; 1977). Two typical examples of research inspired by this theory concern public transportation use (Hunecke, Blöbaum, Matthies, & Höger, 2001) and recycling (Guagnano et al., 1995). Further empirical support for the behavior-significance of moral norms in the conservation domain comes from studies employing the value-belief-norm theory by Stern and colleagues (e.g., Stern, 2000b; Stern et al., 1999). Stern and colleagues (1999) could confirm their value-belief-norm theory's efficacy in accounting for different types of behavior (i.e., private sphere behavior, policy support action, or environmental citizenship). The value-belief-norm theory was also tested by Kaiser and his colleagues (Kaiser, Hübner, & Bogner, 2005) using a composite measure of ecological behavior as a dependent variable. They found 64% of their general behavior to be accounted for by moral norms.

In summary, we believe these results from different lines of research speak of a person's morality to be a strong, if not the key motivational force behind ecological behavior. Hence, morality's importance for ecological behavior is hard to dispute. Nevertheless and despite morality's impressive behavior efficacy, the following arguments show that it could be rewarding to also consider alternative motivational sources.

The first argument comes from Hardin (1968). In his influential paper, he considered appeals to guilt and other forms of moral exhortation as unfair, because only agreeable, "good" people will voluntarily respond. Hardin also expects appeals to guilt and to a person's conscience to be pathogenic as they cause anxiety and stress. Obviously, moral based interventions can also do without appeals or they can use positive appeals, for example by rewarding or encouraging certain behaviors, which will not evoke feelings of guilt. Nevertheless, the argument shows that moral-based education can, under certain circumstances, draw negative consequences. A further argument against moral-based behavior-change campaigns concerns the presumed rigor of moral convictions and the very concept of traits. If environmentalism is a virtue and environmentalists are the "better," the more prosocially acting people, and if environmentalism is a trait rather than a state (e.g., Joireman et al., 1997), moral-based interventions might not be as effective as hoped for if they cannot be effectively mended (Kaiser & Byrka, 2011).

Connection with nature, as we will see next, is a similarly strong motivational source for ecological behavior as are moral norms. The literature suggests that the best way to fostering connection with nature is providing children with (positive)

experiences in nature (Schultz, 2002a). Although connection with nature is found to be a quite stable disposition during adulthood, authors assume it to be formable by education during childhood (Müller, Kals, & Pansa, 2009). Connection with nature promises, thus, to offer access to educational interventions, without the criticisms that can concern moral-based interventions.

2.2 What is connection with nature?

The notion of a human-nature connection has a long history, far beyond environmental psychology. For example, a positive bond between humans and the natural environment is addressed from religious (for a presentation of the human-nature-relation in buddhism, see Sandell, 1981) and philosophical perspectives (see e.g., ecological philosophy/"ecosophy", Naess, 1972; or environmental ethics, Rolston, 1991). The importance of a positive human-nature relation is also an important topic in the writing of ecologists (Leopold, 1949) and ecopsychologists (e.g., Roszak, 2001) alike. These early approaches, however, remained in the main experientially and have not been subject to empirical research until more recently. During the last years, a remarkable number of empirical studies have been undertaken with the aim to conceptualize the human-nature connection and to develop and validate measures for it. One important research goal also was to assess relationships to important possible correlates, first and foremost ecological behavior. The names of the different concepts form a list of seemingly heterogeneous constructs, such as nature relatedness, connectedness to nature, commitment to the environment, inclusion of nature in self, implicit association with nature, environmental identity, to name just a few. While some of these approaches build on purely cognitive processes to explain the phenomenon of the human-nature connection, others emphasize affective aspects of that connection.

Mayer and Frantz (2004), for example, define "connectedness to nature" as a person's emotional connection to nature or as an individual's experiential sense of oneness with the natural world. Their concept entails both the feeling of being part of a larger whole, and, at the same time, considering the natural environment as part of the own self. Mayer and Frantz furthermore compare connectedness to nature to the feeling of connection with another person. Similarly, Kals, Schuhmacher, and Montada (1999) conceptualize affinity towards nature as a positive feeling of inclination in different nuances such as love of nature, feeling good, free, and safe in nature, as well as feeling oneness with nature. Davis, Green, and Reed (2009), equally

define the phenomenon of connection with respect to emotion. They draw on interdependence theory of interpersonal relations (see Kelley & Thibaut, 1978) to explain the human-nature relationship. Just like interpersonal relationships, the natural environment and humans are dependent of each other. Commitment is defined as the subjective experience of that interdependence which is taking the form of psychological attachment to and long-term orientation towards the natural world.

Clayton (2003), by contrast, defines environmental identity with regard to cognitive processes as one particular level of a person's identity, that is, a person's way of organizing information about his/her self. Like one part of that information might concern the membership in a certain social group, another part of a person's identity provides him/her with a sense of connection with the natural environment, associated with the belief that the environment is important to him/her and an important part of who he/she is. Environmental identity is expected to vary in both content and importance among individuals. Clayton furthermore assumes that considering the environment as important part of the identity leads to a strong and positive sense of self as the environment provides experiences of autonomy, connection, and competence. In a similar way, Schultz (2002a) presents a purely cognitive conceptualization of connection with nature, which refers to the extent to which an individual includes nature within his/her cognitive representation of the self. In other words, a person who sees himself or herself as part of nature has cognitive representations of the self that overlap extensively with that person's cognitive representation of nature. For a person who does not define himself or herself as part of nature, accordingly, the representations of nature and self will not overlap. Schultz, Shriver, Tabanico, & Khazian (2004) argue that connection with nature can also be conceptualized and measured as an implicit connection that individuals make between self and nature. Schultz (2002a) examines connection with nature in the larger framework of inclusion with nature. Connection with nature is hypothesized to advance commitment to protect nature, mediated by caring for nature.

Nisbet and her colleagues (Nisbet, Zelenski, & Murphy, 2009) integrate affective as well as cognitive aspects in their concept. They claim nature relatedness to be a person's affective appreciation for nature, and, at the same time, the understanding of the human's interconnectedness with all other living things on Earth.

In the next section, we will review explanations and results concerning the relationship between connection with nature and ecological behavior. As we will see, there is a high consensus in the results, although the different approaches build on different theories.

2.3 Connection with nature as motivational force

The idea that a close connection to nature leads to ecological behavior or that a deficient connection with nature causes environmental deterioration, respectively, is regarded as self-evident, and already has been before the actual relationship had been empirically tested. For example, we expect that, to a Sámi reindeer herder, whose subsistence is closely linked to the forest, the idea of felling trees would not even occur. In the opposite way, a passionate games console addict is not expected to see a reason to use, for example, recycled paper. Such ideas were put forward early on, as reflected in Leopold's (1949) famous quote "We abuse land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect". Similarly, ecopsychologists suspect that feeling a sense of belonging to the natural environment may be a prerequisite for increasing ecological behavior (see e.g., Roszak, 2001).

In more recent empirical approaches, the relationship between the humans' connection with nature and their ecological behavior often is the very rationale for the research on the concept of connection. Clayton (2003) claims that the validity and utility of the construct of environmental identity lies in the evidence that it affects human behavior, and in that it outperforms other determinants, such as, for example, attitudes. Kals and colleagues (1999) believe that ecological behavior cannot sufficiently be explained using the traditional mostly cognitive approaches and, as a response to that, introduce their conceptualization of affinity towards nature. The authors state that such a construct, on an intuitive basis alone, seems to be apt for explaining ecological behavior. In introducing their measure for nature relatedness, Nisbet and colleagues (2009) argue that nature relatedness captures many of the interindividual differences in propensities preceding ecological behavior, and thereby differences in ecological behavior itself.

To explain the strong relationship between connection with nature and ecological behavior, the authors draw on the different theories on which their concepts of connection with nature are built. Davis and colleagues (2009), in analogy to the interdependence theory (Kelley & Thibaut, 1978), assume that a person who is committed to nature shows behaviors that are consistent with the well-being of the environment. Schultz' theory of inclusion with nature (2002a) aims at explaining how connection with nature (in form of common representations of nature and self) eventually leads to ecological behavior. Schultz predicts connectedness to result in caring for nature which, in turn, has a positive effect on a person's commitment to

protect nature. Mayer and Frantz (2004) compare connectedness to nature to feelings of interpersonal connection. Just like increasing relationship closeness leads to empathy and willingness to help (see also Cialdini, Brown, Lewis, Luce, & Neuberg, 1997), so does connectedness to nature result in ecological behavior. Theories that define connection with nature as a part of a person's identity, imply the following assumption: A person who is connected to nature is less likely to behave damagingly to the environment out of self-interest alone (Clayton, 2003), as that would in essence imply harming that person himself/herself.

Approaches addressing the relationship between a human-nature connection and ecological behavior refer, thus, to very different frameworks such as self-interest or altruistic behavior, respectively. While the theoretical frame around that relationship is still controversially discussed, the empirical results could not be more consistent. Clayton (2003), for instance, reports a person's environmental identity to substantially covary with ecological behavior (r = .64). In the same vein, Kals and her colleagues (1999), also found their emotional affinity towards nature measure to correlate with different ecological behaviors (coefficients range from r = .49 to r = .60). Similarly, Davis and colleagues (2009) found commitment to the environment to determine a composite measure of ecological engagement (r = .60). With proportions of explained behavior variance between 25% and 40%, there is, thus, surprising consensus in the findings of the various research groups.

2.4 Aspects requiring further research

In this chapter, we summarized the research confirming connection with nature to be one prime motive for ecological behavior. Additionally, we assume that it might be more easily accessible to educational interventions than other motivational sources are. However, further research is needed. First, existing measures for connection with nature are not yet completely satisfying. For one thing, the available instruments apparently all measure something different. For another, existing measures reveal shortcomings which are particularly problematic for adolescents which are our target group. Second, although there is a strong interest in the phenomenon connection with nature, only little research addresses conditions of its development and not a single study, to our knowledge, has examined the underlying processes. However, knowledge about the processes of the development is essential for an effective promotion of connection with nature, and thereby, of ecological behavior.

2.4.1 How to measure connection with nature?

In the following, we will first give arguments for our assumption that measures of apparently different concepts such as environmental identity (Clayton, 2003) or inclusion of nature in self (Schultz, 2002a) reflect one single phenomenon – connection with nature. Second, we will detail drawbacks to available instruments.

Different conceptualizations – one phenomenon? The different conceptualizations of connection with nature that have been presented in this chapter seem to be very diverse. In fact, the existing approaches also draw on very different theories such as identity theory (Rosenberg, 1981; Clayton, 2003) or interdependence theory (Kelley & Thibaut, 1978; see also Davis et al., 2009). However, the approaches bear remarkable similarities, especially when compared at the level of operationalizations. Although Mayer and Frantz (2004), for example, claim to measure a purely affective connection with nature with items like "I feel as though I belong to Earth as equally as it belongs to me", the similarities to a typical environmental identity item (Clayton, 2003), "I think of myself as a part of nature, not separate from it", are undeniable. This is also reflected in excessive empirical overlap among the various concept measures: that is, correlations (not even corrected for measurement error attenuation) between $r = .55$ and $r = .80$ (e.g., Hinds & Sparks, 2008). Therefore, we predict, in line with earlier suspicions from Schultz (2002a), that these concepts, although theoretically conceptualized differentially, speak of a unique psychological phenomenon.

Problems with existing measures for connection with nature. The measurement of connection with nature reveals some problems that most questionnaires assessing psychological constructs have to deal with. First, abstract constructs such as "inclusion of nature in one's self" (Schultz, 2002a) or "environmental identity" (Clayton, 2003) are neither easy to convey nor intellectually graspable. It is however even more difficult to exactly assess one's own level of such a construct, which most instruments require. We believe that for children and adolescents, this is a particularly difficult task. In Mayer and Frantz's (2004) Connectedness to Nature measure, for example, people have to assess in how far they "…think of the world as a community to which [they] belong". Second, as regards connection with nature in particular, some authors even assume that people are not consciously aware of their own extent of connection with nature (e.g., Schultz et al., 2004).

While these problems apply to most of the currently existing connection with nature measures, there is one exception. The implicit association with nature measure

(Schultz et al., 2004; Schultz & Tabanico, 2007) derives connection with nature from reaction times. A conscious assessment of one's own level of connection with nature is not required.

Unfortunately, the implicit association with nature measure only shows very moderate correlations with connection with nature as measured directly (Schultz & Tabanico, 2007) and with ecological behavior (Schultz et al., 2004). Due to this insufficient overlap, the implicit association with nature measure apparently is not the appropriate way to overcome the deficiencies of the currently existing connection with nature measures.

In Chapter 3, we present a new connection with nature measure that avoids the problems the currently available instruments are suffering from and that therefore is also more appropriate for use with children and adolescents. Additionally, we give evidence for our suspicion that the apparently distinct concept measures largely reflect individual differences in a single psychological phenomenon.

2.4.2 How does connection with nature develop?

In the framework of this thesis, we discuss connection with nature as a motive for ecological behavior in general, and more specifically as motivational component for the environmental competence model presented in Chapter 5 and 6. The short literature overview dealing with the relationship between connection with nature and ecological behavior showed that connection is increasingly recognized as one of the most important motives for ecological behavior. Its behavior-effectiveness is the basis on which we integrated connection with nature as a motivational constituent in our competence model. The behavior effectiveness is however not sufficient. A motivational constituent of a competence model also has to be amendable by interventions. There is consensus among researchers that a promotion of connection with nature in one way or another has to involve experiences with nature (Kals et al., 1999; Schultz, 2002a). For effectively promoting connection with nature, however, a deeper knowledge about its origins and development is needed, as that knowledge sheds light on its malleability in general, and mechanisms that behavior change programs could build on.

Although a growing number of approaches has addressed the issue of a positive human nature connection, surprisingly little efforts have been made so far to analyze processes of its acquisition and development. In the following, we will present the few

existing propositions that, as we will see, are either only speculative or that rather address the boundary conditions of the development than the processes themselves. Subsequently, we will detail how classical and operant conditioning could represent the mechanisms behind the development of connection with nature and how conditioning is able to explain the relationship that other approaches address, that is, the often described relationship between experiences in and connection with nature.

Boundary conditions. There are, thus, hardly any studies that empirically investigated the developmental processes of connection with nature. Instead, there is a considerate number of approaches speculating about boundary conditions of the development of connection with nature: The assumption that experiences in nature are a crucial precondition for the development of a bond with nature has a long tradition (e.g., Kaplan & Kaplan, 1989; Leopold, 1949). In a reverse conclusion, technology and with it the advancing alienation of humans from their natural environment is held responsible for a continuous loss in people's connection with nature (e.g., Pergams & Zaradic, 2008; Schultz, 2002a). The longstanding view that contact with nature is essential for developing a bond with nature is also supported by a few studies. Kals and colleagues (1999), for example, found that past and present frequency of time spent in nature could predict affinity towards nature. Hinds and Sparks (2008) presented evidence that persons who spent their childhood in a rural environment differ significantly from persons grown up in an urban environment with respect to environmental identity and affective connection. Even short-time experiences in nature such as zoo visits have been shown to result in enhanced connection with nature (Clayton, Fraser, & Saunders, 2009).

Most attempts to *explain* the found relationship between natural experiences and connection with nature remain rather vague. To explain how connection with nature arises through contact with nature, some researchers draw on ideas from research on attitude formation. In that way, they argue that direct and repeated exposure to an object can contribute to the development of a positive attitude toward that object (see Millar & Millar, 1996; Zajonc, 1968). Many authors' assumptions however go beyond the idea that the mere contact with nature (for example, spending time in a forest or a park) is enough to develop a positive connection with it. Kals and colleagues (1999) underline the importance of *positive emotional experiences* in nature. Clayton (2003) emphasizes the significance of an active interaction with the natural world, in contrast to mere contact. In a similar way, Kahn presumes connection with nature to develop through interaction with the physical and the social world (Kahn, 2002). Furthermore,

Clayton presumes people's bond with nature as being due to the psychological and physiological benefits of nature on humans. These benefits, in turn, are well documented in numerous publications, for example, on nature's positive effects on stress reduction (Ulrich, Simons, Losito, Fiorito, Miles & Zelson, 1991), relief from pain (e.g., Kline, 2009), faster recovery after surgery (e.g., Ulrich, 1984), "green exercise" effects on blood pressure, self esteem and mood (Pretty, Peacock, Sellens, & Griffin, 2005), and mental restoration (Hartig, Kaiser, & Strumse, 2007; Hartig & Staats, 2006; Kaplan, 1995). Research suggests that children and adolescents might even be more benefiting of those effects due to children's greater plasticity and vulnerability (e.g., Wells & Evans, 2003).

Mechanisms behind the origin and development of connection with nature. No research exists to date about the *mechanisms* through which positive experiences with nature and perceived positive effects of nature on well-being lead to connection with nature. This is however exactly the knowledge that is needed in order to develop behavior change interventions. Classical and operant conditioning, that is, learning processes might play an important role. Kaiser, Roczen, and Bogner (2008) suspect joyful activities to lead to connection with nature through classical conditioning: as a result of the repeated association with (unconditioned) enjoyable experiences, such as, for example, playing soccer in a park with friends, the natural environment becomes a conditioned stimulus that ultimately triggers conditioned enjoyable responses by itself. The frequently reported positive effects of nature on humans, in turn, could function as reinforcement in the sense of operant conditioning, and thereby, effectuate an enhancement of a positive connection with nature. In Chapter 4, we present two studies that were designed to further examine the acquisition of connection with nature and to get first insights into the role conditioning processes could play.

CHAPTER 3

Measurement of connection with nature

3.1 Introduction

In this chapter, we present a new connection with nature measure that overcomes the methodological deficiencies other approaches are suffering from. This can be realized by conceptualizing connection with nature as a personal attitude. We measure a positive attitude toward nature indirectly, by deriving it from reports of past activities and of evaluative statements that reflect a person's connection with or positive attitude toward nature. As our instrument is not demanding in terms of self-reflection, requiring only easily accessible information such as behavioral records, we expect our instrument to be better suited especially for children and adolescents.

3.1.1 Connection with nature as an attitude

To measure "implicit connection with nature", Schultz and his colleagues (2004) employed an instrument that traditionally is used in attitude research (see Wittenbrink & Schwarz, 2007). Traditionally, attitudes are defined as psychological tendencies which become tangible in evaluations of a particular attitude object (Eagly & Chaiken, 1993). If connection with nature is interpreted as an attitude, consequently, it should be measurable by evaluative statements regarding the attitude object nature. Existing connection with nature measures use such evaluative statements, too. For example, Clayton's (2003) Environmental-Identity scale uses items like "I have never seen a work of art that is as beautiful as a work of nature, like a sunset or a mountain range," or "I really enjoy camping and hiking outdoors". Mayer and Frantz (2004) use evaluative statements like "I recognize and appreciate the intelligence of other living organisms" in their Connectedness to Nature scale.

Most of the traditional attitude scales have to deal with the same methodological problems existing connection with nature measures are suffering from, as they explicitly ask for the extent of appreciation for a certain attitude object (see Eagly & Chaiken, 1993). One possibility, apart from the implicit association test, to circumvent these difficulties in the assessment of attitude, is the Campbell Paradigm (see Kaiser, Byrka, & Hartig, 2010). According to Campbell, an attitude can be defined as an acquired behavioral disposition that brings about both the expression of verbal claims and other behavioral responses toward a certain attitude object (Campbell, 1963; see also Kaiser et al., 2010). The common definition of attitudes today equates evaluative statements with attitudes (e.g., Eagly & Chaiken, 1993), however, they are regarded as rather weak predictors for behavior (e.g., Ajzen & Fishbein, 2005). In Campell's conceptualization, both evaluative statements and behavior are expressions of an attitude. The often found inconsistency between attitude and behavior is unmasked as a purely methodological problem: evaluative statements and other behavioral responses correlate only moderately with each other because they differ regarding their difficulty (Campbell, 1963). For example, it is easier to state that environmental protection is important than to donate money to an environmental organization (Kaiser et al., 2010). Nevertheless, both the statement, as well as the donation are expressions of the same underlying disposition or attitude.

Based on that conception, we understand attitude toward nature as an individual disposition, that is expressed both in behaviors such as "taking time to consciously smell flowers" or "consciously watching or listening to birds" as well as in evaluative statements such as "Watching animals is exciting" or "Pets are part of the family". Consequently, from those behaviors and evaluative statements that are indicators for attitude toward nature, the extent of that attitude can be derived.

3.1.2 The measurement of attitude toward nature

How can a positive attitude toward nature be derived from different behaviors and statements? First, it can be assumed that for a person who is strongly connected to nature, this will become observable in a multitude of different behaviors and statements. One would expect a person with a strong attitude toward nature to not only consciously watch or listen to birds, but also, for example, to get up early to watch the sunrise or to spend time in a park. If, however, somebody claims to enjoy gardening but does neither collect mushrooms or berries nor mimic the sounds of animals nor cross meadows barefoot, one would assume that his or her level of attitude toward

nature must be rather low. Second, the fact that a positive attitude toward nature is manifested in a multitude of behaviors has further implications. Regarding the expression of one's connection with nature, people have a choice and can select from different behaviors. While one person expresses his or her attitude toward nature by talking to plants and stating that watching animals is exciting, another person's attitude becomes evident in helping snails cross the street and in taking time to consciously smell flowers.

Every single behavior alternative a person can choose from involves costs in terms of money, time, or social reputation. For example, travelling to impressive natural sceneries costs both money and time. A simple statement can insofar be costly, as it might not enjoy public recognition. For example, a person's confession that he/she regards plants as important part of the family might earn him/her amused looks.

Generally, if people can choose between different behaviors, they rather prefer the more convenient, socially approved actions over the more costly ones. People would, thus, first mourn the loss of pets, feel miserable when seeing a hedgehog that was hit by a car and claim to like forest hikes better than city strolls. Only a person with a very high extent of attitude toward nature would additionally also publicly mimic animal behavior. In other words, a person's extent of connection with nature is expected to become obvious in the face of progressively demanding behaviors and statements (in terms of time, money, or social acceptance) indicating connection with nature. Expectedly, the more and more demanding behaviors a person shows, the stronger this person's attitude toward nature is. The probability that a person shows a particular behavior or makes a certain statement depends thus on two components: (1) a person's level of attitude toward nature, and (2) the costs or difficulty of a particular act or statement. The Rasch model is suited to mathematically describe the formal link between the probability that a person shows a certain behavior, that person's attitude level and the costs or difficulty of the respective behavior (see Kaiser et al., 2010). This relationship between attitude level, difficulty of a particular behavior and the probability of showing this behavior is represented by the Rasch model formula (for more details see e.g., Bond & Fox, 2007):

$$\ln\left(\frac{p_{ki}}{1-p_{ki}}\right) = \theta_k - \delta_i$$

In this model, the natural logarithm of the ratio of the probability of person k's engagement or affirmation (p_{ki}) relative to the probability for non-engagement or

denial (1-p_{ki}) of a specific activity or a specific statement *i* (reflecting a positive attitude toward nature) is given by the arithmetic difference between *k*'s level of attitude toward nature (θ_k) and the difficulty involved in realizing a specific behavior or in conforming a certain statement *i* (δ_i).

Recalling previous behavior and making evaluative statements do not require self-reflection abilities regarding one's own extent of connection with nature. The employed questions concerning the behaviors and statements are easy to answer as they basically require recollection. As such, we expect them to be particularly suited for the use with children and adolescents. Moreover, as we do not directly ask for a person's assessment of his or her connection with nature but, instead, derive it indirectly, the precise subject of the questionnaire should remain unrecognized by the participants.

3.1.3 Research goals

In this study, we present the development and validation of an indirect measure of people's connection with nature (see Brügger, Kaiser, & Roczen, 2011) based on the idea that such a connection can be derived from inspecting individual reports of (a) behaviors people engage in as means for bonding with nature, and (b) verbal statements that reflect an appreciation of nature. Although our newly developed scale does not require a direct assessment of one's connection with nature, we expect our scale to converge much closer with direct and explicit connection-with-nature scales than with the other non-direct instrument, the implicit-association-with-nature measure (e.g., Schultz & Tabanico, 2007). Moreover, with regard to discriminant validity, we predict that our new measure will be better distinguishable from environmental concern (i.e., the New Ecological Paradigm; Dunlap et al., 2000) than traditional explicit connection-with-nature instruments, such as the Connectedness to Nature Scale (Mayer & Frantz, 2004), the Environmental-Identity scale (Clayton, 2003), and the inclusion-of-nature-in-self measure (Schultz, 2002a) are. We chose environmental concern to verify the discriminant validity of the different connection with nature measures as this concept has a certain similarity with connection: It also concerns the relationship between humans and nature. However, it is a distinct concept as it does not relate to individual connections with nature but assesses beliefs about the general relationship between humanity and nature (see Dunlap et al., 2000). Finally, we anticipate that our new scale will be superior in its predictive significance of ecological behavior.

3.2 Methods

In the following, we will describe our participants, the procedure of data collection, and the different scales that we employed in our questionnaire. Finally, we present the statistical analyses that we performed with our data.

3.2.1 Participants and procedures

Participants were recruited by student mailing lists from the University of Zürich, Switzerland, mailing lists from sports clubs and music associations, and public forums on the Internet. In addition, links to our study were placed on the Internet pages of various Swiss newspapers.

Of the 2935 persons who accessed the Internet questionnaire, 1309 (response rate: 44.60%) completed it. Participants' median age was 28 (M = 34.05, SD = 15.30; range: 18 to 80). The percentage of females was 45.16%. These figures imply that our sample cannot be regarded as representative for the general population. For the purposes of this research, however (i.e., scale development and the comparison of the strengths of relationships), it is sufficient that the participants reflect a wide range of diversity regarding the included variables. The average time required to answer the survey (without the implicit association test) was M = 22.22 minutes (SD = 10.14). To carry out the implicit association test, approximately 10 minutes were needed.

3.2.2 Measures

The questionnaire consisted of seven instruments either originally developed in German or using translations of the original English instruments: three explicit measures of connection-with-nature (i.e., Environmental Identity, Connectedness to Nature, Inclusion of Nature in one's Self), one indirect (i.e., Attitude toward Nature), and one implicit (i.e., Implicit Association with Nature) measure of connection, and two established scales for environmental concern and ecological behavior. For all items, "not applicable" was a response option when an answer could not be given. These answers were coded as missing values. Note that only data for those instruments for which participants had minimally answered 80% of the questions were retained.

Environmental identity involves 24 statements, such as "I think of myself as a part of nature, not separate from it" (Clayton, 2003). One's personal point of view could be

expressed on a 5-point Likert scale from 1 (strongly disagree) to 5 (strongly agree). Of all statements, 16.49% were found to be missing. The internal consistency of the identity measure was $\alpha = .93$ ($N = 1064$). Person scores were conventionally calculated as mean values of the original 24 environmental-identity items.

Connectedness to nature (Mayer & Frantz, 2004) was assessed with 14 statements like "I often feel a kinship with animals and plants." Three of these statements were negatively formulated (expressing a lack of connectedness). For all questions, people could respond on a 5-point Likert scale from 1 (strongly disagree) to 5 (strongly agree). Across all statements, 11.42% were missing. The internal consistency of the connectedness measure was $\alpha = .80$ ($N = 1121$). Again, person scores were calculated as the arithmetic mean of the original 14 connectedness-to-nature items.

Inclusion of Nature in one's Self was the third explicit connection-with-nature measure. This measure is based on only one item (see Schultz, 2001; Schultz, 2002a). By means of a series of seven differentially overlapping circles (labeled "self" and "nature"), participants could choose the one that best described how interconnected they felt with nature. This item was not answered by 10.74% of the participants. Since this measure is a single-item measure, its internal consistency could not be estimated from our data. Schultz and his colleagues (2004) report a 4-week test-retest reliability of $r_{tt} = .84$.

Implicit association with nature was assessed with an Internet template developed by Schultz and his colleagues (e.g., Schultz et al., 2004; Schultz & Tabanico, 2007). It makes use of a specially designed version of the implicit association test (e.g., Greenwald, Nosek, & Banaji, 2003). The measure uses the response time difference that can be found when people link words from different categories. In Schultz and his colleagues' version, people are compared with respect to how rapidly they associate either self-related words (i.e., one's own first name) or other-related words (i.e., an unspecified first name) with nature-related words (such as "flower") or with artifact-related words (such as, e.g., "truck"). The internal consistency of the implicit-association-with-nature measure was $r = .67$ ($N = 734$; details regarding this consistency estimate can also be found in Bruni, Fraser, & Schultz, 2008 and in Schultz & Tabanico, 2007).

Table 1. *Forty attitude-toward-nature items*

		δ_1	p_1	δ_2	p_2
1	*I mimic animal behavior, for example, the way a vulture walks*	*1.26*	*.37*	*4.09*	*.03*
2	*I get up early to watch the sunrise*	*-0.18*	*.71*	*3.35*	*.07*

continued

3	I collect mushrooms or berries	0.34	.59	3.28	.07
4	I mimic the sounds of animals	-0.23	.72	3.11	.08
5	I cross meadows barefoot	-0.40	.75	3.08	.09
6	*I talk to plants*	*0.98*	*.43*	*2.80*	*.11*
7	I help snails cross the street	0.90	.45	2.46	.15
8	*I watch TV shows that have animals as the main characters*	*-1.24*	*.88*	*2.36*	*.16*
9	*I have a CD or tape with recorded sounds of nature*			*2.15*	*.19*
10	*I take time to watch the clouds pass by*	*-2.28*	*.95*	*2.06*	*.21*
11	I take time to consciously smell flowers	-1.60	.91	1.92	.23
12	*I consciously watch or listen to birds*	*-1.51*	*.90*	*1.88*	*.24*
13	*I spend time in a park*	*-2.42*	*.96*	*1.79*	*.25*
14	*I collect objects from nature such as stones, butterflies, or insects*			*1.69*	*.27*
15	*I deliberately take time to watch stars at night*	*-2.57*	*.96*	*1.69*	*.27*
16	Indoor plants are part of the family			1.46	.32
17	*I would always prefer spending time with my friends to spending time alone in nature*			*1.42*	*.33*
18	Even when it is very cold or rainy I go out for a walk	-2.24	.95	1.35	.35
19	I hike or run in nearby nature reserves or forests	*-1.42*	*.89*	1.08	.41
20	*I talk to animals*	*-1.40*	*.89*	*0.66*	*.51*
21	*Carving a tree feels like cutting myself*			*0.47*	*.56*
22	If one of my plants dies, I reproach myself			0.43	.57
23	If there is an insect, such as a fly, in my home, I try to catch and release it rather than kill it			0.41	.58
24	The croaking of frogs is comforting			0.33	.60
25	I enjoy gardening			0.32	.60
26	*I prefer living in a city*			*-0.04*	*.68*
27	*I feel the need to be out in nature*	*-3.96*	*.99*	*-0.19*	*.71*
28	My favorite place is in nature			-0.28	.73
29	*Walking through a forest makes me forget about my daily worries*			*-0.93*	*.84*
30	*As a child I spent time in the woods*			*-1.06*	*.86*
31	*I personally take care of plants*			*-1.11*	*.86*
32	The noise of crickets gets on my nerves			-1.29	.88
33	*I prefer outdoor to indoor sports*			*-1.33*	*.89*
34	*Listening to the sounds of nature makes me relax*			*-1.40*	*.89*
35	*I prefer forest hikes to city strolls*			*-1.50*	*.90*
36	Pets are part of the family			-1.56	.91
37	A cleared forest makes me miserable			-1.59	.91
38	I mourn the loss of pets			-1.85	.93
39	It makes me miserable to see a hedgehog that was hit by a car			-2.07	.94
40	Watching animals is exciting			-2.09	.94

Note. δ represents the difficulty of an item expressed in logits; the more negative a logit value, the easier, and the more positive, the more difficult the particular item is. Logits stand for the natural logarithm of the engagement/nonengagement or endorsement/nonendorsement ratio, respectively, the natural log odds. *p* refers to the probability that the average person engages in the corresponding behavior or endorses a corresponding verbal statement. Some items have two difficulties and two probabilities: The first of the two stands for either "seldom" or "occasionally" engaging, and the second for either "often" or "very often" engaging. Items with only one difficulty and one probability were assessed using a yes/no format (representing engagement or endorsement, respectively). *Items in italics* were adopted from Beckers (2005). Shaded items represent a deficient connection with nature. Prior to the statistical analysis, the shaded items were reversed in their coding.

A person's *attitude toward nature* was assessed with 40 items [22 items originally developed by Beckers (2005); see Table 1]. Out of these 40 items, 26 concerned behavioral self-reports presented with two different response formats: (a) for 17 behaviors, a 5-point frequency scale from 1 (never) to 5 (very often) was employed, and (b) for 9 behaviors, a dichotomous yes/no format was used. Based on Becker's (2005) research, we decided to recode the responses to the first 17 behaviors from a 5-point to a 3-point format by collapsing "seldom" and "occasionally," as well as "often" and "very often." "Never" was retained as "never." The remaining 14 items contained evaluative statements presented with a yes/no format. Of the 40 items, 3 were negatively formulated, expressing a deficient attitude toward nature (see Table 1). Of all responses, 5.45% were found to be missing.

The New Ecological Paradigm (Dunlap et al., 2000) is a popular *environmental concern* measure. The scale consists of 15 evaluative statements, such as "Plants and animals have as much right as humans to exist." These statements were presented together with a 5-point Likert response format ranging from 1 (strongly disagree) to 5 (strongly agree). Seven items were negatively formulated (expressing an unconcerned attitude). Of all concern statements, 14% were missing. The internal consistency of the 15 concern items was $\alpha = .84$ ($N = 1128$). Once again, person scores were conventionally calculated as the arithmetic mean of the 15 original items.

For *ecological behavior*, we included 50 behavioral self-reports from Kaiser and Wilson (2004), such as "I buy meat and produce with eco-labels." Of the 50 behaviors, 19 represented non-ecological activities. Engagement in 18 behaviors was verified with a yes/no format and in 32 behaviors with a 5-point frequency scale ranging from 1 (never) to 5 (always). The responses to the latter set of behaviors were recoded into a dichotomous format by collapsing "never," "seldom," and "occasionally" into "unreliable ecological engagement." "Often" and "always" were united into "reliable ecological engagement." Of all possible behavior statements, 7.36% were missing. The calibration of the behavior scale and the estimation of person scores, based on the classical Rasch model, were in line with previous calibrations of the same instrument (see e.g., Kaiser & Wilson, 2004). All behavior items acceptably fitted the model, and the Rasch model based reliability estimate of the scale was $rel = .85$ ($N = 1186$).

3.2.3 Statistical analyses

The Attitude toward Nature Scale was calibrated with the partial-credit Rasch model[2] using the software program ConQuest (Wu, Adams, & Wilson, 1998). From these calibrations, we will provide information about the reliability of the scales and about the item fit statistics. The fit indices are based on the mean squared residuals (MNSQ)[3] of expected and observed scores and, ideally, have a value of one.

Convergent and discriminant validity information was derived from measurement-error-attenuated-corrected Person correlations between the different connection-with-nature measures on the one hand, and between the connection-with-nature measures and environmental concern (NEP) on the other hand. To further explore convergent and discriminant validity, we performed a maximum likelihood-based exploratory factor analysis with an oblique rotation (i.e., direct oblimin). We assumed the two factors (i.e., connection and concern) to be correlated, based on the corresponding empirical evidence (e.g., Mayer & Frantz, 2004). Predictive validity information for the newly developed Attitude toward Nature Scale was derived from a set of (hierarchical) regression analyses anticipating ecological behavior.

3.3 Results

The results are presented in three parts. In the first part, we describe the scale calibration of the proposed new attitude-toward-nature measure. In the second part, we test our hypothesis that the various measures of a connection with nature largely reflect individual differences in the same or, at least, a very similar personal experience. For that, we examine the convergent validity of the various connection-with-nature measures. Regarding discriminant validity, we explore how connection with nature diverges from environmental concern. Using an exploratory factor analysis, we further explore convergent and discriminant validity. Finally, we also

[2] The partial-credit Rasch model is a generalization of the dichotomous Rasch model for responses scored in more than two ordered categories (for model details see Bond & Fox, 2007).

[3] A MNSQ value indicates the relative discrepancy between the Rasch model prediction and actual data in a way that, e.g., a MNSQ of 1.10 corresponds to a 10% excess of variation. We present MNSQ residuals that are weighted by their variance (“infit”). As a rule of thumb, MNSQ values below 0.75 can be regarded as overfit, whereas values higher than 1.3 indicate underfit (Bond & Fox, 2007).

present data that speak of the predictive validity of the various connection-with-nature measures regarding ecological behavior.

Scale calibration. Based on the partial-credit Rasch model, we were able to successfully calibrate an Attitude toward Nature Scale. All 40 items fitted the model-prediction with reasonable mean square (*MNSQ*) values between 0.86 and 1.16. Of the participants, only a tolerable number of 82 (6.26%) demonstrated poor fit with the model-prediction ($t > 1.96$). The Rasch-model-based reliability of our newly developed measure was also found to be good with $rel = .89$ ($N = 1309$).

Table 2. *Descriptive statistics and bivariate correlations of five connection-with-nature measures, environmental concern, and ecological behavior*

	M	*SD*	*N*	AN	EID	CNS	INS	IAN	NEP	GEB
Attitude toward Nature (AN)	0.72	1.15	1239	*.89*	**.79**	**.71**	**.65**	.22	.39	**.56**
Environmental Identity (EID)	3.47	0.71	1064	**.72***	*.93*	**.78**	**.68**	.19	**.57**	**.61**
Connectedness to Nature Scale (CNS)	3.85	0.58	1121	**.60***	**.67***	*.80*	**.66**	.10	**.62**	.48
Inclusion of Nature in Self (INS)	4.45	1.25	1182	**.56***	**.60***	**.54***	*.84*	.10	.31	.44
Implicit Associations w/ Nature (IAN)	0.49	0.41	734	.17*	.15*	.07	.08	*.67*	.13	.21
New Ecological Paradigm (NEP)	4.00	1.00	1128	.34*	**.51***	**.51***	.26*	.10	*.84*	.49
General Ecological Behavior (GEB)	0.25	0.98	1186	.49*	**.54***	.40*	.37*	.16*	.42*	*.85*

Note. To the right of the vertical line, the *figures in the diagonal cells* either indicate Rasch-model-based reliability-estimates or internal consistency reliabilities. Inclusion of Nature in Self is a single-item measure. Thus, estimating the reliability was not possible with our data. The reported value is a 4-week test-retest reliability from Schultz et al. (2004). Off-diagonal figures represent Pearson correlations: uncorrected (below the diagonal) and corrected for measurement error attenuation (above the diagonal). A generic correction adjusts correlations for the unreliabilities of the two measures involved. The standard procedure entails taking the ratio between an observed correlation and the square root of the product of the two reliabilities (see Charles, 2005). **Bold coefficients** represent large effect sizes (i.e., $r > .50$). * stands for $p < .001$; widely accepted significance tests are only available for uncorrected correlation coefficients

Convergent and discriminant validity. The pattern of correlations between various connection-with-nature measures provides information about convergent validity. In line with our hypothesis, the correlations of these connection-with-nature instruments revealed that four of the five measures substantially shared information with each other. This was indicated by consistently large effect sizes ($.65 < r_{corr} < .79$; see Table

2). By contrast, correlations with implicit association with nature were small (.10 < r_{corr} < .22).

The correlations between the five connection-with-nature measures and environmental concern provide information about the discriminant validity. These effects were moderate at most for attitude toward nature, inclusion of nature in self, and implicit association with nature (.13 < r_{corr} < .39; see Table 2). However, environmental identity and the Connectedness to Nature Scale largely overlapped (r_{corr} = .57 and r_{corr} = .62, respectively) with environmental concern.

The exploratory factor analysis that was conducted to further explore convergent and discriminant validity, led to the following result: A two-factor model fit the data reasonably well (N = 983): $\chi^2(4) = 15.79$, $p = .003$, compared to a one-factor model, $\chi^2(9) = 115.50$, $p < .001$: $\Delta\chi^2(5) = 99.71$, $p < .001$. Overall, 69.20% of the common variance of the six instruments was determined by two factors (see Table 3).

All communalities exceeded .40, except for the one for implicit association with nature (see Table 3). As can be seen in Table 3, and as theoretically anticipated, all connection-with-nature measures, except for the implicit-association-with-nature instrument, had non-trivial loadings of a > .60 on the same factor.

Table 3. *Factor loadings and communalities (h^2) of the five connection-with-nature measures and an environmental concern scale*

	Factors		
	1	2	h^2
Attitude toward Nature	**.85**	-.08	.66
Environmental Identity	**.84**	.09	.79
Connectedness to Nature Scale	**.67**	.17	.59
Inclusion of Nature in Self	**.74**	-.11	.48
Implicit Association w/ Nature	.11	.02	.02
New Ecological Paradigm	.04	**.98**	.99
Eigenvalues	3.16	0.99	
Proportion of explained variance	52.72%	16.48%	
Factor correlation		.46	

Note. **Bold** figures indicate factor loadings greater than .60

All measures of people's connection with nature (Attitude toward Nature, Environmental Identity, Connectedness to Nature Scale, Inclusion of Nature in Self,

and Implicit Association with Nature) loaded on the first factor which had an Eigenvalue of 3.16. Note that implicit association with nature loaded on this anticipated factor (a = .11), too, although not as clearly as the other connection-with-nature measures. The New Ecological Paradigm loaded on the second factor which had an Eigenvalue of 0.99. The factors were correlated with each other (r = .46).[4]

Even beyond the already acknowledged conceptual overlap of a connection with nature and environmental concern, recognizable in the correlation of the two factors, the Connectedness to Nature Scale and environmental identity still revealed some substantial cross-loadings on the second factor, i.e., the concern factor (a = .17 and a = .09, respectively). Such an accentuated conceptual overlap, by contrast, did not appear with inclusion of nature in self and with attitude toward nature. Their cross-loadings happened to be negative (a = -.11 and a = -.08, respectively), which, in combination with the positive correlation of the two factors, numerically reduces the extent of the relationship with the second factor. No substantial cross-loadings were found with implicit association with nature. These results speak of the fact that the Connectedness to Nature Scale and the Environmental Identity measure also partly reflect people's environmental concern and not exclusively their connection with nature.

Predictive validity. When attitude toward nature was used as a single determinant in a regression analysis, it explained 23.79% of the variance of General Ecological Behavior: β = .49, $t(1134) = 18.82$, $p < .001$. In a four-step hierarchical regression analysis, we first controlled for age and gender. Both determinants were statistically significant (see Table 4). Combined, they explained 4.09% of the variance in ecological behavior. The New Ecological Paradigm, the environmental concern measure, accounted for an additional 15.87% of the variance in ecological behavior when entered in Step 2. Entering attitude toward nature in Step 3 increased the amount of explained variance by another 11.11%. Entering the remaining four connection-with-nature measures in Step 4 increased the explained variance by another 3.61%.

[4] Because of their substantial number, we replaced missing values with average person scores of implicit association with nature and of inclusion of nature in self. With these changes, the results of the factor analysis presented in Table 3 remained basically unaffected ($\Delta a < |.05|$), compared to an alternative analysis where missing values were retained (N = 639). In other words, missing values apparently did not distort the results of this analysis.

Table 4. *Hierarchical regression analysis predicting General Ecological Behavior*

	Step 1			**Step 2**			**Step 3**			**Step 4**		
	B	SE B	ß	B	SE B	ß	B	SE B	ß	B	SE B	ß
Age	0.01*	<0.01	0.15*	0.01*	<0.01	0.16*	<0.01	<0.01	0.01	<0.01	<0.l0	0.04
Gender	-.30*	0.06	-.15*	-.13	0.06	-.07	0.02	0.06	0.01	-.02	0.06	-.01
New Edological Paradigm				0.71*	0.05	0.41*	0.50*	0.05	0.29*	0.38*	0.06	0.22*
Attitude toward Nature							0.33*	0.03	0.39*	0.18*	0.04	0.21*
Environmental Identity										0.42*	0.06	0.30*
Connectedness to Nature Scale										-.11	0.07	-.07
Implicit Associations w/ Nature										0.10	0.09	0.03
Inclusion of Nature in Self										0.02	0.03	0.02
ΔR^2	.04			.16			.11			.04		
R^2	.04			.20			.31			.35		

Note. $N = 982$.

$^{*}p < .001$.

However, only one of the newly entered variables (i.e., environmental identity) had a statistically significant influence on ecological behavior (see Table 4)[5].

In another model, we inverted Steps 3 and 4 to test the uniqueness of the Attitude-towards-Nature effect on ecological behavior. We found that our newly developed measure (even when entered in Step 4) could uniquely and significantly contribute 1.7% to explain ecological behavior: $\beta = 0.21$, $t(963) = 5.02$, $p < .001$.

The results of the regression analyses concur with the findings of the factor analysis: Given that attitude toward nature, environmental identity, inclusion of nature in self, and the Connectedness to Nature Scale share a substantial amount of variance (see Table 3), which can be collapsed into one single factor (representing connection with nature), we cannot expect all four individual indicators of people's connection with nature to become significant in the prediction of a third variable. Necessarily, there is no variance left once the ecological-behavior variance is regressed on the common connection-with-nature factor (represented by the two most predictive of its indicators, attitude toward nature and environmental identity).

3.4 Discussion

With the study presented in this chapter, we aimed to develop a reliable and valid connection-with-nature measure that largely avoids self-reflection and therefore is also better suitable for the use in children and adolescents than the existing scales. The Rasch-model test revealed very reasonable scale qualities with respect to item fit statistics and reliability. But not only with regard to reliability, but also concerning convergent, discriminant, and predictive validity, the results speak for our newly developed attitude toward nature measure.

Our results could show, that most of the existing connection with nature instruments share the largest proportion of their variance, although they refer to supposedly different concepts such as connectedness to nature (Mayer & Frantz, 2004), environmental identity (Clayton, 2003), or inclusion of nature in one's self (Schultz, 2002a). The newly developed scale, although it assesses connection with nature

[5] Missing values were again replaced by average person scores of implicit association with nature and of inclusion of nature in self. The results of the multiple regression analyses presented in Table 4 were nearly identical ($\Delta\beta < |.04|$; $\Delta R^2 < |.01|$) to those of an alternative analysis where missing values were retained ($N = 668$). Again, missing values did not distort the results of this analysis.

indirectly, essentially measures what the other existing instruments are measuring, too. There is one exception: Implicit association with nature relates to a different content than the remaining instruments, which is also revealed in its relationship with ecological behavior.

The Attitude toward Nature Scale not only has a high convergent validity, but is also, in the sense of discriminant validity, better distinguishable from environmental concern than some of the already existing connection with nature measures. The high correlations between environmental identity and connectedness to nature with environmental concern suggest that those two measures are confounded with environmental concern when assessed with the New Ecological Paradigm (Dunlap et al., 2000). Moreover, the new Attitude toward Nature Scale proved to be, together with environmental identity, the best predictor for ecological behavior. It seems, thus, that both instruments cover that part of connection with nature's variance that is especially relevant for ecological behavior.

The newly developed scale turned out to be very precise. This advantage, however, comes at a price: with 40 items, the scale is rather long. For research purposes, in which the reliability of the person estimates is not the most important criterion, a more parsimonious instrument should be used. The Inclusion of Nature in Self measure (Schultz, 2002a) has a surprisingly high reliability for a single-item-measure.

Three shortcomings concerning the method of data collection might have affected the findings of this study. First, our data were collected through self-administrated questionnaires, thus, we were not able to control for the individual assessment conditions. Second, we expect that only those persons already interested in nature-related topics answered to our study. Consequently, our sample is a self-selected one. Third, as our participants were recruited via e-mail and the Internet, we reached only persons who use computers. So, by trend, this leads to a bias towards a comparatively young sample. Although these restrictions underscore that we do not have a random sample, it is necessary to stress that for the purpose of this study (i.e., scale development), it is sufficient that the participants reflect a wide range of diversity on the included variables.

In our study, we developed an attitude measure deriving people's connection with nature indirectly from behavior reports and simple evaluative statements. As such, we expect it to be better suited for research with children. Overall, our results speak of the quality of our newly developed, indirect attitude measure. It not only shares most of its variance with the other connection-with-nature measures, but only moderately

correlates with environmental concern. It also has more predictive power regarding ecological behavior.

CHAPTER 4

Development of connection with nature

4.1 Introduction

In this chapter, we want to shed light on the development of connection with nature by exploring the role of conditioning processes in that development. With two studies, we want to approximate that issue. In the first study, we compared how students with either a high or low level of connection with nature differ in terms of gratifying experiences in nature. For this, we employed interviews with a small sample of students. Specifically, we explored experiences that could work as reinforcement such as enjoyment and stress reduction. In the second study, we aimed at confirming the results of the interview study with a large-scale survey. The studies provided us with suggestions regarding the way in which these gratifying experiences play a role in the development of connection with nature.

4.2 Study 1

In this first study, we conducted interviews to explore how different experiences in nature[6] that are perceived as gratifying are associated with high and low levels of connection with nature. By means of interviews with students high and low in their level of connection with nature, we aimed to gather information on possible conditioning processes that could explain the well-suspected relationship between

[6] Both in this study and in Study 2, we define "nature" rather broadly: Experiences in nature can, thus, include spending time in one's own garden or even taking care of indoor plants. Based on empirical evidence confirming that these nature experiences in a broader sense already do have an impact, for example on stress reduction (e.g., Dijkstra, Pieterse, & Pruyn, 2008), we expect these experiences to also have the potential to promote a person's connection with nature.

experiences in nature and connection with nature. For that purpose, for a broad range of activities and experiences in nature, we recorded whether the students enjoyed them and whether they perceived them as restorative.

If joyful activities in nature lead to a higher connection with nature through processes of classical conditioning, highly connected students should report enjoyment of activities in nature more often than low connected students. Similarly, if connecting with nature is reinforced by positive effects such as stress reduction after spending time in nature, students high in their connection with nature should report experiencing positive effects of nature more often than students with a low level of connection with nature.

4.2.1 Methods

In the following section, we first describe the participants of our interview study, then outline the interview guidelines and the procedure. Finally, we present statistical analyses of the frequencies of answers.

Participants. For the interviews, we chose four students from a grammar school in Bayreuth (100,000 inhabitants), Southern Germany, in which all students of the 6th, 7th, and 8th grade had been scanned with the Attitude toward Nature Scale (see Chapter 6). We chose four students aged from 11 to 14, two (one male and one female) with a relatively high level of connection and two (again one male and one female) with a relatively low level of connection with nature.

Table 5. *Endorsement probabilities for statements and behaviors expressing connection with nature*

	Probabilities of endorsement for students high in their connection with nature		**Probabilities of endorsement for students low in their connection with nature**	
	$p_{(A)}$	$p_{(B)}$	$p_{(C)}$	$p_{(D)}$
Pets are part of the family	1.00	1.00	0.99	0.91
I mourn the loss of pets	1.00	1.00	0.98	0.90
I prefer outdoor to indoor sports	1.00	1.00	0.96	0.76
It makes me miserable to see a hedgehog that was hit by a car	1.00	1.00	0.95	0.73
I personally take care of plants	1.00	0.99	0.90	0.58
I prefer living in a city	1.00	0.99	0.89	0.55
The noise of crickets gets on my nerves	1.00	0.99	0.88	0.53

continued

Watching animals is exciting	1.00	0.99	0.88	0.52
Listening to the sounds of nature makes me relax	1.00	0.99	0.88	0.52
I prefer forest hikes to city strolls	1.00	0.99	0.86	0.48
A cleared forest makes me miserable	1.00	0.99	0.86	0.48
Walking through a forest makes me forget about my daily worries	1.00	0.98	0.83	0.43
My favorite place is in nature	1.00	0.98	0.79	0.36
If there is an insect, such as a fly, in my home, I try to catch and release it rather than kill it	0.99	0.97	0.72	0.28
I enjoy gardening	0.99	0.97	0.72	0.28
Indoor plants are part of the family	0.99	0.96	0.69	0.25
I talk to animals	0.99	0.96	0.67	0.24
If one of my plants dies, I reproach myself	0.99	0.96	0.67	0.23
I feel the need to be out in nature	0.99	0.96	0.66	0.23
Carving a tree feels like cutting myself	0.99	0.95	0.63	0.20
The croaking of frogs is comforting	0.99	0.94	0.60	0.18
I spent time in the woods	0.99	0.93	0.55	0.16
I collect objects from nature such as stones, butterflies, or insects	0.98	0.91	0.48	0.12
I hike or run in nearby nature reserves or forests	0.98	0.89	0.41	0.10
Even when it is very cold or rainy I go out for a walk	0.98	0.88	0.39	0.09
I help snails or worms cross the street	0.98	0.88	0.39	0.09
I cross meadows barefoot	0.97	0.84	0.33	0.07
I collect mushrooms or berries	0.96	0.79	0.25	0.05
I would always prefer spending time with my friends to spending time alone in nature	0.95	0.77	0.24	0.04
I mimic animal behavior: for example, the way a vulture walks	0.95	0.76	0.23	0.04
I take time to watch the clouds pass by	0.95	0.76	0.22	0.04
I spend time in a park	0.95	0.75	0.22	0.04
I deliberately take time to watch stars at night	0.95	0.74	0.21	0.04
I mimic the sounds of animals	0.94	0.72	0.19	0.03
I have a CD or tape with recorded sounds of nature	0.93	0.70	0.18	0.03
I watch TV shows that have animals as the main characters	0.92	0.64	0.14	0.02
I take time to consciously smell flowers	0.91	0.63	0.13	0.02
I consciously watch or listen to birds	0.91	0.62	0.13	0.02
I talk to plants	0.91	0.62	0.13	0.02
I get up early to watch the sunrise	0.78	0.37	0.05	0.01

Note. Shaded items represent a deficient connection with nature. Here, the numbers indicate the probability of *not* endorsing the particular item.

Table 5 lists the probabilities of engagement in different activities and of endorsement of different statements indicating connection with nature (i.e., the items of the Attitude toward Nature Scale; Brügger et al., 2011) for the four interviewees. For example, for the two students with high levels of connection with nature (i.e., A and B, see Table 5), the probability of spending time in the woods is 0.99 and 0.93, respectively. The two students with relatively low levels of connection with nature (i.e., C and D), in contrast, endorse that item only with probabilities of 0.55 and 0.16.

Materials and procedure. A semi-structured interview was chosen, with in total 45 open-ended questions. In each of the four interviews, 28 questions were asked in a pre-

established order. The interviewers had 17 additional questions available at their discretion to probe a subject in more detail when necessary. Questions concerned the following domains: Home environment (e.g., “Do you enjoy gardening?”), leisure activities (e.g., “What are your hobbies?”), excursions (e.g., “What were the last destinations of your weekend trips?”), holidays (e.g., “Where did you spend your last vacation?”) and experiences of nature phenomena (e.g., “Do you like watching sunrises?”). Answers to each question were coded in a response form, for which either a positive, a negative, or no answer was registered by both interviewers independently. Codes could fall in one of four categories: (1) The possibility of engagement in the activity, (2) the realization of the activity, (3) enjoyment of the activity and (4) the restorative value of the activity. Except for the last domain (experience of nature phenomena), questions were not directed towards nature, in order not to bias the interviewees. If a statement concerned an activity in nature, the interviewer carefully prompted whether this activity is actively carried out, whether the interviewee enjoys that activity and whether it is perceived as restorative. As an example, one interviewee stated that his family lives in a house with a garden - this would fulfill the condition of being able to spend time in the garden. The interviewer then asked whether he/she makes use of the garden - this would indicate whether gardening activities are realized - then asked whether these activities are enjoyable and whether he/she thinks gardening gives him/her the chance to restore. Interrater reliability for the categorization of the interview data was calculated using Cohen’s Kappa (1960), and, with a value of k=0.99, it showed to be very high. There were only two cases where the two raters disagreed in the categorization scheme, out of 216 possible cases. These two statements were not included in the analyses.

The interviews took place in the school building of the students, and lasted between 20 and 30 minutes. Two interviewers were present, one asking the questions and simultaneously filling in a response form, the second interviewer observing and independently filling in the response form without actively participating in the data collection.

Statistical analyses. To analyze the answers of the students in the interviews, we summed up the total score of affirmative responses to each of the categories for the two interviewees with a relatively high level of connection with nature and for the two students with a relatively low level. Using a Chi-Square test, we investigated whether the interviewees with higher levels of connection with nature have significantly more possibilities to access nature, whether they are using these opportunities more often,

and whether they are experiencing significantly more enjoyment and restoration in activities in nature than those with low levels of connection with nature.

4.2.2 Results

As regards the possibility of carrying out different activities in nature, the interviewees with high levels of connection with nature did not report significantly more possibilities to engage in activities in nature than those with low levels [χ^2 (1, N = 124) = 1.36, $p > 0.05$, n.s.; see Table 6]. The Chi-Square test for the realization of activities in nature was statistically significant, [χ^2 (1, N = 118) = 4.88, $p < 0.05$], showing that students high in their level of connection with nature realized a greater amount of activities in nature than students with low levels. There was a statistically significant difference between the amount of situations in which enjoyment was experienced, [χ^2 (1, N = 112) = 9.58, $p < 0.01$], students with high levels of connection with nature experienced enjoyment in more than twice as many situations than did students with low levels (30 vs. 14).

Table 6. *Number of responses addressing possible, realized, enjoyed and relaxing activities in nature*

	Possibility	**Realization**	**Enjoyment**	**Restoration**
high level of connection with nature	60 (48.39%)	36 (30.51%)	30 (26.79%)	29 (25.89%)
low level of connection with nature	57 (45.97%)	24 (20.34%)	14 (12.50%)	13 (11.61%)
total number of responses	124	118	112	112
χ^2	1.36	4.88	9.58	9.76
p-value	>.05	<.05	<.01	<.01

The fourth Chi-Square test, which concerned the number of situations in which restoration was experienced was again statistically significant, χ^2 (1, N = 112) = 9.76, $p < 0.01$, showing that students with high levels of connection with nature indicated they could also relax in nature in significantly more situations than did students with low levels. As with enjoyment, the students high in their connection with nature could relax in more than twice as many situations than the students low in their connection with nature (i.e., 29 vs. 13).

4.2.3 Discussion

In Study 1, we conducted interviews with students high and low in their connection with nature. In line with our expectations, we found that students with high levels of connection with nature realized possibilities to spend time in nature significantly more often than students with low levels in connection with nature. The students high in their level of connection with nature also stated for about twice as many situations involving nature that they were enjoying themselves and that the particular situations helped them to relax than did students low in their levels of connection.

In our interviews, we did not find significant differences between the students with high and with low levels of connection with nature in the frequency of possibilities to access nature. This result is not surprising, as we were interviewing students from the same, rather small town (Bayreuth) in which the possibilities to access nature, expectedly, do not differ much between the students. The results concerning the use of the possibilities to access nature show that students with a high level of connection with nature make more use of the same possibilities than the students with low levels.

The most noteworthy limitation of our study concerns the sample size. A total of four participants is clearly too small a sample to generalize to the whole population. Although we collected a large sample of situations with which we conducted the statistical analyses, only careful conclusions can be drawn. For further research, it would be especially interesting to conduct interviews on a larger scale, also encompassing other variables such as place of living, which was kept constant for our four interviewees.

4.3 Study 2

With this second study, we want to add further support to the findings of the interview study. Additionally to replicating our results from the interviews with a large sample, we aim at confirming the role of gratifying experiences as crucial psychological mediator that renders contact to nature into a stronger connection with nature.

In a sample of $N = 496$ students in Southern Germany, we measured connection with nature as well as several indicators for living environment, contact with nature and enjoyment of outdoor activities. In chapter 2, we argued that enjoyable and other gratifying experiences could play an important role in the development of connection with nature. Two different ways are conceivable. First, as most activities in nature,

such as playing outdoor games, hiking or camping, are associated with enjoyment, through processes of classical conditioning, eventually nature itself would elicit positive emotions. Second, the numerous positive effects of nature, for example, as regards stress reduction or mood enhancement, are anticipated to work as reinforcements of connection with nature and of spending time in nature in the framework of operant conditioning. If these mechanisms or at least one of them actually take place, enjoyment should mediate the relationship between experiences in and connection with nature. Specifically, we compare two mediation processes by which the particular living circumstances (i.e., the ease of access of nature) and contact with nature are thought to translate into a stronger connection with nature.

4.3.1 Methods

In the following, we describe the participants, the procedure of the data collection, the scales and the additional questions we were employing. Finally, we present the statistical analyses that were conducted to test our predictions.

Participants and procedure. Two grammar schools ("Gymnasium") in Southern Germany were contacted and asked to participate in our study. One of the schools is located in the city of Nürnberg (500,000 inhabitants). The other school is located in Lauf, a smaller town with 25,000 inhabitants, with many students living in surrounding villages. In each school, teachers of the 6th, 7th, and the 8th grade were instructed to have their students fill out the questionnaires during lessons. In total, 580 questionnaires were given to 21 classes, N = 496 students completed them (response rate = 85.5%). Participants' median age was 12 (M = 11.79, SD = 0.95). The percentage of females was 48%.

Measures. The questionnaire consisted of (a) a set of connection with nature items, and (b) six sets of items measuring enjoyment of activities in nature, ease of access of nature and actual activities carried out in nature. For all items, "not applicable" was a response option when an answer was for whatever reason not possible. These answers were handled as missing values.

A person's *connection with nature* was assessed with the Attitude toward Nature Scale. As in the original study (see Chapter 3; Brügger et al., 2011), items were presented with two different response formats. While with 23 behaviors and evaluative statements a dichotomous yes/no-format was used, with 17 other statements a five-

point frequency scale from 1 (never) to 5 (very often) was employed. We also recoded the responses from a five-point to a three-point format by collapsing "seldom" and "occasionally", as well as "often" and "very often". "Never" was retained as "never". Of all responses, 7,28% were missing. The reliability of the scale was *rel* = .90 and the scale mean was *M* = 0.12 (*SD* = 1.13). As regards the item fit, the MNSQ values were one or very close to the ideal value one [*M (MNSQ)* =1.00, *SD (MNSQ)* = 0.11]. On the level of single items, with a maximum of 1.27 and a minimum of 0.81, none of the item MNSQ values left the range for acceptable fit (0.75 < *MNSQ* < 1.30; see Bond & Fox, 2007). The average of the person MNSQ values was *M (MNSQ)* =1.00 with a standard deviation of *SD (MNSQ)* = 0.28. The percentage of persons with a poor fit (*t* > 1.96) remained with 5.65% in an acceptable range.

We furthermore employed four dichotomous items (“agree”/”disagree”) that contained *information about whether the participant was enjoying himself/herself in nature* (e.g., “Doing sports in nature is fun”). To investigate whether the four items measure a one-dimensional construct, we conducted an exploratory factor analysis (principle factor analysis, PFA)[7] on the four enjoyment-in-nature items. One factor with an Eigenvalue greater than one (1.97) resulted. All of the four items loaded higher than .50 (see Table 7).

Table 7. *Principal factor analysis with enjoyment items*

	Factor Enjoyment in nature	h^2
1. I enjoy caring for my pet.	**0.50**	0.25
2. Doing sports in nature is fun.	**0.51**	0.26
3. I enjoy having a picnic outside.	**0.85**	0.72
4. The smell of a flowering meadow is pure pleasure.	**0.86**	0.74
Eigenvalue	1.97	
Proportion of explained variance	49,25%	

Note. **Bold** figures indicate factor loadings greater that .50.

Additionally, we used dichotomous items (“true”/”false”) describing the living environment (4 items for urban living environment, e.g., “My home is predominantly

[7] As the four items were dichotomous, we performed a special factor analysis suitable for categorical data using the software program Mplus (Version 5.21; Muthén & Muthén, 2009; Bartholomew, 1980).

surrounded by asphalt and other houses"; 6 items for rural living environment "From my home, I can reach a lake or a river on foot"). Further items included leisure activities such as excursions (8 items, e.g., "I go hiking"), everyday contact with nature, (5 items, e.g., "I have my own pet") using a 5-level response format from "less than once a year" to "daily". Finally, with 6 items using a 5-level response format from "never" to "more than five times" the participants were asked about their vacations in nature (e.g., "I have been to the mountains for vacation").

To check whether these items can actually be interpreted as indicators of the two aspects *ease of access of nature* (i.e., the living environment) and actual *contact with nature*, we calculated indices (arithmetic means) for each group of items (i.e., urban living environment, rural living environment, excursions in nature, everyday contact with nature and vacations in nature). Subsequently, a principal component analysis was carried out on these 5 indices. The Varimax-rotated solution gave two factors with an Eigenvalue greater than one. As expected, according to the factor loadings higher than .50, the two factors can be interpreted as "(rural) living environment" and as "contact with nature" (see Table 8).

Table 8. *Principal components analysis with items describing the living environment as well as activities carried out in nature*

	Factor		
	1 (rural) living environment	**2** contact with nature	**h2**
1. Urban living environment	**-.87**	.00	.76
2. Rural living environment	**.82**	.28	.75
3. Everyday contact with nature	-.15	**.81**	.67
4. Activities in nature	.35	**.67**	.58
5. Vacation in nature	.29	**.66**	.52
Eigenvalue	1.66	1.61	
Proportion of explained variance	33.14%	32.13%	

Note. **Bold** figures indicate factor loadings greater that .50.

Statistical analyses. The Attitude toward Nature Scale was calibrated with the partial-credit Rasch model (for model details see Bond & Fox, 2007) using the software program ConQuest (Wu et al., 1998). To test our assumptions concerning the mediating role of enjoyable experiences in the relationship between contact with

nature and living environment on the one hand and connection with nature on the other hand, structural equation modeling analyses (Mplus version 5.21; Muthén & Muthén, 2009) were performed. For each of the variables two indicators were calculated (four for connection with nature) as mean values of the corresponding items. For the actual model tests, we will report the following fit indices[8]: The Nonnormed Fit Index (NNFI), the Comparative Fit Index (CFI), the Root Mean Square Error of Approximation (RMSEA), and the Standardized Root Mean Square Residual (SRMR). As we were using nested data, that is, the participating students were clustered in classes and schools, standard statistical regression procedures would lead to an underestimation of standard errors. Therefore, we were using a procedure that adjusts the standard error for clustering in consideration of the intraclass correlations[9] (Mplus version 5.21; Muthén & Muthén, 2009).

4.3.2 Results

We tested two different models to investigate the role that enjoyable/gratifying experiences play in the relationship between experiences in and connection with nature. In the first model, contact with nature as well as living environment were indirectly influencing connection with nature, mediated by enjoyment (see Figure 1).

[8] As our study is based on a rather large sample, the χ^2-index is no appropriate indicator of the model fit as it is sensitive to sample size . Alternatively, we report the following indices which are less affected by sample size (Hu & Bentler, 1998): NNFI, CFI, RMSEA, SRMR. The NNFI and the CFI index are generally ranging from zero to one with higher values indicating better fit. Following traditional recommendations (Bentler & Bonett, 1980; Browne & Cudeck, 1993), a value higher than .97 is indicative of a good model fit, whereas values higher than .90 may be interpreted as an adequate fit. For the RMSEA and the SRMR index, the value of zero indicates perfect fit, values smaller than .05 can be considered as a good fit and values between .05 and .10 (.08 for RMSEA) as an acceptable fit.

[9] The intraclass correlations are expressing the proportion of the variance that is due to the class membership. As a rule of thumb, if intraclass-correlations are higher than 0.05, it is recommended to use multilevel-analyses or to adjust standard errors correspondingly (Muthen & Satorra, 1995). In this sample, the intraclass correlations ranged from 0.01 for “contact with nature” (second indicator) to 0.29 for “living environment” (first indicator), and thereby, made the adjustments of standard errors necessary.

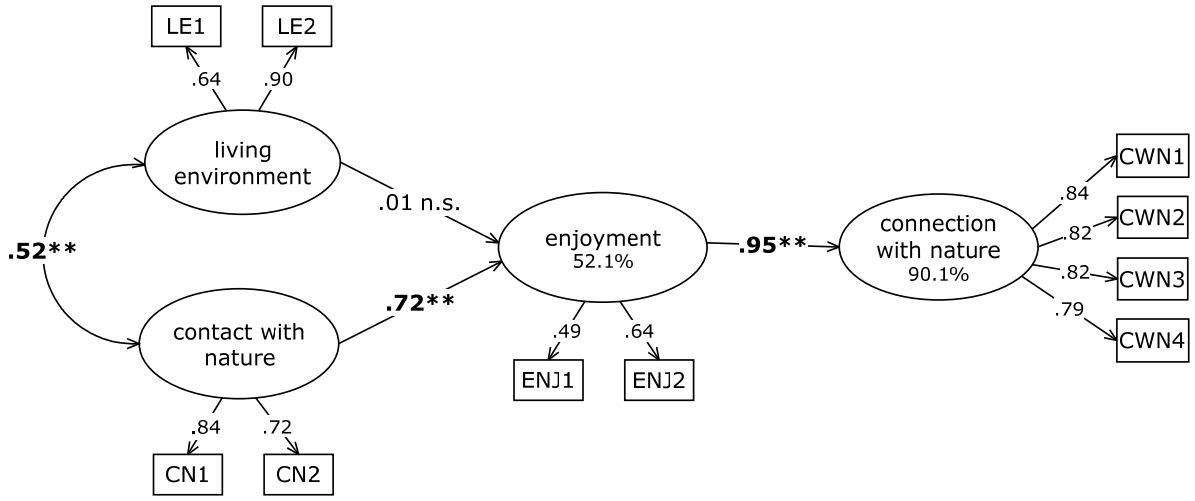

Figure 1. *Full mediation model*

The model fitted the data well, as all of the four fit indices show (i.e., CFI = .98; NNFI = .96; RMSEA = .06; SRMR = .03). Interestingly, living environment did not have an effect on enjoyment, unlike contact with nature which was a strong predictor for enjoyment (β = .72). 51.1% of enjoyment's variance was explained virtually by contact with nature alone. However, the correlation between living environment and contact with nature (r = .52) showed that living environment alone would be able to explain a part of the variance of enjoyment that contact with nature was explaining. Enjoyment in nature, in turn, was a very strong predictor for connection with nature (β = .95) and explained 90.1% of its variance.

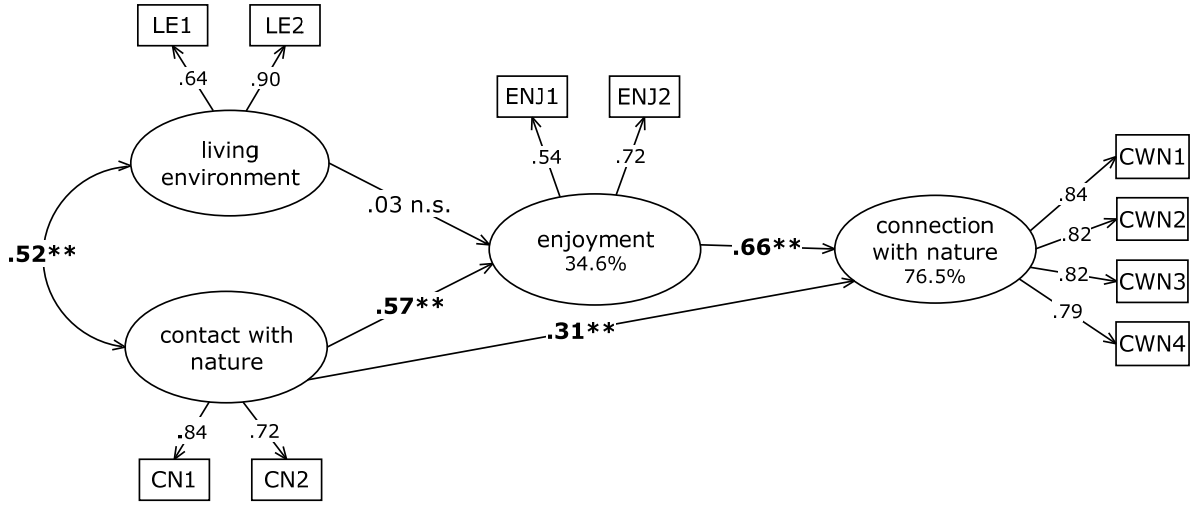

Figure 2. *Partial mediation model*

In a second model (see Figure 2), we added an additional, direct path from contact with nature to connection with nature. The NNFI index was with .97 slightly higher than in the first model, while the values for the other three indices remained unchanged (i.e., CFI = .98; RMSEA = .06; SRMR = .03). A Chi-Square difference test revealed that the second model [$\chi 2$ (30) = 85.36, $p < 0.01$] fitted the data significantly better than the first model [χ^2 (31) = 91.42, $p < 0.01$]: $\Delta\chi^2$ (1) = 6.06, $p < 0.05$.

4.3.3 Discussion

In Study 2, we further analyzed the role enjoyable experiences play in the development of a person's connection with nature. Specifically, we aimed at examining different mediation processes by which the ease of access and actual contact with nature possibly translate into attitude toward nature.

We first tested a model in which contact with nature and living environment were not exerting a direct influence on connection with nature, but only indirectly influencing the latter, mediated by enjoyment. In the second model, enjoyment only partially mediated contact-with-nature's and living-environment's influence on connection with nature, while there was also a direct effect from contact with nature on connection with nature. The results were in line with our predictions: Both models yielded good fit statistics. The second model fitted the data slightly better than the first one. However, the first model is more parsimonious, and a slightly worse fit must therefore be anticipated. Based on the fit, we thus cannot clearly choose one of the two models. We can only conclude that at least a part of the relationship between contact with nature and connection with nature is mediated by enjoyment of experiences in nature.

Another interesting result, which becomes evident in both of the models, concerns contact-with-nature's and living-environment's common influence on connection with nature. In our study, a person's contact with nature, like playing outside or hiking, turned out to be a strong predictor for his or her connection with nature, whereas living environment, for example the closeness to a forest or a lake, did not have an effect. However, both predictors were closely related to each other. These results can be interpreted as the following: The possibilities that a person's living environment provides have to be realized. Thus, closeness to nature needs to directly translate into engagement, otherwise it will not affect a person's connection with nature. The high correlation between the two variables, closeness to nature and contact with nature,

however, speaks of the fact that with ease of access of nature, contact with nature usually increases as well.

A few shortcomings of our second study are worth mentioning: (1) In the first model, enjoyment explained nearly the entire variance of connection with nature. This result points to a difficulty concerning the concepts included in our study: connection with nature's *precedents* in our model are simultaneously *constituents* of connection with nature. This is clearly reflected in the item contents of the Attitude toward Nature Scale. The scale also contains items that explicitly imply enjoyment of activities in nature, such as, e.g., "Watching animals is exciting" or "I enjoy gardening". Similarly, contact with nature is also an important expression of connection with nature, for example spending time in a park or going out for a walk even when it is very cold or rainy. The concepts in our model are, thus, not clearly separable from each other which limits the strength of the evidence. However, the fact that experiences in nature and enjoying them might be a central part of connection with nature does not contradict the assumption that they also play a key role in its acquisition process. (2) We analyzed structural equation models to test our predictions, and although SEM is also referred to as "causal modeling", it does not give information about whether a theoretically anticipated causal model is "true", but rather whether the postulated structure could be possible, given the empirical data. In other words, our results cannot rule out the possibility that the direction of causality is the other way around. For example, a high level of connection with nature could also be the reason why people enjoy experiences in nature and why they spend time in nature. The fit indices would indeed remain the same if the arrows in our two models were turned to the opposite direction. However, the differences of average connection levels between students from cities and those who live in rural places (Müller et al., 2009) and the correlation between indicators for living environment and connection with nature found in this study, respectively, let the presumed direction of influence seem more plausible, as in most of the cases children cannot deliberately choose their environment.

4.4 General discussion

With the two studies presented in Chapter 4, we aimed to shed light on the processes of acquisition and development of connection with nature. Previous attempts to address its development only focused on boundary conditions rather than on the process itself.

In our interview study, we could show that students high in their level of connection with nature more often experience enjoyment and restoration in nature than students low in their level of connection. However, we did not only confirm that gratifying experiences in nature are related with a person's individual level of connection with nature, and therefore might play an important role in its development. With our survey study, we also further investigated *how* that role of gratifying experiences could look like. We showed that the relationship between nature experiences and connection with nature is mediated (at least partially) by enjoyable sensations. In other words, a child will develop a stronger bond with nature if he or she enjoys himself/herself while hiking.

With these findings, we provide explanations for assumptions concerning the development of connection with nature expressed by other researchers. For example, Clayton (2003) suspects nature's many positive effects on humans to be a crucial aspect in the development of "environmental identity". We propose that those positive effects (which we could confirm to be experienced more often by people with high levels of connection) work as reinforcements and thereby lead to a closer connection with nature. The often referred to relationship between experiences in and connection with nature can be explained with help of enjoyable sensations as an – at least partially – intermediate link.

It is important to mention that our results concerning the relationship between enjoyable experiences in and connection with nature on the one hand and between positive effects of nature and connection with nature on the other hand, offer no empirical evidence for the conditional processes presumed. However, they confirm the preconditions that have to be given, if these conditioning processes do play a role. Our data provide, thus, a basis for further investigations of the processes involved in the acquisition of connection with nature. As next step, longitudinal studies that monitor the development of connection with nature over a longer period of time, are needed. In our view, intervention studies that use enjoyable experiences *in* and effects *of* nature, would be particularly suitable for that purpose.

Moreover, the two studies' results show how the ease of access of nature and contact with nature are interrelated and how they are conjointly influencing connection with nature. In former studies, only one of these two variables at a time had been analyzed in their influence on connection with nature (Hinds & Sparks, 2008; Müller et al., 2009). If two persons from the same living environment with high and low levels of connection with nature are compared with each other (see Study 1), we see that those persons differ with respect to the use of the same opportunities. In a

simultaneous study of the ease of contact's and actual contact's influence on connection with nature (see Study 2), it becomes obvious that both variables are correlated, but that only contact with nature has a direct effect on connection. In other words, a person who has more possibilities of spending time in nature generally carries out more activities in nature as well. However, the environmental conditions, such as living close to a forest, only translate into a stronger bond with nature if the person concerned actually takes advantage of it by, for example, taking regular walks. If we, thus, know about the outdoor activities of a person, information about his or her living environment does not provide any further information about that person's strength of connection with nature.

To conclude, with the two studies presented in this chapter, we contribute to a better understanding of the acquisition and development of connection with nature. Even though our studies could not, due to the cross-sectional design, actually confirm or disprove the involvement of conditioning processes, a start towards analyzing the mechanisms of the development has been made. We could corroborate that positive effects of nature on humans are closely related to connection with nature, which is directly applicable to interventions. We believe that it is also relatively unproblematic to employ those insights into existing behavior change approaches.

PART II

ENVIRONMENTAL COMPETENCE

CHAPTER 5

Environmental competences

French language teaching aims at leading an individual to get along in French speaking countries and to successfully communicate there in different fields of daily life. If, however, the students of French know grammatical rules in detail and have a broad vocabulary, but hardly speak and write French, the language teaching will not be regarded successful. Likewise, environmental education's aspiration is to ensure that people, for example, recycle waste, buy regional food, or commute to work by bike or public transportation, in other words, to advance people's ecological behavior. It is obviously not sufficient if people know about the processes that lead to global warming and if they theoretically know about efficient ways to save energy, but do not change their behavior. In these two examples, the ultimate goal of education becomes obvious: To advance functional abilities or *competences*.

In educational psychology, competences are defined as abilities and dispositions that lead to successful behavior in a certain field. Accordingly, in the field of environmental education, competences are those abilities and dispositions that are prerequisites for ecological behavior. Environmental competence models describe the structure between these prerequisites and ecological behavior. There are two environmental competence models we know of. Although both are elaborate models that implement important aspects of competence, they also have significant shortcomings as regards the choice of prerequisites for ecological behavior, the conceptualization of the target criterion as well as the differentiation of competences from other constructs. With the competence model we will present in this chapter, we avoid these shortcomings by conceptualizing environmental competence as interplay of environmental knowledge, connection with nature and ecological behavior.

5.1 What is a competence?

„Competence“ is a commonly used word in everyday language. Everybody has an idea what competence is, for example, “competent service personnel” or an “incompetent vendor” (see Hartig, 2006; Weinert, 2001), without being able to precisely define it or to distinguish it from other concepts such as „ability“, „capacity“, or „proficiency“.

In educational psychology, competences are defined as abilities and skills that allow people to cope effectively and successfully with real-life tasks and everyday challenges, in short, as prerequisites for successful action (Weinert, 2001). As regards competences, two issues are thus essential: On the one hand, there is a mundane, real-life attainment. On the other hand, there are one or more personal abilities or dispositions, which are thought to be necessary constituents for attaining the particular real-life goal. Accordingly, French competence consists of those abilities that let a person understand both written texts and spoken language, and be able to express herself/himself in French. In the field of environmental psychology, correspondingly, competence is formed by those abilities and propensities that result in an improved ecological behavior.

A stronger focus on competences in the field of educational psychology is the result of the criticism of conventional didactic approaches that focus on input, that is, on what contents students should be taught. Modern educational approaches explicitly focus on the outcome of teaching: What should students be able to do? What kind of problems should they be able to solve? Which tasks will they be required to handle? In other words, these approaches focus on competences (de Haan, 2006). A competence-orientation was first adapted by further education and vocational education, and later by school and university education as well.

Most competence modeling approaches are applied in the framework of large scale school achievement studies, such as, for example, PISA (Programme for International Student Assessment, OECD, 2009). These approaches commonly concentrate on merely cognitive prerequisites of successful actions, decisions or interpretation of results. However, even in areas in which cognitive achievement is of prime importance, motivational processes are recognized to additionally play a significant role. For scientific competences, for example, not only abilities such as drawing appropriate conclusions from data or evaluating claims made by others but also interest in science and appreciation of science’s contribution to society are considered important (OECD, 2006). In areas that are less aiming at cognitive competences, but that are rather addressing competences such as social, intercultural, or environmental

competence, a consideration of motivational aspects is even more important. Accordingly, such approaches explicitly include motivational dispositions, personal value orientations and attitudes, as well. (see e.g., the action competence approach, Weinert, 2001). For example, to successfully behave as a democratic citizen, in other words, to demonstrate civic competence, factual knowledge and political analyzing skills represent an important basis. However, the pursuit of justice, appreciation of cooperation and solidarity, as well as possessing the ability to empathize is also regarded as crucial (Himmelmann, 2005).

5.2 Conceptualizations of environmental competence and competence models

In the area of environmental education, there are several approaches that broach the issue of environmental competence. Some of these approaches deal with the conceptualization of environmental competence without being competence *models*. In other words, those approaches do not aim at describing the structure that is formed by different competence components. We will give a short overview over these approaches before we turn to the two existing competence models in more detail and relate them to our new environmental competence model.

One group of competence conceptualizations is less aiming at a precise description of environmental competence but rather reflect a general orientation in environmental education. In a countercurrent to behavior change approaches in environmental education, authors of these conceptualizations recommend focusing educational interventions on competences (Kyburz-Graber, Halder, Hügli, & Ritter, 2001) such as "action competence" (Jensen & Schnack, 2006) or "shaping competence" (de Haan, 2006) instead of changing certain single behaviors. The conceptualizations are characterized by a broad and ecology-unspecific focus. De Haan, for example, defines shaping competence as the "specific capacity [...] to modify and shape the future of society and to guide its social, economic, technological and ecological changes along the lines of sustainable development" (de Haan, 2006, p.22). Similarly, Jensen and Schnack (2006, p.472) conceptualize environmental action competence as the capacity to envision "...alternative ways of development and to be able to participate in acting according to these objectives". Kyburz-Graber's socio-ecological concept (Kyburz-Graber, 2004) addresses critical thinking and problem solving abilities.

Another group of environmental competence conceptualizations focuses on getting further insight into the different aspects of environmental competence and how these components can be described and measured. The concept "environmental literacy"[10] (e.g., Roth, 1992) distinguishes between six forms of environmental literacy: ecological knowledge, socio-political knowledge, knowledge of environmental issues, affect, cognitive skills as well as environmentally responsible behaviors. Eggert and Bögeholz's (2006) approach of decision making competence in contexts of sustainable development defines different competence components as well. The different components are 'knowledge about sustainable development', 'knowledge about values and norms', 'reflection of factual information' as well as 'evaluation, choice and reflection'. Here, for each competence part, different competence levels are described.

In the following, we will present two environmental competence models and, thereby two different conceptions how environmental competence should be operationalized. Both models entail important aspects that can also be recovered in our newly developed competence model. However, both models also exhibit insufficiencies, which we overcome with our newly developed environmental competence model.

Models of environmental competence – competence as a disposition or as a structure?
The two conceptualizations that we discuss in the following represent two different understandings of what a competence is: While the first one conceptualizes environmental competence as a higher order disposition, the second one does not define competence as a single construct but rather as a structure.

Corral-Verdugo's structural model of proenvironmental competency (2002, see Figure 3) defines competence as a latent construct which is influencing both skills (i.e., knowing how to carry out different ecological behaviors such as composting or reusing water) and conservation requirements (i.e., ecology-specific beliefs and motives). Proenvironmental competency is conceptualized as predictor of (a specific) ecological behavior (i.e., water consumption). The model also includes contextual factors (such as, e.g., water scarcity), which are anticipated to directly have an influence on proenvironmental competency.

[10] Although the authors do not use the term „competence", we included their concept, as „literacy" is commonly used as a synonym for competence – originally in the field of reading and writing (see e.g., OECD, 2009), but it has been extended to further areas such as, for example, political literacy (Cassel & Lo, 1997).

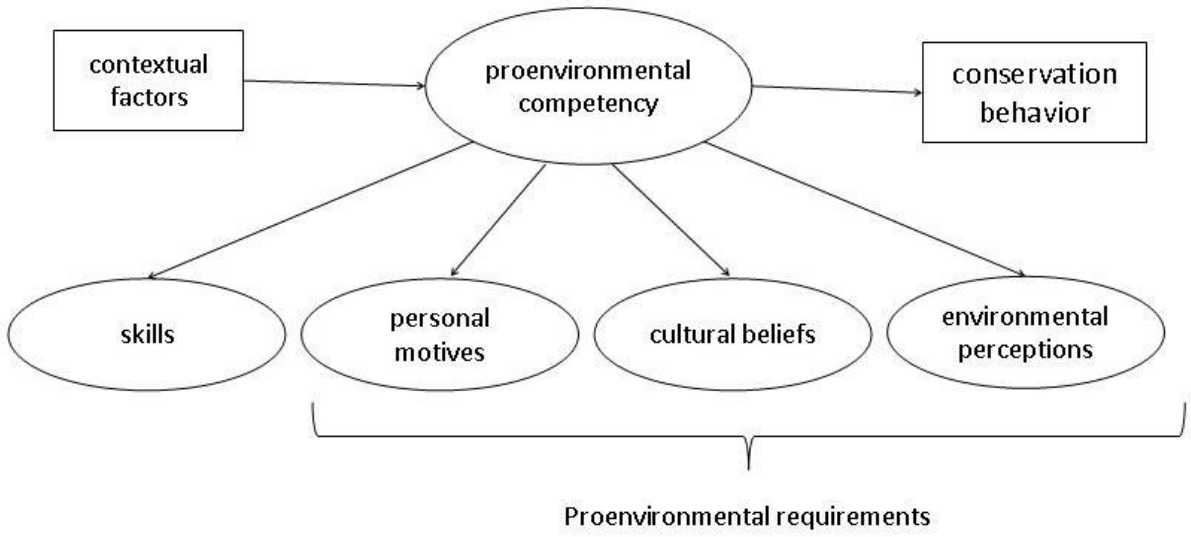

Figure 3. *Corral-Verdugo's model of proenvironmental competency*

Corral-Verdugo, thus, defines competency as a latent disposition which comprises different ecology-specific propensities and which is supposed to have an impact on behavior (which is, however, not a part of the competence definition). This model is a comprehensive conceptualization of environmental competence, as it includes ecology-specific cognitive as well as motivational abilities, and, at the same time, considers the target criterion ecological behavior (although it is not regarded as a part of the competence itself). Corral-Verdugo's model, however, also entails some downsides. First, proenvironmental competency is technically conceptualized as a second order factor and consequently, the first order factors, such as proenvironmental requirements and skills have to correlate with each other. Furthermore, the complexity of the model is limited as no interplay between the first order factors is possible. In addition, Corral-Verdugo's competence model does not conceptually differentiate competences from other constructs, such as 'ability', as the target criterion ecological behavior is not conceptualized as determinant of the competence.

In *Gräsel's model of ecological competence* (2001), in contrast, competence is not defined as one construct, but rather as a whole structure between different constructs (see Figure 4). The model includes those propensities which represent preconditions for ecological behavior, namely the application of knowledge, the evaluation of behavior alternatives in terms of their feasibility and their consequences, as well as self-reflection. As an indicator for ecological behavior, a person's overall energy balance is chosen. Therewith, Gräsel does not focus on behavior itself, but on the impact of that behavior. Gräsel argues that the reduction of a person's total energy

balance is superior to focusing on isolated behaviors as it leaves people the choice with which behaviors they make their energy use more sustainable.

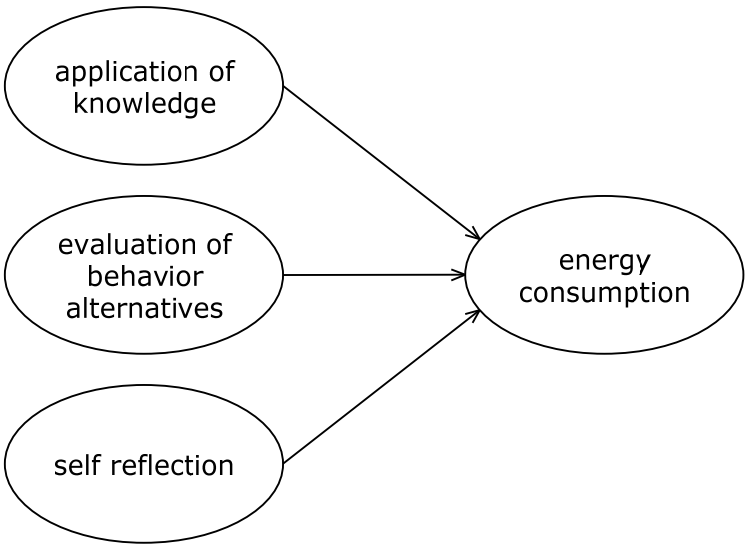

Figure 4. *Gräsel's model of ecological competence*

Although this is an elaborate and innovative competence model, there are two shortcomings. First, Gräsel's model only focuses on cognitive competence components and neglects motivational sources. However, research has shown that particularly those propensities, such as moral norms and values (Bamberg & Möser, 2007; Joireman et al., 1997) or connection with nature (Brügger et al., 2011; Clayton, 2003) are the most behavior effective. The second shortcoming refers to the target criterion. We agree with Gräsel that reducing people's harmful environmental impact should be, ultimately, the main goal of environmental education approaches (see also Gatersleben, Steg, & Vlek, 2002). However, applying this criterion leads to a severe problem. Psychological propensities' (such as e.g., moral norms or knowledge) influence on the environment, that is, the environmental impact, is mediated through behavior. Yet, with shared variances of 5% to 15%, the link between ecological behavior and its environmental impact is far from perfect (see Gatersleben et al., 2002; Tanner, Kaiser, & Kast, 2004). That is because the environmental impact of a behavior is often more strongly influenced by the technology involved and by the context than by psychological propensites (Midden, Kaiser, & McCalley, 2007; Scheuthle, Carabias-Hütter, & Kaiser, 2005). For example, in the winter time, it is the outside temperature that mainly dominates the heating energy consumption while individual differences in the propensity to conserve energy only have a marginal influence (Becker, Seligmann, Fazio, & Darley, 1981). As a result, when the mediator between

psychological factors and environmental consequences is disregarded, the actual significance of psychological propensities, and thereby of environmental education, is attenuated. In other words, if we do not wish to underestimate instruction and other means of educational formation, we should focus on behavior as the intermediary between the individual mind and the ecological footprint (Kaiser et al., 2008). In the following, we will see that there is a way to target behavior without loosing track of the environmental impact: A person's overall ecological behavior.

5.3 Environmental competence as interplay between abilities and behavior

The review over existing competence conceptualizations shows that there are already a few models that address important aspects of environmental competence. However, as we have seen, there are still some significant criticisms. In the following, we will outline how an ecology-specific competence model has to look like to overcome problems other conceptualizations are suffering from. At first, we will explain how the target dimension can be conceptualized without missing the important mediator behavior out and without loosing track of the environmental impact, either. Subsequently, we will address the cognitive and motivational preconditions of ecological behavior. Finally, we present our theoretically anticipated model which describes the interplay between these cognitive and motivational preconditions in promoting ecological behavior.

Ecological behavior. If we do not want to underestimate the influence of psychology, thus, we have to conceptualize a person’s conservation performance as behavior and not directly as the environmental impact of that person’s behavior. In environmental psychology, so far, ecological behavior has often been operationalized as specific behaviors, such as environmental activism, consumerism, or energy conservation (see Kaiser & Wilson, 2004). Gräsel (2001) rightly criticizes that a focus on single ecological behaviors neglects the fact that people can choose between various behaviors, that they can behave strategically to improve their environmental impact. Instead of commuting by bike, people may switch to a vegetarian diet or focus more on saving heating energy in order to do something for the environment (see Kaiser, 2004).

A way to address this fact is to aim at people’s overall ecological behavior rather than on specific behaviors. This overall consumption pattern of a person can be attained if ecological behavior is understood as the disposition or the motivation to act

ecologically (Kaiser, 2004; Kaiser, Oerke, & Bogner, 2007), that is, as the behavioral means by which an individual tries to achieve his or her personal conservation goal. In this way, thus, the extent of a person's disposition to act ecologically is considered, regardless of whether that person expresses his/her disposition by separating waste and using public transportation or rather by becoming a member of an environmental organization and by convincing others of an ecological lifestyle. Simultaneously, such a composite behavior measure has the advantage that once an augmentation in the disposition to act ecologically is achieved, it will automatically have an influence not only on one, but on numerous specific behaviors (Byrka, Kaiser, & Hübner, 2009).

Environmental knowledge. Environmental knowledge has never been seen as a strong force behind ecological behavior (Hines et al., 1986/87; Stern, 2000a). However, it is viewed by some researchers as a necessary precondition (Gardner & Stern, 2002; Schultz, 2002b) as it creates awareness and produces reasons for ecological behavior.

Research on environmental knowledge has, apart from its behavioral relevance, also explored the ways in which various forms of knowledge work together in promoting individual ecological behavior (Kaiser & Fuhrer, 2003). This research on the structure of environmental knowledge has shown that before people can act properly, they have to know why they should, and how they can do something for the environment; plus they need to know about the specific environmental consequences of a particular behavior (Frick et al., 2004). In other words, advancing ecological behavior through environmental knowledge requires disentangling three different forms of factual knowledge: "system knowledge", "action-related knowledge", and "effectiveness knowledge". System knowledge concerns the operating of ecosystems, the interaction of organisms, and the origins of environmental problems (e.g., Schahn & Holzer, 1990). Action-related knowledge, by contrast, involves the available behavioral options (e.g., Ernst, 1994). Effectiveness knowledge entails knowing about the specific environmental impact of different courses of action, for example in terms of energy savings or reduction of CO_2 emissions (Kaiser & Fuhrer, 2003).

Frick and colleagues (2004) predicted the ways the three forms of knowledge would work together before they affect people's ecological behavior. According to their model, system knowledge does not directly promote ecological behavior, but provides a reason for people to search for suitable actions (i.e., action-related knowledge) and for information on the environmental impact of these actions (i.e., effectiveness knowledge). Ideally, action-related knowledge provides a wide range of behavioral alternatives, whereas effectiveness knowledge helps a person to effectively choose

from these different behavioral alternatives. Effectiveness knowledge should therefore only be consulted if knowledge about different actions is already available. Action-related knowledge was, thus, expected to simultaneously represent the rationale for acquiring effectiveness knowledge and for engagement, whereas effectiveness knowledge was hypothesized to exclusively stimulate behavior, and none of the other forms of knowledge. These interrelations were corroborated based on a large population-representative sample of German speaking Swiss (Frick et al., 2004).

The development of that knowledge structure has not yet been subject to empirical investigations. However, in an analysis of the knowledge-behavior structure in a sample with a high knowledge level (see Kaiser & Frick, 2002), the three forms of knowledge became technically indistinguishable. For these persons with high knowledge levels, the three forms of knowledge, thus, seem to be very closely interwoven with each other. The results suggest that the knowledge structure, as confirmed by Frick and colleagues for a population-representative sample (Frick et al., 2004), might collapse into one single knowledge dimension with increasing knowledge.

Proenvironmental motivation. In contrast to Gräsel's ecological competence model (2001) which only includes cognitive prerequisites of ecological behavior, our model also includes a motivational source. In Part I of this thesis, we have argued that for such a propensity to be included in a competence model which is useful for environmental education, this propensity not only has to be behavior effective with regard to ecological behavior, but also has to be accessible to educational interventions. We have argued that connection with nature might be such a motivational source (see also Roczen et al., 2010), as it is not only behavior effective but also promises to be well accessible by educational interventions. The method of choice predictably is to provide children with enjoyable experiences in nature, a measure that is easily implemented and that does not draw negative consequences, which could be the case for moral-based interventions, for example.

The interplay between knowledge, connection with nature, and ecological behavior. While the interrelations between environmental system knowledge, action knowledge and effectiveness knowledge and how they are working together in promoting ecological behavior have been thoroughly investigated (Frick et al., 2004; see the interplay between the forms of knowledge and ecological behavior in Figure 5), the role of an individual’s connection with nature within that structure is yet largely

unknown. The strong motivational effect of connection with nature on ecological behavior is established in the literature. However, the interplay between the different forms of knowledge and nature connection has hardly been subject to considerations within environmental psychology and even less to empirical investigations. On the one hand, it seems plausible that knowledge about nature, possibly mediated by fascination, leads to a higher connection with nature. This idea is well captured by the following quote of the ornithologist Roger Tory Peterson (Mongillo & Booth, 2001, p.228): "The philosophy that I have worked under most of my life is that the serious study of natural history is an activity which has far-reaching effects in every aspect of a person's life. It ultimately makes people protective of the environment in a very committed way. It is my opinion that the study of natural history should be the primary avenue for creating environmentalists". On the other hand, it is equally conceivable that a person's connection with nature serves as motivator for further knowledge acquisition. Here again, only anecdotic evidence can be drawn upon as illustration.

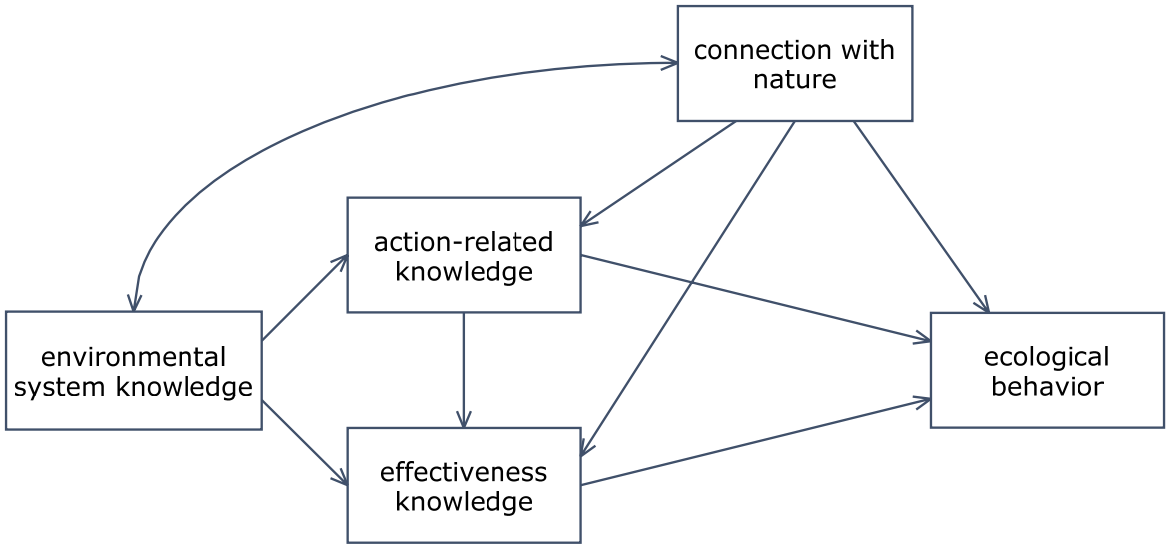

Figure 5. *Environmental competence as interplay between knowledge, connection with nature, and behavior*

For example, a young girl that discovers its passion for horses and that feels deeply connected to her four-legged friends also wants to know everything about breeds of horses, their history or how to properly care for horses. It seems, thus, equally plausible that environmental system knowledge provides a basis for the development of a stronger bond with nature or that connection with nature motivates further acquisition of knowledge about nature, respectively.

Concerning the relationship between action-related knowledge as well as effectiveness knowledge and ecological behavior, only one direction of influence seems plausible. While it is conceivable that connection with nature motivates the search for information about possible behaviors and their effectiveness, along with the wish to do something for the environment, the other direction of influence is difficult to imagine. It is hardly conceivable that knowledge about how to properly separate waste, for example, leads to a stronger sense of connection with the natural world.

We conceptualize competence as a model, in which behavior is explained by different predictors. This might raise the question in how far a competence model can be differentiated from existing behavior explanation models such as models based on the value-belief-norm theory (Stern 2000b; Stern et al., 1999) or on the theory of planned behavior (Ajzen & Fishbein, 2005; Harland et al., 1999). Our competence model is primarily distinguishable from these models by the goal that is pursued with a competence model: the model is supposed to help educational approaches to more effectively promote or change behavior. It is, thus, not only a matter of predicting behavior as well as possible. It is equally important for a competence model's predictors to be optimizable by training and to be suitable for educational interventions. For example, certain personality traits such as agreeableness or conscientiousness might be good predictors for ecological behavior (Fraj & Martinez, 2006). However, as basis for intervention programs, they are not suitable due to their presumed rigor. Summing up, our environmental competence model can be classified as a subform of behavior explanation models, which is characterized by its reference to competences and by its guiding function for environmental education interventions. In the next chapter, we will present an empirical test of that interplay between environmental knowledge, connection with nature, and ecological behavior.

CHAPTER 6

Environmental competence

Interplay between knowledge, connection with nature and behavior

6.1 Research goals

In this study, by means of survey data from students in lower grades of grammar schools in Germany, we aim to corroborate the assumed structure of environmental competence as the interplay between environmental knowledge, connection with nature, and ecological behavior, as presented in the previous chapter. Specifically, we want to test the following three hypotheses: (1) The knowledge-behavior-structure in our model corresponds to the one confirmed by Frick and colleagues (Frick et al., 2004). We hypothesize adolescents' knowledge-behavior structure to correspond to the one confirmed for adults. This is not self-evident, as previous studies (see in this chapter, 5.3, "Environmental knowledge") indicated that the knowledge-behavior structure is not necessarily constant for different stages of knowledge acquisition. (2) As we integrate environmental knowledge as a necessary basis into the model, whereas connection with nature is conceptualized as motivational force, consequently we expected connection with nature to be a far better predictor relative to environmental knowledge (action-related knowledge and effectiveness knowledge). (3) Regarding the interrelations between connection with nature and environmental knowledge, we hypothesize connection with nature to exert an influence on both action-related and effectiveness knowledge. For the relationship between connection with nature and environmental system knowledge, in contrast, we do not formulate a specific hypothesis (see double-headed arrow in Figure 5).

6.2 Methods

In the following section, we will describe the participants and how we collected the data. We present the employed instruments and how different test forms were created. Finally, the scale calibration and the test of the competence model are outlined.

6.2.1 Participants and procedure

Seven schools in Southern Germany were contacted and asked to participate in our study. Three of them were grammar schools ("Gymnasium") and four of them were secondary schools ("Realschule"). In each school, all classes of the 6th, 7th, and the 8th grade took the questionnaires. The materials were handed out to the teachers who were instructed to have their students fill out the questionnaires during the lessons. In total, 2300 questionnaires were given to 82 classes. 1907 (74%) students completed them. Participants' median age was 14 (M = 13.72, SD = 1.15). The percentage of females was 57%.

6.2.2 Measures

As the participating schools requested questionnaires to fit in a single lesson (i.e., 45 minutes), we decided to apply a test item rotation plan to nevertheless be able to present all items. The items of all five scales, in total 165, were allocated to thirteen item clusters with each cluster containing about the same amount of items (on average 16) and requiring the same time to work on (5-8 minutes). The items were presented to students in thirteen test booklets, with each booklet being composed of four clusters. Each cluster appeared four times and each combination of two clusters appeared one time in the thirteen test booklets (for a similar approach see e.g., OECD, 2009). After combining the clusters to booklets, the items were ordered according to the five dimensions.

Each of the 13 versions of the questionnaire consisted of (a) a set of ecological behavior statements, (b) a set of behavior and evaluative statements indicating a person's connection with nature, and (c) three sets of environmental knowledge questions. Not only the scales measuring ecological behavior and connection with nature were originally developed in German, but also the environmental knowledge scales. For all items measuring connection with nature or ecological behavior, "not applicable" was a response option when an answer was for whatever reason not

possible. These answers were handled as missing values. In the following, we will describe the five employed instruments: the Attitude toward Nature Scale, the three scales for environmental system knowledge, action-related knowledge and effectiveness knowledge, and finally, the General Ecological Behavior scale in their complete forms.

A person's *connection with nature* was assessed with the Attitude toward Nature Scale (see Chapter 3; Brügger et al., 2011). As in the two studies presented in Part I of this thesis, the 40 items were presented with two different response formats. While with 23 behaviors and evaluative statements a dichotomous yes/no-format was used, with 17 other statements a five-point frequency scale from 1 (never) to 5 (very often) was employed. Again, we recoded the responses from a five-point to a three-point format by collapsing "seldom" and "occasionally", as well as "often" and "very often". "Never" was retained as "never". Of the 40 items, three were turned negative expressing a deficient attitude toward nature. 6% of all connection with nature items were missing[11].

The extent of *environmental knowledge* was assessed with 90 items. 48 of these items were taken from Frick and colleagues (2004), from which 28 were adapted for adolescents. The remaining 42 questions have been newly developed in cooperation with the Department for the Didactics of Biology at the University of Bayreuth. Thirty-eight items are indicators of system knowledge, 23 of action-related knowledge, and 29 of effectiveness knowledge. 64 of these items were presented in a multiple choice format, of which 22 allowed multiple responses (partial credit was given for partially correct responses). Another 26 items were presented as dichotomous true/false statements. Unanswered questions were coded missing. Of all answers to the knowledge questions, 2% were missing.

For *ecological behavior*, we employed the adolescent version of the General Ecological Behavior scale (Kaiser et al., 2007), which consists of 40 behavioral self-reports. As in the version for adults, behaviors can be grouped into six domains: recycling, waste avoidance, consumerism, mobility and transportation, energy conservation, and vicarious behaviors towards conservation. Of the 40 behaviors, 14 represented unecological activities. Engagement in 7 behaviors was verified with a yes/no-format and in 33 behaviors with a five-point Likert scale from 1 (never) to 5

[11] Due to the design, the percentage of missing values for each item was about 70%. We only report true missing values, that is, the ones that actually have been left unanswered by a student.

(always). The responses to the latter behaviors were recoded into a dichotomous format by collapsing "never" "seldom" and "occasionally" into "unreliable ecological engagement". "Often" and "always", by contrast, were united into "reliable ecological engagement". Of all possible behavior statements, 7% were found to be missing.

6.2.3 Statistical analyses

All five scales were calibrated with either the classic or the partial-credit Rasch model (for model details see Bond & Fox, 2007) using the software program ConQuest (Wu et al., 1998) depending on whether the particular scale included only dichotomous or polytomous items as well. From these calibrations, we will provide information about the item fit statistics and about the reliability of the scales. Additionally, data were simulated (Conquest; Wu et al., 1998), using the given item and person parameters to investigate the reliability that could have been expected for each scale if we had complete data for all persons across all items.

Using the person estimates (i.e., weighted least squares; for more details see Wang & Wang, 2001) from the Rasch calibrations, a path analysis based on maximum-likelihood structural equation modeling (Mplus version 5.21; Muthén & Muthén, 2009) was performed. We used the model results to test our predictions about the interplay of ecologically-specific abilities and dispositions in promoting ecological behavior[12].

Our study is based on an even larger sample than the study presented in Chapter 4. Therefore, again, the χ^2-index would lead to wrong conclusions about the model fit. Alternatively, we report the following relative fit indices, which are less sensitive to sample size (Hu & Bentler, 1998): The Nonnormed Fit Index (NNFI), the Comparative Fit Index (CFI), the Root Mean Square Error of Approximation (RMSEA), and the Standardized Root Mean Square Residual (SRMR).

[12] As in Study 2 of Chapter 4, we were using nested data, i.e., the participating students were clustered in classes and schools. Again, we were using a procedure that adjusts the standard error for clustering in consideration of the intraclass correlations (Mplus version 5.21; Muthén & Muthén, 2009). In our sample, the intraclass correlations for our five scales ranged from 0.04 for effectiveness knowledge to 0.13 for system knowledge, and thereby, made the adjustments of standard errors necessary.

6.3 Results

The results will be presented in two parts. First, we describe calibration results of the five instruments, including item fit statistics and scale reliabilities. Second, we will present the path modeling results concerning our hypotheses about the interrelations between environmental knowledge and connection with nature on the one hand and ecological behavior on the other hand.

Scale calibrations. Table 9 lists the item and person fit statistics for the five scales. As regards the item fit, the MNSQ values were for all five scales one or very close to one, which represents the ideal value. The standard deviations for the MNSQ values were for all scales below .10. On the level of single items, the MNSQ value of none of the items left the range for acceptable fit ($0.75 < MNSQ < 1.30$; see Bond & Fox, 2007). The same holds true for the person fit statistics. The average of all person MNSQ values was for all five scales one or very close to one with standard deviations between 0.30 and 0.50. For none of the scales, the percentage of misfitting persons exceeded an acceptable limit (i.e., 5%). The Rasch model based reliabilities for ecological behavior, connection with nature, as well as for system, action-related, and effectiveness knowledge are also presented in Table 9. Data simulations based on the person and item estimates from the scale calibrations showed what reliabilities could have been expected if we had answers from all participants to every item of each scale. Reliabilities would have ranged from *rel* = .76 (action-related knowledge) to *rel* = .91 (connection with nature).

Scale means for the person estimates had values between M = -0.26 (ecological behavior) and M = 0.02 (environmental system knowledge). Standard deviations of the person estimates ranged from SD = 0.74 (environmental system knowledge) to SD = 1.31 (connection with nature). Kurtosis values varied between γ_2 = 0.78 (connection with nature) and γ_2 = 3.81 for environmental system knowledge. The distributions of system knowledge and action-related knowledge exhibited, thus, a particularly restricted variance. The remaining scales also had rather narrow distributions, relative to the normal distribution.

The restricted variance of the scales becomes especially obvious when the distributions of individual person estimates and distributions of item difficulties are looked at together. Figure 6 exemplarily shows the distributions of the system knowledge levels in our sample and the difficulties of the 38 system knowledge items.

Table 9. *Fit statistics, reliability information and scale descriptors for ecological behavior, connection with nature, and the environmental knowledge measures*

Fit Statistics	***ecological behavior***	***connection with nature***	***system knowledge***	***action-related knowledge***	***effectiveness knowledge***
item fit:					
M (MNSQ)	0.99	1.00	1.00	1.00	1.00
SD (MNSQ)	0.08	0.10	0.06	0.06	0.03
M (t)	-0.04	-0.13	0.03	-0.02	0.03
SD (t)	1.69	1.84	1.68	1.61	0.95
Minimum *(MNSQ)*	0.92	0.87	0.95	0.96	0.97
Maximum *(MNSQ)*	1.08	1.14	1.06	1.06	1.02
person fit:					
M (MNSQ)	0.99	1.01	0.99	0.99	1.00
SD (MNSQ)	0.43	0.48	0.33	0.46	0.32
M (t)	-0.02	0	-0.02	-0.04	0.02
SD (t)	1.03	1.10	0.98	1.07	0.96
% persons with poor fit (t > 1.96)	4,1%	0,3%	1,1%	2,8%	2,7%
reliability: Separation Reliability based on simulated, complete data	*rel.* = .88 (40 Items) *N* = 1907	*rel.* = .91 (40 Items) *N* = 1907	*rel.* = .79 (38 Items) *N* = 1907	*rel.* = .76 (23 Items) *N* = 1907	*rel.* = .77 (29 Items) *N* = 1907
scale descriptors: M	-0.26	-0.03	0.02	-0.04	-0.10
SD	1.12	1.31	0.74	0.91	0.78
Kurtosis	0.92	0.78	3.81	2.67	0.98

Inspecting these two distributions, it becomes obvious that the distribution of knowledge levels is so restricted that a considerable part of the items is either so easy that it is correctly answered by almost every student (i.e., items 34, 16, 18, 3, 5, 17, 38) or so difficult that almost no student is able to answer it correctly (i.e., items 21, 26, 28, 4, 27).

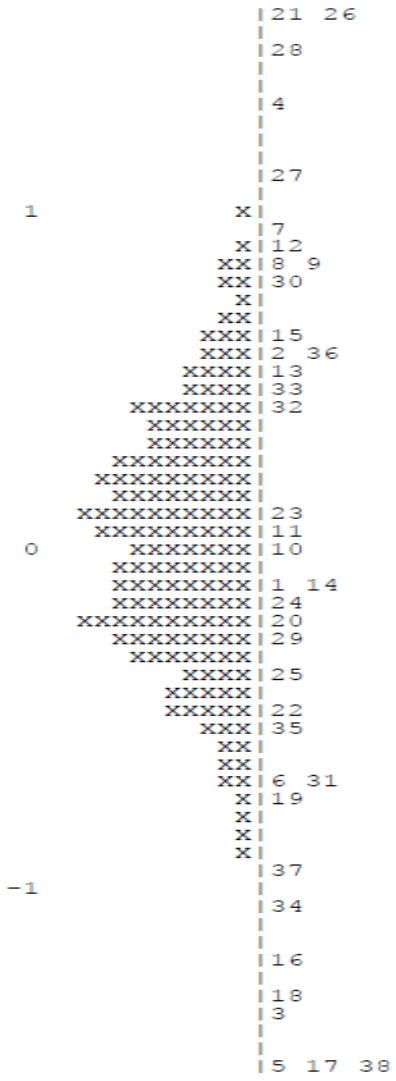

Figure 6. *Distributions of the person and item estimates of the environmental system knowledge scale*

Note. The scale on the left of the figure equally refers to the knowledge level of the participants and the difficulties of the items. Persons are represented by the crosses on the left side of the dashed line, whereby one cross represents 11 persons on average. The numbers on the right side refer to the numbers of the 38 system knowledge items. If a cross is on the same level as a particular item, this can be interpreted as following: The probability that a person with this knowledge level answers this particular item correctly is 0.5. The higher an item is located above a particular cross, the more the person's probability of solving the item approximates to zero. The lower an item is located beneath a particular cross, the more that person's probability of solving the item approximates to one.

As regards the knowledge scales, there is not only a restricted variability but also the average knowledge levels were rather low. Table 9 shows an average student's probabilities for a correct answer of a particular environmental knowledge item.

Table 9. *Environmental knowledge items ordered by the average probability of a correct answer*

Environmental System Knowledge	p_{avg}
What stands the abbreviation CO_2 for?	0.95
True or false: Oxygene is generated during forest fires.	0.87
True or false: Europe is affected most by the hole in the ozone layer.	0.83
Some devices, such as calculators for example, work with an environmentally friendly form of energy. How is it called?	0.82
True or false: The sea level would rise by 80m, if all polar ice masses completely melted.	0.81
True or false: Young children who have frequent contact with animals are more susceptible to allergies later on.	0.79
True or false: When wind energy is converted, no CO_2 is emitted.	0.76
True or false: Ozone naturally occurs in forests to a larger extent.	0.72
Where are the tropical rainforests located?	0.72
True or false: If all ozone-destroying emissions were eliminated right now, it would take 100 years for almost complete regeneration of the ozone layer.	0.67
True or false: Solar energy is unlimitedly available.	0.63
Which of these countries has the biggest contiguous areas of forest?	0.63
Forests bind … for a long time.	0.61
Which of the following kinds of energy are renewable?	0.57
Why is acid rain damaging to trees?	0.57
True or false: The "El Niño" phenomenon is a direct consequence of global warming.	0.55
Where does most of the cellulose for German paper mills come from?	0.55
On clear nights, why does it get colder towards the morning?	0.54
Why is carbon dioxide (CO_2) a problem?	0.51
If trees are burned, … is produced.	0.48
What does "sustainable forestry" mean?	0.39
Solar energy can be used for...	0.38
The vegetation of the hills and mountains of Bavaria is very resistant to external influences and even survived the last ice age.	0.37
Why is paper being bleached?	0.37
Global warming also has an effect on the Gulf Stream that will affect Europe. What is this effect?	0.36
True or false: When coal is converted into engery in a conventional power plant, a quarter of the energy is lost.	0.35
True or false: Clear lakes as a rule are not polluted with harmful substances.	0.35
What are the protective functions of the forests? They protect from...	0.31
What are characteristics of fossil energy (such as coal and oil)?	0.31
Where does groundwater come from?	0.28
True or false: If the concentration of atmospheric carbon dioxide (CO_2) was doubled, the global mean average temperature would rise by about 5°C (41°F).	0.28
What causes wind?	0.22
What is unique about the tropical rain forest?	0.22

continued

In a humid climate (such as Bavaria) how long does it take for 10 cm (4 inches) of soil to form?	0.21
Today's forestry is based on which principle?	0.15
Why is ozone a problem?	0.15
During photosynthesis...	0.08
What are the reasons for the rainforest destruction?	0.01
Action-Related Knowledge	p_{avg}
Where are old batteries disposed?	0.94
What is exclusively printed on recycling paper?	0.92
True or false: Energy can be saved if one takes a shower instead of taking a bath.	0.86
In Germany, one of the following labels stands for certified organic cultivation. Which one?	0.85
True or false: The good thing about recycling is that less energy is used than with new production.	0.80
Which of the following statements is true? Asparagus from California is environmentally harmful because…	0.79
Properly airing the house means…	0.79
How can soil be protected from erosion?	0.44
The energy consumption for heating can be reduced by…	0.38
True or false: All propellant gases in spray cans contribute to the greenhouse effect.	0.36
As a consequence of plowing fields...	0.35
What is the main cause of the increasing levels of nitrate pollution in groundwater?	0.34
Why is it better to collect and recycle aluminum than to throw it away?	0.29
To counteract global warming, it makes sense to...	0.28
Which wood certificates guarantee sustainable forestry?	0.25
At which part of the year are which fruit or vegetables imported from other countries (or greenhouse produced)?	0.21
Which certificate guarantees paper to be recycled?	0.21
Using a personal computer can be made more environmentally friendly by ...	0.11
To keep water use as low as possible, you should water your garden...	0.11
If ozone warnings are issued in the summertime, you should not drive because…	0.10
What is "grey energy"?	0.08
What can be done to save the (tropical) rainforests?	0.06
How can ozone build-up be reduced in summer time?	0.05
Effectiveness Knowledge	p_{avg}
True or false: A tv or stereo needs so little energy on „standby" that practically, it makes no difference to turning it out completely.	0.87
True or false: Doing the laundry using the 60° program saves 35% energy compared to the 90° program.	0.81
True or false: For Italian-grown tomatoes twice as much energy is used by the time they are sold in Germany as compared to locally grown tomatoes.	0.78
True or false: It takes the same amount of energy to produce recycled paper as it takes to produce conventional paper.	0.77
True or false: It takes more energy to produce and transport batteries than the batteries themselves contain.	0.75
True or false: Cooking 1.5 l soup needs 3 times more energy without lid that with a lid.	0.74
By using a pressure cooker instead of a conventional cooker, …% of the cooking energy can be saved.	0.72
True or false: For meat as compared to vegetables (in amounts containing the same number of calories), the same amount of energy is needed.	0.66
Energy saving light bulbs consume …% less energy than conventional light bulbs with the same illuminating power.	0.63
What is more environmentally friendly? Exchanging components of the old pc or buying a new pc?	0.60
Water-saving showerheads consume … of the water consumed by conventional showerheads.	0.60
What type of milk packaging is the more damaging to the environment?	0.56
True or false: Conventionally grown tomatoes consume only half the energy consumed by organically produced tomatoes.	0.54
How much water does it take to fill a bathtub?	0.53
True or false: Incineration of waste is generally preferable to land filling of waste.	0.46

continued

Lowering the heating temperature at home by 1°C, means …% less energy consumption.	0.44
How often can paper be reused by recycling?	0.39
With each time a person goes to the toilet, … liters drinking water disappear in the sewage system.	0.33
What type of lamp consumes the least energy for the same amount of light?	0.33
True or false: A car consumes per person and kilometer 10 times more energy, compared to a train.	0.29
A car emisses … CO_2 per person, compared to a bus.	0.28
When cooking noodles, most energy will be saved if …	0.26
Returnable bottles can be reused up to … times.	0.24
How much energy is required to grow wheat by integrated farming as compared to growing wheat by organic farming?	0.23
A household needs most of the energy for…	0.23
What has consumed the most energy up to the point that Italian peppers are in the vegetable section of your grocery store?	0.22
How many trees (the size of a spruce) a felled each year for one student?	0.20
Recycling which of the following materials saves the most energy as compared to producing new material?	0.18
For the production of an aluminium can … times more energy is used than for the production of a glass bottle.	0.14

Note. The values on the right refer to the probability for an average student to correctly answer a particular item. For the items, for which partly correct answers were possible, we only give probabilities for the completely correct answer.

For example, a student with an average action-related knowledge level answers the item "What is 'grey energy'?" correctly with a probability of 0.08. The respective probability of solving the item "What is exclusively printed on recycling paper" is 0.92. According to the proceeding of the PISA study, it can be assumed that a student possesses the knowledge or competence level represented by a certain item, if the probability of solving that item exceeds 0.62 (OECD, 2009). Applying that rule, our sample's knowledge level can, thus, be evaluated as low. As concerns environmental system knowledge, an average student's knowledge level was only high enough to answer 12 out of 38 items with a probability of 0.62 or higher. A student with an average level of action-related knowledge was able to solve 7 out of 23 items of the action-related knowledge scale. Regarding effectiveness knowledge, an average student's knowledge level was only sufficient to answer 9 out of 29 items correctly.

Model test. The model is depicted in Figure 7 and fitted the data well: While two indices suggested an acceptable fit (RMSEA=.08; NNFI=.92), the two other ones indicated an excellent fit (SRMR=.02; CFI=.99). All hypothesized paths proved significant with the exception of the one between effectiveness knowledge and ecological behavior. The strongest path in the model was the one between connection with nature and ecological behavior (β=.48). Together with action-related knowledge (β=.12) and effectiveness knowledge (β=.03), 26% of the variance of ecological behavior were explained.

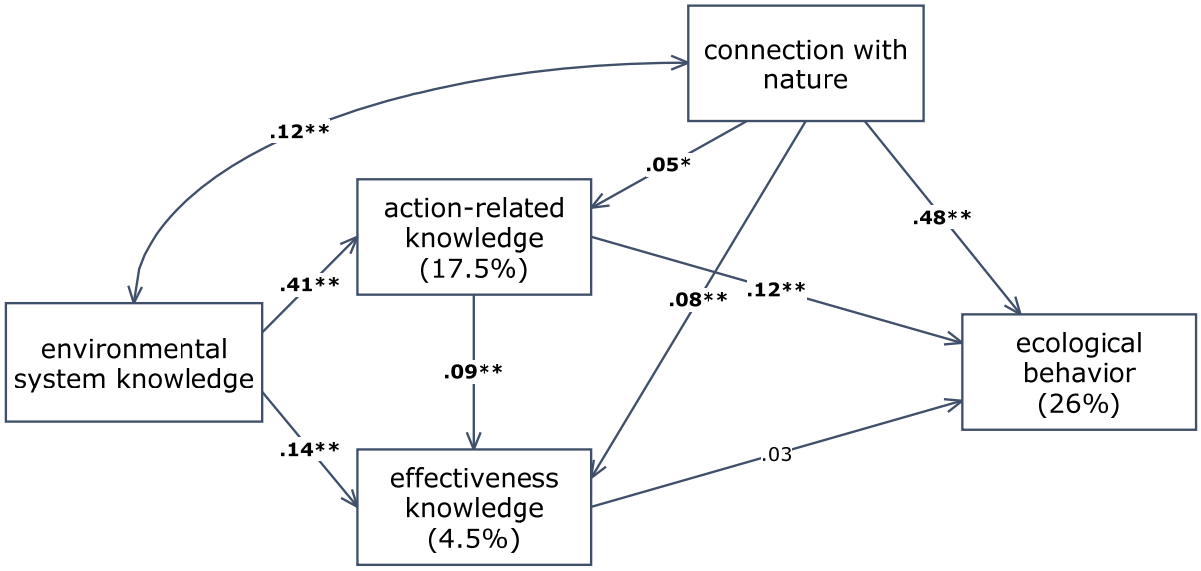

Figure 7. *Environmental competence as interplay between knowledge, connection with nature, and ecological behavior*

Note. The labels on the arrows are the ß-coefficients and represent the strengths of the paths. The proportion of explained variance is indicated on the rectangles representing the different constructs.

Out of the variance of effectiveness knowledge, 4.5% was explained jointly by action-related knowledge (β=.09), system knowledge (β=.14) and connection with nature (β=.08). System knowledge (β=.41) and connection with nature (β=.05) determined 17.5% of the variance of action-related knowledge. The correlation between environmental system knowledge and connection with nature was r = .12.

6.4 Discussion

With this research, we examined the structure between different forms of environmental knowledge, connection with nature, and ecological behavior. Specifically, we wanted to (1) explore the relative influence of connection with nature and environmental knowledge on ecological behavior. That is, connection with nature was hypothesized to be the strongest predictor for ecological behavior within our model. Knowledge is commonly regarded as only being a necessary precondition and as such, it is expected to only weakly to moderately influence ecological behavior. Furthermore, we aimed at (2) confirming the knowledge-behavior-structure, which is already corroborated for adults, for adolescents as well. Finally, we (3) were interested in the interrelations between connection with nature and environmental knowledge. We expected connection with nature to motivate the search for information about

ecological actions and their effectiveness. Regarding the relationship between knowledge about nature and connection with nature, we confined ourselves to analyze the strength of the correlation between both constructs.

Overall, our hypotheses about the interplay between different forms of environmental knowledge, connection with nature and ecological behavior were confirmed by the model test. Only knowledge about the effectiveness of different actions does not seem to have an influence on a person's ecological behavior. This path was not always found significant in former studies, either (see Frick et al., 2004). Additionally, the moderate reliability of effectiveness knowledge leads to an under-estimation of the real relationship. Concerning the *relative significance of environmental knowledge and connection with nature for ecological behavior*, our results support the hypothesis that a person's connection with nature strongly motivates his or her ecological behavior. The comparatively much weaker influence of environmental knowledge speaks for the assumption that knowledge actually forms a foundation, in a way that the necessity of acting in the sense of conservation is recognized. However, it does not seem to be enough to actually motivate ecological behavior. This requires a motivational source such as the individual connection with nature. By confirming that environmental knowledge only exerts a very moderate influence on ecological behavior, our results support previous findings concerning the relationship between environmental knowledge and ecological behavior (Hines et al., 1986/87; Stern, 2000a). However, the effect of environmental knowledge on ecological behavior was even weaker that what would have been expected from Frick and her colleagues' study (e.g., Frick et al., 2004). This can be attributed to the fact that, in our sample, students did not know much about ecological issues, and they all knew similarly little. A restricted variance generally leads to a reduced covariance with other constructs. The low variability in environmental knowledge also has an effect on reliability: Only a small part of all knowledge items were able to differentiate between the students in our sample. However, a large part of the items were either correctly answered by almost every student or by almost no student, respectively (see Figure 6). Those items, consequently, could not contribute to the quality of the scales. Connection with nature turning out to be by far the best predictor in our model is also consistent with literature attesting connection with nature to be a prime motive for ecological behavior (Clayton, 2003; Mayer & Frantz, 2004).

In our model, we also tested the *environmental-knowledge – behavior structure* as described by Frick (Frick et al., 2004) before. We aimed at confirming that structure which already had been established for adults, for adolescents as well. From our

results, we can assume that for adolescents as well, a person's knowledge about nature and environmental problems does not directly influence that person's ecological behavior. However, it provides a basis for acquiring knowledge about different ecological behaviors and their effectiveness. These forms of knowledge, in turn, are direct precedents of ecological behavior.

As regards the *interplay between the different forms of knowledge and connection with nature*, a person's connection does not seem to be an important motivation for gathering information about how to preserve nature and with which behaviors this works best. Although the concerning paths were significant, the relationship resulted to be weak (β = .05 and β = .08). We did not test a certain direction of causality between environmental system knowledge and connection with nature, but only assessed the strength of their relationship, which turned out to be only moderate (i.e., r = .12). Our results leave open whether knowledge about nature is the foundation on which connection with nature builds up or whether connection with nature is the reason for interest in nature.

One methodological aspect of our study may limit the interpretation of our findings. In the present study, we used path modeling instead of deducing latent, measurement error free, concepts from several manifest indicators. As all the employed scales were Rasch scales, it was possible to calculate general, comparable person estimates for each person, even though different participants responded to different items. However, it would not have been possible to create several sum scores for each scale that could have been used as indicators for a measurement model with our incomplete data set. Also, there were too little items of one scale answered by each person to calculate two different Rasch model based estimates per scale. As a result, the path coefficients we are reporting, are not free from measurement error attenuation[13], as it would have been the case if we had been able to use structural equation modeling. However, the attenuation of the correlations we are reporting also means that environmental knowledge and connection with nature are actually (even) more significant for

[13] The measurement error attenuation in a path model can be illustrated with the following example: Suppose, the actual correlation between to constructs is r = .60 and suppose these two constructs can be measured with reliabilities of rel = .70. If the correlation between the two constructs was then estimated, the resulting correlation would only be r = .42. This is because only the true variance parts contribute to the correlation, whereas the measurement errors are uncorrelated (Bortz, 1999). That is, the higher the measurement error is, the more the "true" correlation is underestimated. In structural equation models, with help of the measurement model, the measurement error is taken into consideration and the latent variable is error-free measured (Bollen, 1989).

ecological behavior than our results reveal, and therefore, speak for our competence model. Nevertheless, it remains a task for future research to investigate the precise level of the correlations using latent, and thereby, measurement error free constructs. Moreover, further research would be desirable to investigate the development of the environmental competence structure over time.

In this study, we presented the test of a competence model, in which environmental competence is conceptualized as the interplay between environmental knowledge and connection with nature in promoting the target dimension ecological behavior. From our results, we can conclude that for an effective promotion of ecological behavior, it is important to also focus on motivational components and not only concentrate on intellectual abilities. Furthermore, we found that the level of environmental knowledge in our sample, and presumably among German students of that age in general, was surprisingly low and therefore requires intensive promotion.

CHAPTER 7

General discussion

The aim of this dissertation was to develop and empirically test an environmental competence model. In contrast to already existing models, our newly developed competence model includes a person's overall ecological behavior as goal dimension as well as cognitive and motivational prerequisites of that behavior. As motivational prerequisites, such as connection with nature, have a far stronger effect on ecological behavior than cognitive prerequisites, interventions based on such a model will be more effective than approaches that only concentrate on cognitive abilities. In the first part of the dissertation, we described the development and validation of a connection-with-nature measure that is also suitable for children and adolescents, as it does not require demanding self-reflections about one's own extent of connection. Instead, only simple behavior and evaluative statements have to be answered. We furthermore investigated the origins of an individual's connection with nature. The results are suggesting that experiences in nature lead to an enhanced connection if they are perceived as enjoyable. In the second part, we corroborated our theoretically anticipated competence model, which was conceptualized as the interplay between environmental knowledge, connection with nature and ecological behavior, with a large sample of adolescents.

In the following, we will summarize the most important findings and discuss the theoretical and practical implications of our results. Furthermore, we make some proposals for hopefully more efficient ways to promote ecological behavior as well as for future research.

7.1 Main findings

Chapter 3 dealt with the development of a measure for connection with nature that avoids the problems existing instruments have to face. The aim was, thus, to measure connection with nature without requiring the intellectually difficult task of directly assessing one's own extent of connection. For our new instrument, we conceptualize connection with nature as an attitude, which is both expressed in behaviors such as helping snails cross the street, mourning the loss of pets and in statements such as considering plants as part of the family. By indirectly deriving a person's connection with nature or attitude toward nature from these behaviors and statements, we hope to provide an instrument that is better suited for the use with children and adolescents and, at the same time, is less vulnerable to response biases than direct self-report measures. Although the new scale derives the level of connection indirectly, it converged closely with direct connection-with-nature measures (unlike the only other available instrument that does not measure connection with nature directly). Thereby, we were also able to show that most of the instruments (with the exception of the Implicit Association with Nature measure), whether they conceptualized connection as intellectual or rather as emotional disposition, essentially measure the same variance. Furthermore, we also confirmed the discriminant validity of the instrument; the new measure could be better differentiated from environmental concern than most of the other measures. As regards the predictive validity, the Attitude toward Nature measure showed the strongest explanatory power regarding ecological behavior (along with only one other instrument, the Environmental Identity scale).

In Chapter 4, we carried out two studies to gather information about the processes behind the development of connection with nature. Surprisingly, hardly any research has been done to explore these processes, in spite of the strong interest in the concept itself. It is assumed, and supported by a few studies, that experiences in nature play an important role in the development of connection with nature. It is however, necessary to know *how* these experiences lead to a higher connection with nature, if connection shall be effectively promoted through interventions. With the two studies, we contributed to answering that question. In the first study, based on interview data from students high and low in their connection with nature, we corroborated that students with high levels of connection with nature recall more enjoyable and relaxing experiences in nature than students with low levels. These experiences earlier on in life might be responsible, through learning processes, for their comparatively stronger connection with nature today. In the second study, we further analyzed the role

enjoyable, gratifying experiences play in the development process of connection with nature. If learning processes, that is classical and operant conditioning, actually play a role, enjoyment should work as a mediator between nature experiences and connection with nature. With an empirical model test, we could confirm that (at least) a major part of that relationship is mediated by enjoyment. Our results, thus, supported the assumption that experiences in nature, such as mountain hikes, have a considerably stronger effect on a person's connection with nature, if they are perceived as pleasant. We furthermore explored the interrelations between the ease of access of nature (i.e., the living environment) and the actual contact and how these variables are conjointly influencing connection with nature. In a simultaneous analysis of both variables' influence on connection with nature, the living environment did not provide any information about a person's bond with nature beyond what was already explained by the activities that person carries out in nature. However, the two variables were strongly correlated with each other. Accordingly, the living environment can be interpreted as an important prerequisite for the development of connection with nature, but only insofar as it facilitates (or hampers) experiences in nature. However, if these possibilities are not used, they will stay without effect on connection with nature.

In Chapter 6, we empirically tested our theoretically anticipated competence model. We conceptualized environmental competence as the structure of different precedents of ecological behavior and ecological behavior itself, which is the target criterion. In contrast to existing competence models, we did not only include intellectual (environmental knowledge) but also motivational (connection with nature) preconditions and define the target criterion as a person's overall ecological behavior. We know from previous studies that the environmental knowledge structure (which is part of our competence model) does not remain constant across different levels of knowledge (Frick et al., 2004; Kaiser & Frick, 2002). Therefore, it was an important question whether the environmental-knowledge–behavior structure confirmed by Frick (Frick et al., 2004) is also found for adolescents. In line with our predictions, a model in which system knowledge is only indirectly influencing ecological behavior, mediated by action-related and effectiveness knowledge, fitted the data well. Likewise in line with former research, we found connection with nature to be a strong predictor for ecological behavior. Although we expected environmental knowledge to have a comparatively lower influence on ecological behavior, the influence resulted to be surprisingly low in our sample. Also, there was a very low average knowledge level and only a very low variability of knowledge levels in the sample, which contributed to that unexpectedly low influence of environmental knowledge on ecological

behavior. As concerns the relationship between nature connection and the different forms of knowledge, connection only seems to be a weak motivational basis for searching for information about possible ecological behaviors and their effectiveness. The relationship between system knowledge and connection with nature also turned out to be only moderate.

7.2 Theoretical implications

With our studies, we provided some new insights into the measurement and development of connection with nature as well as into the interplay between connection with nature, environmental knowledge and the target criterion, ecological behavior. Our results call the current conceptual differentiation between cognitive (e.g., Clayton, 2003) and emotional connection with nature (e.g., Mayer & Frantz, 2004) in question. With our research, we have also turned to the development processes of connection with nature, which have not been targeted before. With our results, we have laid the foundations for further investigations into the origins of people's bond with nature. As regards the assessment of connection with nature, we propose a new measurement approach, with which known issues of current instruments can be overcome. We examined the interplay of connection with nature and environmental knowledge in promoting ecological behavior. Our results make the usefulness of some other competence approaches appear questionable.

7.2.1 Concept of connection with nature

In Chapter 2, we have seen that there is a strong and growing interest in people's connection with nature within environmental psychology. This interest, however, is mostly expressed in ever new concepts, such as, for example, connectedness to nature (Mayer & Frantz, 2004), environmental identity (Clayton, 2003) or commitment to the natural environment (Davis et al., 2009), which conceptually differ considerably. Furthermore, it became clear (see Chapter 3) that some of these concepts insufficiently differentiate between connection with nature and environmental concern.

The absence of a generally accepted standard is, however, an obstacle that impedes psychological science from empirically accumulating theoretical knowledge about the phenomenon itself. Instead of coming up with more and more allegedly novel conceptualizations and instruments, the construct connection with nature should be

investigated more profoundly. With our study presented in Chapter 3, we aim to overcome this drawback, by demonstrating that the apparently diverse constructs in fact reflect the same phenomenon. The conceptualization of connection with nature as an attitude has the advantage, beyond the indirect measurement we are applying, to reconcile the different concepts: Attitudes are presumed to have cognitive, emotional and behavioral expressions (see e.g., Triandis, 1975). We hope that, in future, research on a person's connection with nature will combine its efforts, to further investigate the origins and the psychological processes behind the disposition that is expressed in behaviors such as deliberately watching clouds and helping snails cross the street. We already made a start with our studies on the origins of connection with nature.

7.2.2. Further insights into the development of connection with nature

In environmental psychology, so far, the development of a person's connection with nature has been subject to much speculation. Experiences in nature are unanimously regarded as essential precondition for its development. However, as regards empirical investigations of the processes behind the relationship between experiences in and connection with nature, there has been a gap in research so far. We made an important contribution to filling that gap: We were able to show that a major part of this relationship is mediated by feelings of enjoyment in nature. Although the strength of our evidence is limited by the fact that we only analyzed cross-sectional data and that the concepts were not clearly separable from each other, our results form a basis for further investigations into the development processes of connection with nature.

At this point, we would like to stress the fact that, in the framework of this dissertation, we exclusively concentrated on a positive relationship with nature. All connection with nature concepts we have presented here describe a positive connection with nature, as the theories on which the different approaches are based (e.g., interdependence theory, Davis et al., 2009; Kelley & Thibaut, 1978) underline. As regards the development of connection with nature, so far, it has only been discussed, in how far positive, enjoyable experiences in nature lead to an intensified connection. However, not only positive but also negative nature experiences (such as e.g., natural desasters) could have an influence on a person's connection with nature. In how far such a connection is captured by the existing instruments and whether it entails additional components remains to be investigated.

7.2.3 Implications for the measurement of connection with nature

In the framework of this dissertation, we have shown that connection with nature can also be interpreted as an attitude toward nature. According to the Campell Paradigm (see Campbell, 1963; Kaiser et al., 2010), we derived connection with nature from behavioral records and statements indicating connection with nature rather than requiring a person to directly estimate his/her level of connection. In spite of the different measurement approach, our instrument converges with the direct connection-with-nature measures and mostly surpasses them as regards reliability and discriminant as well as predictive validity. Additionally to the advantage of the indirect assessment of connection with nature, our scale possesses further desirable properties resulting from the Rasch model based scale construction. For example, Rasch scales are strictly one-dimensional and thus allow for unambiguous interpretation of results. Furthermore, person parameters reach interval level by definition. Finally, with Rasch modeling, the level of a certain propensity, such as, for example a person's connection with nature, can be assessed with different items and the resulting person estimates still remain comparable. Due to these properties, adaptive testing, pre-post-measurement without memory effect distortions and employing different questionnaire forms becomes possible (for more details see, e.g., Bond & Fox, 2007; see also Wirtz & Böcker, 2007).

7.2.4 Implications for environmental competence approaches

We conceptualized environmental competence as the interplay between environmental knowledge, connection with nature, and ecological behavior. The rather moderate influence of environmental knowledge on ecological behavior and the comparatively strong effect of connection with nature support our assumptions that environmental knowledge works as a basis for ecological behavior (presumably by creating awareness and providing reasons for becoming active), whereas connection with nature, as motivational source, actually triggers behavior. In our research, environmental knowledge and connection with nature have been investigated together for the first time. In the light of our investigations, it seems questionable to develop environmental competence concepts that exclusively build on cognitive constituents (e.g., Gräsel, 2001).

7.3 Practical implications

Our results hold potential for practical use, both in what concerns general contents of intervention programs and specific techniques to be employed in such programs. Altogether, basing interventions on the competence model we presented in this thesis has at least four properties that will lead to an increased effectiveness of behavior change approaches. (1) Our approach focuses on ecology-specific propensities, unlike many other concepts that focus on general abilities. Targeting ecology-specific abilities and dispositions, however, will provide more concrete leverage points for environmental education programs than most of the conventional approaches that basically build on general abilities such as, for example, problem solving or critical thinking (see Kyburz-Graber, 2004). (2) We propose a simultaneous focus on cognitive as well as on motivational prerequisites of ecological behavior. It can be assumed that a simultaneous promotion of cognitive and motivational precedents of ecological behavior will be more behavior-effective than less comprehensive models (e.g., Gräsel, 2001) allow. (3) Our competence model and interventions derived from that model build on intrinsic motivations of ecological behavior. Focusing on intrinsic motivational sources of ecological behavior and their promotion has an advantage over methods that build on external incentives: Approaches that are employing social norms (see, e.g., Schultz, Khazian, & Zaleski, 2008) or financial incentives (see, e.g., vouchers for the use of public transport; Thøgersen, 2009) presumably, achieve less sustainable effects than approaches that are directly targeting intrinsic motivations. In addition, with the just mentioned approaches, typically, only one behavior or a small range of behaviors (for example motor oil recycling, Schultz & Tabanico, 2008) is targeted. However, if the motivation behind ecological behavior is successfully enhanced, a long-term improvement of the individual ecological behavior, in various different fields, can be expected. That is why, for an optimal promotion of ecological behavior, motivational sources of ecological behavior, such as connection with nature, should in any case be targeted. If possible, this should happen in parallel with other (external) approaches to achieve an even better result. And finally, (4) our competence model is particularly suited for the evaluation of environmental education interventions. The model provides a guideline how ecological behavior can effectively be promoted. The effectiveness of such an intervention can be precisely tested by means of the model and the associated measures, respectively. It is not only possible to quantify the effect on the target variable, ecological behavior, but also to assess what part of the intervention had been especially helpful.

However, our model and the empirical data not only help to decide on which contents to focus and then to evaluate the interventions. They also shed light on *how* these prerequisites could possibly be targeted. In the following, we will discuss the implications of our results for the promotion of connection with nature and environmental knowledge in particular.

7.3.1 Promotion of connection with nature

The analyses of environmental knowledge's and nature-connection's joint influence on ecological behavior, in our sample, revealed an only weak impact of knowledge on ecological behavior while connection with nature turned out to be the expected strong motivational force. However, most behavior change campaigns are predominantly knowledge based (see, e.g., Boerschig & De Young, 1993; Buller & Borland, 1999). In the framework of a school curriculum, environmental education takes place within the natural sciences curriculum. Our results suggest that, by integrating a motivational component, such as an individual's connection with nature, a far stronger behavior effect can be achieved. As regards the question of how an individual's connection with nature can be effectively promoted, researchers agree that experiences in nature somehow have to play an important role. However, so far, no attempts have been made to fathom the processes behind that relationship. The knowledge of such processes are crucial for an effective promotion of connection with nature. In one of our studies we found that students high in their levels of connection with nature report having enjoyed activities in nature more often than students low in their levels of connection. In a second study, we found that the relationship between contact with nature and connection with nature is mediated by gratifying experiences. Further developmental studies are needed to clarify the nature of the relationship between contact with nature, enjoyment and connection with nature. Our results already suggest that implementing enjoyable, gratifying nature experiences in existing programs (by including, for example, outdoor adventure activities) could help to promote connection with nature more effectively.

7.3.2 Transfer of environmental knowledge

In the last paragraph, we stated that knowledge based campaigns are insufficient and that the focus should rather be on motivational sources for ecological behavior, such as people's connection with nature. However, at this point, we explicitly want to speak on

behalf of an enhanced and better promotion of environmental knowledge, rather than turning away from knowledge based interventions. In our study, we found a low level of environmental knowledge with a restricted variance, too. To put it differently, there are not many differences between the students in what they know, and the level is rather low. Such a low variance automatically leads to low covariances with other constructs, even if the actual relationship is stronger. In other words, we can expect to find a stronger effect of environmental knowledge on ecological behavior, if we manage to create more variance of individual knowledge levels. A more effective promotion of environmental knowledge will inevitably lead to more variability, as students will respond differently to the instruction materials. In other words, if the students from our sample now took part in a systematic, effective intervention program, we would expect some students to strongly benefit from that program and some to benefit less and again others to hardly retain anything. Eventually, not only the general knowledge level would rise, but also the variability. Cross-sectional studies seem to confirm that assumption: In samples with rather low variability regarding environmental knowledge, the found effects on ecological behavior are with a proportion of 1-6% of explained variances low (as shows the study presented in Chapter 6, see also Frick et al., 2004). In another sample that comprised students from very different fields of study, including environmental studies, and that therefore had a wide variety in environmental knowledge levels (and on average a higher knowledge level), with an explained variance of 18% a significantly stronger behavior effect was found (Kaiser & Frick, 2002). Our model results presented in the last chapter, not only suggest that environmental knowledge and thereby its variances should be increasingly promoted (and complemented by a promotion of the motivational source connection with nature), but also provide possibilities how to tackle knowledge transfer. The confirmed interplay between the different forms of knowledge and ecological behavior suggests that teaching of those forms of knowledge should be implemented in coordination with each other. Knowledge promotion should start with system knowledge as a basis and then link it to action-related and effectiveness knowledge. For example, a lesson could start with the problem of immense water consumption that is associated with the production of certain consumer goods. Based on that information, students should be introduced to different behaviors such as recycling or buying certain products while avoiding others as well as those behaviors' effectiveness (in terms of water savings relative to alternative behaviors). From different cross-sectional studies in which the knowledge-behavior structure was examined, we can conclude that with increasing knowledge, the correlation between the different forms of knowledge becomes increasingly stronger, and that they are finally not

distinguishable from each other any more (Frick et al., 2004; Kaiser & Frick, 2002). By explicitly connecting the different forms of knowledge in analogy to the structure confirmed in our study, presumably, the knowledge acquisition can be made more efficient (see Kaiser et al., 2008).

7.4 Future research

With our studies, we open up some new perspectives for further research and also leave some questions open that will have to be addressed. In Chapter 4, we have shown that enjoyable experiences in nature play an important role in the development of connection with nature, and that they, presumably, work as a mediator of the relationship between experiences in and connection with nature. However, data from which we have drawn our conclusions are cross-sectional. Furthermore, the concepts which we analyzed in Study 2 were overlapping. Therefore, we recommend to thoroughly, over a longer period of time examine the acquisition of connection with nature in the framework of a developmental study to assess the actual impact of enjoyable experiences in nature on a person's connection. It would be especially interesting, in such a study, to experimentally investigate the effectiveness of different interventions to promote connection with nature.

Thanks to the studies presented in Chapter 6, we gained knowledge about the structure of environmental competence, that is, the interplay between environmental knowledge, connection with nature, and ecological behavior. An important subject of further research is to longitudinally analyze the development of that interplay. It would be particularly interesting to investigate whether system, action-related, and effectiveness knowledge actually collapse into one indistinguishable environmental knowledge dimension with increasing knowledge and how the role of connection with nature in the whole competence structure develops. Furthermore, our results could not contribute to answering the question whether knowledge about nature forms a basis for connection with nature or whether it is the other way around. Here again, longitudinal studies could provide an answer.

With our results presented in Chapter 3, we could show that most established available instruments for assessing a person's individual connection with nature, as diverse as they may seem conceptually, reflect one single phenomenon. However, one could argue that the instruments are less different from each other than they claim to be. Mayer and Frantz' concept (Mayer & Frantz, 2004), for example, has been

criticized for not truly measuring an emotional connection with nature (Perrin & Benassi, 2009). Indeed, some of the connectedness to nature items such as, for example, “I think of the natural world as a community to which I belong” or “I feel as though I belong to the Earth as equally as it belongs to me” bear resemblance to cognitive approaches that define connection with nature with regard to knowledge and beliefs about the self (Clayton, 2003). Consequently, further research has to show whether other measures that more consequently assess the emotional connection to nature in the sense of feeling love and affection for nature (e.g., Perkins, 2010) are not separable from the instruments we already examined in our study, either.

In all four studies presented in this thesis, we only include self-reported behavior. An external validation of our results using actual behavior remains, thus, to be realized. It would be particularly interesting to experimentally validate our environmental competence model presented in Chapter 6 by testing whether interventions targeting environmental knowledge and connection with nature eventually lead to an actual change in ecological behaviors. Although we have not included actual behavior in our studies, it can be assumed that our results are relevant for actual behavior. Kaiser, Frick and Stoll-Kleemann (2001) report an average correlation of the self-reported behaviors measured with the General Ecological Behavior Scale and the respective observed behaviors of $r = .81$.

7.5 Final conclusions

In conclusion, with this series of studies, we provide new insights into environmental competence as a network of abilities and dispositions that promote ecological behavior in individuals. We hope to have inspired a shift from developing ever new alternatives describing (the same) connection between humans and nature to more thoroughly investigating the phenomenon itself and its development. We shed light into possible development processes of connection with nature and presented a measure that is not only reliable and valid, but also more suitable for children and adolescents. Furthermore, we contribute to a more profound understanding of how ecology-specific cognitive and motivational dispositions work together in advancing ecological behavior. Hopefully, the established environmental competence model will help to more effectively promote ecological behavior of adolescents and evaluate such educational endeavors.

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Summary

The ultimate goal of environmental education is to advance people's ecological performance, and not only to pass on knowledge. To be able to promote people's ecological behavior, the preceding abilities and dispositions have to be identified. In this dissertation, we conceptualize environmental competence as a model describing the interplay between environmental knowledge, connection with nature, and ecological behavior.

In the first part of the thesis, we focus on the motivational constituent of our environmental competence model, connection with nature, which has been shown to be a prime motive for ecological behavior. First, we report how we developed and validated a new Rasch-model based scale to assess connection with nature. In contrast to already available instruments, participants do not have to assess their own extent of connection which demands a high level of introspection abilities. Instead, connection with nature is indirectly derived from inspecting reports of past activities and statements reflecting a positive bond with nature. Presumably, such an intellectually less demanding scale is also better suitable for the use in children and adolescents. Reliability and convergent, discriminant, and predictive validity were all reasonable. Second, two studies were undertaken to gain further insights into the origins of connection with nature. (1) Based on interview data from students high and low in their connection with nature, we corroborated that students with higher levels of connection with nature recall more enjoyable and relaxing experiences in nature than students with lower levels. (2) Subsequently, based on survey data, we further analyzed the mechanisms behind the development of connection with nature. As expected, enjoyable, gratifying experiences in nature mediated – at least partially – the relationship between time spent in nature and connection. This result points to conditioning processes that possibly play an important role in the development of connection with nature.

In the second part of the thesis, we present our theoretically anticipated competence model and the empirical model test that was performed. Among the existing competence models in the literature, only our newly developed model focuses on the interrelations between ecological behavior and its prerequisites and, at the same time, includes cognitive as well as motivational propensities. While the three knowledge forms, environmental system knowledge, action-related knowledge, and effectiveness

knowledge are understood as necessary prerequisites, connection with nature was expected to be the crucial motivational source behind the ecological performance of individuals. With a large sample of adolescents, the postulated model was empirically tested. Overall, the suggested model fitted the data well. We corroborated the interplay between the three knowledge forms and ecological behavior, which was previously established for adults, for adolescents as well. Moreover, we found connection with nature to be the expected strong predictor of behavior. As regards the relationship between environmental knowledge and connection with nature, a person's connection turned out to be an only weak predictor for action-related and effectiveness knowledge. The relationship between environmental system knowledge and connection with nature was also only moderate.

In conclusion, with this series of studies, we provide new insights into the origins of connection with nature and presented a measure that is not only reliable and valid, but also more suitable for children and adolescents. Furthermore, we contribute to a more profound understanding of how ecology-specific cognitive and motivational dispositions work together in advancing ecological behavior. Hopefully, the established environmental competence model will help to more effectively promote ecological behavior of adolescents.

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Curriculum Vitae

Nina Roczen was born on 5 October 1979 in Frankfurt/Main, Germany. After completing grammar school at Schillerschule in Frankfurt in 1999, she started her studies in Psychology at the Johann-Wolfgang-Goethe University Frankfurt where she obtained her diploma in 2007. After that, she worked as a research assistant at the German Institute for International Educational Research on evaluating a civic education program for half a year. Since then, Nina is a PhD student at the TU Eindhoven, the Otto-von-Guericke University, Magdeburg and the University of Bayreuth. She works on the project "environmental competence" which is part of the priority research program "models of competencies for the assessment of individual learning outcomes and the evaluation of educational processes" founded by the German Research Foundation (DFG).