The Role of Environmental Knowledge and Attitude: Predictors for Ecological Behavior Across Cultures?

An Analysis of Argentinean and German Students[1]

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Abstract

This study examined the relationships between a general measure of environmental attitude (NEP), general environmental knowledge (GEK), and general ecological behavior (GEB) in two university student samples, one from Argentina (N_{Arg}= 85, M_{age}= 24.1, 59 % female) and one from Germany (N_{Ger}= 98, M_{age}= 22.5, 51 % female). Whereas Argentinean and German students did not differ in ecological worldview, Germans displayed more environmental knowledge (d= 1.40) and reported more ecological behavior (d= .87). Two separately conducted hierarchical regression analyses for each sample revealed that after controlling for age and gender, ecological worldview explained about the same amount of variance in both countries (5 % in Germany vs. 6 % in Argentina). Environmental knowledge on the other hand explained an additional 24 % of variance in ecological behavior in the German sample only and accounted for no additional variance in the argentine sample. These differences are discussed in terms of situational restrictions that are thought to be stronger in Argentina and thus suppress the influence of en-

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vironmental knowledge on ecological behavior.

Keywords: Environmental attitudes, environmental knowledge, conservation (ecological) behavior, cultural comparison, Germany, Argentina

Zusammenfassung

Allgemeines Umweltwissen und ökologische Weltanschauung: kulturübergreifende Prädiktoren für Umweltverhalten? Eine Untersuchung deutscher und argentinischer Studierender

Die vorliegende Studie untersucht den Zusammenhang zwischen einem allgemeinen Umwelteinstellungsmaß (NEP), allgemeinem Umweltwissen (GEK) und allgemeinem ökologischen Verhalten (GEB) in zwei studentischen Stichproben, einer Stichprobe aus Argentinien (N_{Arg} = 85, M_{Alter} = 24.1, 59 % weiblich) und einer aus Deutschland (N_{Deu} = 98, M_{Alter} = 22.5, 51 % weiblich). Im Hinblick auf die ökologische Weltanschauung unterschieden sich die beiden Stichproben nicht. Deutsche Studierende verfügten allerdings über mehr Umweltwissen (d = 1.40) und gaben an, sich häufiger ökologisch bewusst zu verhalten (d = .87). In zwei unabhängigen, hierarchischen Regressionen, bei denen die Variablen Alter und Geschlecht kontrolliert wurden, zeigte sich, dass die allgemeine Umwelteinstellung über beide Stichproben hinweg in etwa denselben Anteil an Varianz im ökologischen Verhalten erklären konnte (5 % bei den deutschen vs. 6 % bei den argentinischen Studierenden). Allgemeines Umweltwissen hingegen klärte einen zusätzlichen Anteil von 24 % der Varianz im ökologischen Verhalten in der deutschen Stichprobe auf, während Umweltwissen in der argentinischen Stichprobe keinen zusätzlichen Varianzanteil aufklären konnte. Es wird angenommen, dass die situativen Einschränkungen in Argentinien stärker sind und so den Einfluss von Umweltwissen auf ökologisches Verhalten unterdrücken.

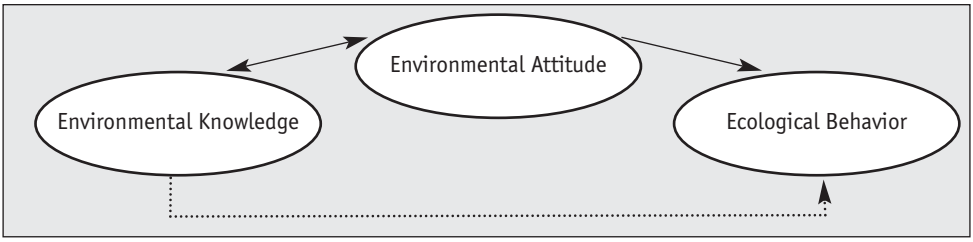
Schlüsselworte: Umwelteinstellung, Umweltwissen, Umweltverhalten, Kulturvergleich, Deutschland, Argentinien

1 An ecology-specific competence model on ecological behavior holding across cultures?

Education for sustainable development is included in the recently announced sustainable development goals (UNESCO, 2014). One intermediary between educational efforts and aspired reduction of collective environmental impact is individual sustainable behavior, evidenced in its consideration as part of the goals (United Nations, 2014). To foster ecological behavior, Kaiser, Roczen, and Bogner (2008) argue for the inclusion of ecology-specific abilities into environmental education instead of concentrating on general competencies, as suggested by other authors (e.g., Fischer & Barth, 2014). Their relative simple model (Roczen, Kaiser & Bogner, 2013) intends to explain the endorsement of a general ecological lifestyle and focuses on the interplay of cognitive aptitudes (i.e., environmental knowledge) and motivational aptitudes (i.e., attitudes on nature). Environmental knowledge is seen as a behaviorally distant variable that forms the base for a positive attitude towards nature, which serves as a motivational force to engage in ecologically responsible lifestyles. For a simplified illustration of their model see Figure 1.

The current study aims at clarifying the comparative importance of these two types of determinants (cognitive and motivational) of ecological behavior in a cultural comparison, instead of trying to exhaustively explain eco-

Figure 1: Simplified Competence Model of Ecological behavior with Distant Role of Knowledge on Behavior



Note: based on competence model by Kaiser, Rozcen and Bogner (2008, fig. 1b)

logical behavior per se. Based on this rationale the study focuses on two variables only (environmental knowledge and attitudes) to explain ecological behavior, which will be, together with ecological behavior, outlined in the following sections.

1.1 Ecological behavior

Within intention-based frameworks, ecological behavior has been defined as behaviors "that consciously seek to minimize the negative impact of one´s action on the natural and built world" (Kollmuss & Agyeman, 2002, p. 240) or behaviors people engage in with the explicit intention to protect the environment (Kaiser & Wilson, 2004). In a broader, impact-based understanding of the concept, all behaviors that leave an impact on the natural environment, whether intended or not, are of interest and are in this conceptualization denominated environmentally significant behaviors (for this account see Steg & Vlek, 2009). In both cases, ecological behaviors span different consumption areas in life such as housing (water or energy consumption), transportation, nutrition and clothing, as well as different consumption phases acquisition, usage and disposal (Geiger, Fischer & Schrader, 2017). Some authors (Kaiser & Wilson, 2004; Corral-Verdugo, 2006) also consider social and vicarious behaviors without a direct, quantifiable impact (e.g., talking to friends about environmental issues). Based on this wide understanding of ecological behavior, Kaiser (1998) developed a self-report scale to measure "General Ecological Behavior" (GEB) comprising six areas of daily consumer behavior: transportation, water and power conservation, ecologically aware purchase choices, ecological waste removal, and avoidance, vicarious model behavior and volunteering in nature protection activities. Rasch-based analyses proved the GEB scale to be a sound, unidimensional measurement of ecological behavior within and across cultures (Kaiser, 1998; Kaiser & Biel, 2000; Kaiser & Wilson, 2000).

1.2 Environmental attitudes

Environmental attitudes or environmental concern are seen as the motivational basis for behaving ecologically (Scheuthle, Frick & Kaiser, 2010). Their positive relationship has been empirically corroborated repeatedly (e.g., Davis, Green & Reed, 2009; Milfont, 2009; Milfont & Duckitt, 2004). In the meta-analysis done by Bamberg and Möser (2007), attitudes emerge as one of three direct predictors of behavioral intention for ecological behavior, although the specific manner of the relation-

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ship has been disputed more recently (Kaiser, Byrka & Hartig, 2010).

In order to differentiate general attitudes and beliefs from more specific attitudes and concerns, the concept of *worldview* has been established (Dunlap, 2008). The most prominent example for assessing a general belief about human mankind and its relation to nature, is the "New Ecological Paradigm" scale (NEP; Dunlap & Van Liere, 1978; Dunlap, Van Liere, Mertig & Jones, 2000). As a general measure, the NEP scale is independent of current environmental problems or specific concerns. It is a widely used instrument in intercultural research. Hawcroft and Milfont (2010) conducted a meta-analysis and analyzed the scale properties of different versions across 69 studies over a period of 30 years, showing that mean values (4.02/ 4.08, Kaiser, Hübner & Bogner, 2005; Schultz, Gouveia, Cameron, Tankha, Schmuck & Franëk, 2005) for the two German samples were close to the Argentinean sample (3.83; Schultz & Zelezny, 1999) and other Latin American nations.

The empirical findings on the relationship of ecological worldview with ecological behavior are heterogeneous. Some results indicate a weak or medium sized relationship between the two (e.g., Corral-Verdugo & Armendáriz, 2000; Davis et al., 2009; Dunlap & Van Liere, 1978), whereas other studies did not find any significant relationship with actual behavior (Poortinga, Steg & Vlek, 2004). There seems to be a gap between ecological worldviews – measured on a general level – and concrete ecological behavior, pointing towards a violation of the correspondence principle: in order to find significant influences of attitudes on behavior, both constructs should be measured on the same level of specificity (Kaiser, Wölfing & Fuhrer, 1999; Preisendörfer, 1997). In the present study, the concept has been chosen because of its general nature and consequently, wide applicability across cultures. We dealt with the correspondence principle in investigating its role in *general* ecological behavior, instead of one specific behavior.

1.3 Environmental knowledge

The transfer of environmentally relevant knowledge to enable people to reflect on their actions rationally and then to act intentionally on this basis has been the dominant model of environmental education (Rost, 1999). And indeed, there is ample evidence that envrionmental knowledge is moderately related to ecoligcal behavior. Hines, Hungerford, and Tomera (1986/87) found in their meta-analysis of 17 studies a mean correlation of $r = .30$, a magnitude corroborated by numerous newer studies (Geiger, Otto & Diaz-Marin, 2014; Kaiser & Frick, 2002; Kaiser & Fuhrer, 2003). There are also studies that report weak correlations (Frick, Kaiser & Wilson, 2004). Bamberg and Möser (2007) took their meta-analyzed finding of a weak relationship between problem awareness (as a type of knowledge) and behavior to reflect a behavioral-distant, indirect role of environmental knowledge on behavior. Accordingly, knowledge is seen as a necessary, however not sufficient, precondition for developing pro-environmental moral norms, attitudes, and subsequent behavior (see Figure 1). Their conclusion of knowledge being a behavior-distant construct is paralleled in the conclusions of other authors (cf. Frick et al., 2004; Schahn & Holzer, 1990). If this conclusion is true, and knowledge is only a distant predictor of behavior exerting its influence via environmental attitudes, no additional influence of knowledge beyond environmental attitude should be observable.

Table 1: Environmentally Relevant Cultural differences

	Argentina	Germany
1. Urbanization rate	92 %	75 %
2. Inhabitants / km²	15.7	231.3
3. Main Environmental Problems	• Monocultures and pesticides • Climate Change • Industrial Waste and Pollution	• Agricultural Nitrate • Noise and exhaust pollution in cities
4. Per capita GHG emissions (2013)	4.47t	9.40t
5. Environmental education	Recent inclusion in public education	Long tradition in different subjects
6. Membership of international political groups	G20	G20 + G8
7. Formation of a Green Party	2012	1980

Note: Sources: CIA Factbook (1,2,6), Wikipedia (4,7), Working groups of Amigos de la tierra Argentina / BUND (3)

1.4 Motivation for an intercultural study and research questions

Systematic cultural comparison research is sparse in environmental psychology (for exceptions see Schultz & Zelezny, 1999; Hawcroft & Milfont, 2010; Kaiser & Biel, 2000) and impeded by measurement difficulties (van de Vijver, 2007). The present study uses instruments that have been validated in the target languages and used in intercultural research before (Geiger et al., 2014; Kaiser & Wilson, 2000; Schultz & Zelezny, 1999).

It compares two countries that differ in various environmentally relevant aspects: the scope of environmental and social problems (Mills-Knapp, Traore, Ericson, Keith, Hanrahan & Cravanos, 2012), the visibility of those in public discourses (Aizen, 2011), but also in the anchorage of environmental education in public education. Germany has a long history of environmental education (for an overview see Michelsen & Fischer, 2015), while Argentina only in recent years included environmental issues in its curricula (e.g., Ministerio de Agua, Ambiente y Servicios Públicos, 2017). Furthermore, from firsthand experience of the first two authors having lived and worked in both countries, infrastructures regarding some ecological behavior were less developed in Argentina in 2012 when the data was taken, e.g., bike lanes or recycling facilities did not exist comprehensively (Secretaria de Ambiente Cordoba, 2017). Regarding general characteristics, Argentina as a Latin American country should be an example for a collectivistic/interdependent cognitive orientation (Corral-Verdugo, Carrus, Bonnes, Moser & Sinha, 2008; Kastanakis & Voyer, 2014), whereas in Germany an individualistic/independent orientation should be more prevalent. For an overview on main environmentally relevant cultural differences, see Table 1.

The two countries compared differ in the scope of environmental and social problems, the visibility of those in public discourses and also in the anchorage of environmental education in public education

Instead of explaining ecological behavior exhaustively, the main aim of the current study was a focused cultural comparison on a restricted set of predictors. In a first step, we descriptively explore cultural differences in this set of predictors.

- *Research question 1a:* Do the samples differ regarding ecological worldview?
- *Research question 1b:* Do the samples differ regarding environmental knowledge?
- *Research question 1c:* Do the samples differ regarding ecological behavior?

In a second step, we want to clarify the incremental influence of environmental knowledge under different cultural circumstances. The results should help to arbitrate between two different positions regarding the role of environmental knowledge as a positive, additional predictor of behavior (cf. Kaiser & Wilson, 2004) vs. a behavioral-distant predictor without any direct influence (cf. Bamberg & Möser, 2007). We were interested in the magnitude of the knowledge effect above and beyond attitude in both cultures.

We descriptively explore cultural differences in a set of predictors and we want to clarify the incremental influence of environmental knowledge under different cultural circumstances

- *Research question 2a:* Does environmental knowledge explain behavioral variance on and beyond environmental attitude?
- *Research question 2b:* Is the amount of explained variance comparable in both cultures?

Both research aims were pursued in a questionnaire study using paralleled student samples in Argentina and Germany.

2 Method

2.1 Participants

Sample criteria. In order to guarantee a comparable level of education, all participants of the present study were students of a nationally accredited university, who were studying an academic subject that lasted at least three years or more. In each country, 140 questionnaires were distributed (as described below). 107 questionnaires were returned in Germany, which represents a response rate of 76 %. Five subjects had to be excluded from analyses because they were not Germans, not a student anymore, or did not provide demographic data, resulting in a German sample of 102 students for analysis. 96 questionnaires were returned in Argentina, representing a response rate of 69 %. Eight had to be excluded from analyses because of nationality being other than Argentinean, not fulfilling the criteria of being a student at a nationally accredited university, or not providing demographic data. Therefore, the Argentinean sample consisted of 88 participants. After data screening for outliers and missing data, the total sample was N_{Arg}= 85 for Argentina and of N_{Ger}= 98 for Germany, respectively.

Sample characteristics. Regarding Age, Gender, and Study Field, both samples are highly comparable. All relevant sample characteristics are summarized in Table 2. In Germany, student samples were from Universities of Heidelberg, Darmstadt, and Mainz; the Argentine sample was from Córdoba, a bigger, but comparable city in terms of nature accessibility.

2.2 Design and procedure

A paper-and-pencil questionnaire study was conducted in Argentina and Germany between July and November 2011. The questionnaire contained a total of 137 items on ecological worldview, environmental knowledge, time perspective[5], and ecological behavior. Participation was voluntary, participants did not receive money. When and where they completed the questionnaire was left up to them with the request to do so without the help of others and without internet use.

Table 2: Demographic Characteristics of Sample for Each Country

	Argentina (N= 85)	Germany (N= 98)
Gender	59 % female	51 % female
Field of study	28 % Psych 19 % Nat. Science 53 % Other	32 % Psych 32 % Nat. Science 36 % Other
Mean Age	24.1 (sd=2.5)	22.5 (sd= 2.2)
Mean Years of Study	4.0 (sd= 1.3)	2.5 (sd= 1.8)
Mean Size of Community[a]	3.5 (sd= 1.1)	2.3 (sd= 1.1)

Note. [a]Question read, "Where did you grow up?, respectively, Where did you spend the major part of your youth?" Response categories were 1 (in the country < 5,000 residents), 2 (in a small size town < 20,000 residents), 3 (in a medium size town < 100,000 residents), 4 (in a big town > 100,000 residents).

2.3 Instruments

Ecological worldview. Ecological worldview was measured with the widely used "New Environmental Paradigm" (NEP) scale in its revised version (Dunlap et al., 2000). Responses were made on a 5-point-Likert scale with answer options coded from (1) *strongly disagree* to (5) *strongly agree*. Data analysis was based on the mean scores of the complete scale (taking into account reverse coding of negatively formulated items). To measure ecological worldview in both languages, two already existing translations of the NEP were used without modifications: the Spanish version by Vozmediano Sanz and Guillén (2005) and the German version that was used by Kaiser et al. (2005).

Environmental knowledge. Environmental knowledge was measured with the "General Environmental Knowledge" (GEK) scale by Geiger et al. (2014) constructed for diagnostic use in South America. The GEK covers the theoretical subscales: *system knowledge, action knowledge*, and *efficiency knowledge* in different behavioral domains. The scale for knowledge assessment contained 36 items, with 12 items for each subscale. Response format was "multiple choice" with five possible answers. For each question, there was only one correct answer resulting in a guessing probability of 20 % per item. For examples of each subscale, please see Table 3.

As instruments, the NEP-scale was used for measuring ecological worldview, the GEK-scale for general environmental knowledge and the GEB-scale for general ecological behavior

Ecological behavior. To measure ecological behavior, the "General Ecological Behavior" (GEB; Kaiser & Wilson, 2000) scale was adapted for the application with students in

Table 3: Example items for three types of knowledge (correct answer in bold).

System Knowledge	Which of the following energy form is not renewable?	Solar energy – Wind energy – Geothermic energy – Hydraulic energy – **Nuclear energy**
Action Knowledge	Which of the following waste products is not compostable?	Egg shell- Fruit left overs – Used Coffee powder – **bones** – Newspaper
Efficiency Knowledge	Which transport medium uses the least energy (per person /km)?	Car – **Overland bus** – City bus – Train – Plane

Argentina and Germany. From the recent version with 50 items (Kaiser et al., 2005), 20 items were selected that appeared to be relevant to young adults in both Germany and Argentina covering the following facets of ecological behavior: ecological waste removal and avoidance, water and power conservation, ecologically conscious consumer behavior, and volunteering in nature protection activities (For the remaining 20 items see Appendix). Participants were asked to indicate how often they perform the given actions. Responses were made on a 5-point-Likert scale with the following options: *never* (0 %), *rarely* (25 %), *sometimes* (50 %), *often* (75 %), or *always* (100 %). Participants were given the option *"Does not apply"* to control for the relevance of the items in both samples. Responses to items were averaged to create a composite index for GEB (in %) with higher scores indicating more frequent ecological behavior. Both language versions – German and Spanish – were taken from the study by Scheuthle et al. (2005) without linguistic adaptation.

2.4 Data preparation and analysis

Mean comparison and regression analyses were done using IBM SPSS 20, IRT-based was conducted with the software ACER ConQuest version 2.0 (Wu, 2007). Before running analyses, NEP, GEK, and GEB of the German (N_{Ger}= 102) and Argentinean (N_{Arg}= 88) samples were checked for missing values, outliers, and fit between their distribution and the assumptions of multivariate analysis (cf. Tabachnick & Fidell, 2007). Analyses were conducted separately for each sample.

Missing values. For six of the twenty GEB items, more than 5 % of the responses – in at least one sample – were "I am not able to answer". We took this to mean that these items were irrelevant for the student sample (e.g., "I wash dirty clothes without prewashing") and excluded them from further analysis. For the remaining 14 GEB items, as well as for the 15 NEP items, the Little's MCAR test indicated that there was no systematic pattern in the remaining missing values (cf. Tabachnick & Fidell, 2007). In two cases of the German sample there were 33.3 % missing values in the knowledge scale because they had skipped complete pages. Both cases were excluded from the initial sample leaving a German sample of N_{Ger}= 100 for the next step.

Outliers, fit between their distribution, and the assumptions of multivariate analysis. Using stem-and-leaf and box plots to determine univariate outliers, three argentine and one German data set were excluded, one further multivariate outlier was excluded in the German sample (due to Mahalanobis distance exceeding $\chi^2(4)$= 18,467), leaving final samples of N_{Ger}= 98 and N_{Arg}= 85 for the main analyses. The variables were also evaluated for multicollinearity and singularity by considering the condition index (below 30 in both samples: Arg: 19.63, Ger: 20.51) and variance proportions (only one variance proportion above threshold of .5 at a time, Arg: .92; Ger: .83). Following suggestions from Belsley, Kuh, and Welsch (1980) we take these results to indicate the absence of singularity and multicollinearity.

IRT modelling of GEK and GEB. As common in IRT models, it was assumed that one single latent dimension underlies the probability of an item-response (Embretson & Reise, 2000). The parameters of interest for the assessment of the item fit are the weighted mean square (*MNSQ*; this parameter should ideally be in the range between .8 and 1.2) and the corresponding *t*-value. If an

item does not fit the model, the *t*-value becomes greater than an absolute value of 2 indicating significance at $\alpha < .05$ (Wu, 2007). Equivalence of measurement instruments in cross-cultural psychology is a crucial aspect for comparability of samples (van de Vijver, 2007) and thus the instruments were evaluated in two steps: Item fits were assessed by first calibrating the scale separately for the German and for the Argentinean sample, and then running the analysis across both samples (N_{total} = 183). It was assumed that if items fit on both levels of analyses – in both samples and for the compound sample – the unidimensionality of the GEK/GEB scales could be assumed and that the mean scores of the GEK/GEB could be compared. An advantage of the Rasch calibration is that the raw sum score provides a sufficient estimator for the person parameter so that if the model fits, the individual sum scores across both samples can be used for comparison. EAP/PV reliability estimates provided by the Conquest program are reported for both scales and can be interpreted as Cronbach's α (for more information, see Rauch & Hartig, 2010; Wu, 2007).

3 Results

3.1 Intercultural measurement: Scale reliability analysis

According to their initial construction, the equivalence assessment of the NEP scale was based on classical reliability estimates. The quality criteria of the adapted GEB short form (14 items) and the GEK scale (36 items) were analyzed based on the Rasch Model of item response theory (IRT; for details on item response theory see, e.g., Embretson & Reise, 2000).

Ecological worldview (NEP). The NEP in this study was treated as a unidimensional construct, yielding a Cronbach's a for the German sample of .78 (*N*= 96) and .68 (*N*= 83) for the Argentinean sample. Item analyses conducted separately for each country showed one zero item-total correlation in Argentina for item 1 ("We are approaching the limit of the number of people the earth can support."). However, to keep scales comparable across both samples, this item was not eliminated.

General environmental knowledge (GEK). The GEK scale (36 items) was calibrated as a dichotomous Rasch model (Rasch, 1960) to assess item fits. For the Argentinean sample, all items fitted a unidimensional knowledge scale ($t < 1.96$, $p > .05$) and EAP/PV reliability was .60. For the German sample, all items fitted a unidimensional knowledge scale ($t < 1.96$, $p > .05$) and the EAP/PV reliability was .58. For the compound sample also all items fitted the 36-items knowledge scale ($t < 1.96$, $p > .05$) and EAP/PV reliability was .62. Consequently, both scores were assumed to be unidimensional *and* comparable. Comparisons were subsequently based on scale means.

General ecological behavior (GEB). The GEB is traditionally analyzed based on a dichotomous Rasch model (e.g., Kaiser & Biel, 2000; Kaiser & Wilson, 2000), but in the present study (14 items), the scale was calibrated using partial credit model analysis (Masters, 1982) accounting for the interval-scaled measurement. For the Argentinean sample, all items fitted the unidimensional behavior scale ($t < 1.96$, $p > .05$) and the EAP/PV reliability estimate was .80.). For the German sample, all items fitted the scale ($t < 1.96$, $p > .05$) and the EAP/PV reliability was .75. For the compound sample, all items fitted the 14-items behavior scale ($t < 1.96$, $p > .05$) and the EAP/PV reliability was .68. Since all the items fitted the GEB scale in

Table 4: Cultural Comparison and Psychometric Properties of the Major Study Variables

	Argentina	Germany	t	d
NEP (worldview) *Cronbach's α*	3.80 (0.48) *.68*	3.78 (.47) *.78*	-.28	-.04
GEK (knowledge) *EAP/PV reliability*	39.05 (9.70) *.60*	52.38 (9.31) *.58*	**9.45****	1.40
GEB (behavior) *EAP/PV reliability*	54.45 (11.56) *.80*	64.16 (10.76) *.75*	**5.88****	0.87

Note: cells contain the mean (sd) of the respective measures (NEP: agreement 1-5, GEK: % correct, GEB: % frequency 0= never – 100= always), in the second row respective measures of internal consistency. The third column reports t-values for independent samples mean difference tests with according effect sizes expressed in Cohen´s d.

both sets of analysis, it was assumed that both scores could be compared and scale means were used for further analysis. Reliability measures for all scales are presented in Table 4.

3.2 Comparison of German and Argentinean students (Research questions 1)

Research questions 1a to 1c concerned differences between the two samples regarding (a) ecological worldview, (b) environmental knowledge, and (c) ecological behavior. To test these hypotheses, independent *t*-Tests of the above named variables were conducted. For an overview of significant mean differences and effect sizes, see Table 4.

Both samples did not differ in ecological worldview; the German sample had more environmental knowledge an reported more ecological behavior

Regarding research question 1a, the Argentine sample (M= 3.80, SD= .48) and German sample (M= 3.78, SD= .47) did *not* differ in ecological worldview, $t(181)$= -.28, $p > .05$. However, regarding research question 1b, on average the German sample (M= 52.4 % correct answers), showed more environmental knowledge than the Argentine sample (M= 39.1 % correct answers), $t(181)$= 9.45, $p < .001$, d= 1.40, yielding a large effect size. Following Kaiser and Biel (2000, see also Geiger, Otto, Diaz-Marin, 2014), we conducted differential item analyses that revealed that for 19 of 36 items, the German students´ hit rates were significantly higher than the Argentineans, while for 1 item it was revers. Table 5 shows the 6 items with the biggest difference in difficulty (5 easier for Germany, 1 for Argentina).

Likewise, answering research question 1c, the German sample reported more ecological behavior (M= 64.16, SD= 10.76, frequency in %) than the Argentinean (M= 54.45, SD= 11.56, in %), $t(181)$= 5.88, $p < .001$, d= .87. Post-hoc comparison of item difficulties revealed, that the samples differed for only 7 of the 14 behaviors (3 environmentally friendly behaviors were more frequent in Germany, while 2 of the 4 more frequent behaviors in Argentina were environmentally detrimental).

Table 5: Item difficulties from GEK (knowledge) and GEB (behavior) items with the biggest differences between countries.

Knowledge items	% correct			Behavioral Items	mean frequency rating (0=never- 4 =always)		
	Arg	Ger	$\chi 2$		Arg	Ger	t
Easier in Germany				*More prevalent in Germany*			
Which of the following actions does not help saving water?	10.4	54.1	38.44	I bring empty bottles to a recycling bin.	0.78	3.57	16.88
Which of the following practices is accepted in ecological agriculture?	43.8	86.7	38.24	I collect and recycle used paper.	1.11	2.90	8.89
What time of the year is the fruit /vegetable imported or grown in greenhouses?*	44.7	86.7	36.49	I prefer to shower rather than to take a bath.	2.54	3.54	5.83
What is the problem with CO_2?	78.8	99.0	19.87				
Which form of consumption is not considered ecological per se?	69.4	93.9	18.88				
Easier in Argentina				*More prevalent in Argentina*			
How many meters would the sea level rise if all the polar ice caps were to melt completely?	34.1	11.2	13.97	I kill insects with a chemical insecticide.	1.86	0.73	-6.35
				I buy fruit and vegetables based upon their seasonality.	3.27	2.56	-5.27
				I read materials about environmental issues.	2.05	1.42	-3.96
				If I am offered a plastic bag in a store, I take it.	2.85	2.25	-3.38

*This item was culturally adapted with according fruits and vegetables for each climate

Note: item difficulty for the dichotomous knowledge items was computed as % of correct answers, for the polytomous behavioral items as the mean observed score, with according difference tests based on 2 or t- values, respectively.

3.3 Prediction of ecological behavior by ecological worldview and environmental knowledge (Research questions 2)

Two independent hierarchical regression analyses, one for each sample, were performed to determine how much of behavioral variance was explained by ecological worldview (NEP) and then, in a second step, how much environmental knowledge (GEK) contributed to improve that prediction for each country. As age and gender have been found to be related to environmental behavior in previous studies, they were entered as control variables into the regression first; followed by NEP second and GEK third. Table 6 displays the standardized regression coefficients (β), the additional variance in GEB explained after each step (ΔR^2), and total explained variance in GEB after step 3 (Total R^2).

For the German sample, R^2 was not significant in step 1 which means that age and gender did not explain any behavioral variance. Ecological worldview was added in step 2 and yielded a R^2 change (ΔR^2_{Ger}) of .05*, meaning that 5 % of the variance in ecological behavior was predicted by ecological worldview. In step 3, environmental knowledge was added to the equation yielding an R^2 change (ΔR^2_{Ger}) of .243**, meaning environmental knowledge explained an additional

24.3 % of the variance in ecological behavior. The total amount of explained variance in the German sample (R^2_{Ger}) is .298, which means that 29.8 % of the variance in ecological behavior in this sample was predicted by ecological worldview and environmental knowledge combined.

For the Argentinean sample, neither gender nor age explained any variance in behavior. Ecological worldview, added in the second step, accounted for 4.6 % of the variance in ecological behavior, (ΔR^2_{Arg}= .046*). Environmental knowledge entered in the third step did not explain any additional variance in ecological behavior, leaving the total amount of explained behavioral variance at *10.7 % (ΔR^2_{Arg}=.107)*. The inclusion of the non-significant knowledge predictor lowered the proportion of explained variance of the NEP predictor. This rare case is possible in hierarchical regressions, where the order of predictors is forced depending on the theoretical assumption that is being tested. In our case, the incremental contribution of knowledge above and beyond attitude was the focus of the cultural comparison, which is why equivalent regressions were performed for both cultures.

4 Discussion

The present study contributes to the understanding of the relationship between environmental attitude, knowledge and ecological behavior in two different cultures. Before turning to particular results, we will first discuss the quality criteria of the measures, followed by the characteristics of German and Argentinean university students in the obtained measures, closing with the differences in predictive powers of environmental knowl-

Table 6: Hierarchical Multiple Regression Analyses Predicting General Ecological Behavior (GEB) from Ecological Worldview (NEP) and General Environmental Knowledge (GEK).

		Argentina		Germany	
Steps	**Predictors**	**β**	**t**	**β**	**t**
Demographic variables (DV)					
	Age	.210	1.89	-.073	-.71
	Gender	-.103	-.93	-.003	-.03
		R^2= .045		*R^2= .005*	
DV + NEP worldview					
	Age	.159	1.42	-.021	-.20
	Gender	-.032	-.28	.021	.20
	NEP worldview	**.227**	**2.02***	**.231**	**2.23***
		R^2= .091 (ΔR^2= .046)*		*R^2= .055 (ΔR^2= .050*)*	
DV + NEP + GEK knowledge					
	Age	.143	1.27	-.063	-.70
	Gender	-.041	-.36	-.152	-1.64
	NEP worldview	.197	1.71	.134	1.46
	GEK knowledge	.133	1.21	**.529**	**5.68**
		R^2= .107 (ΔR^2= .016)		*R^2= .298 (ΔR^2= .243**)*	

edge in ecological behavior in the two samples.

4.1 Quality criteria of measurements in intercultural research

Reliability estimates for the "New Ecological Paradigm" (NEP) scale resulted in being acceptable and comparable to former research (cf. Hawcroft & Milfont, 2010). The low item separability for item 1 in the Argentine sample ("We are approaching the limit of the number of people the earth can support") can be attributed to a cultural characteristic, here the low population density. In a country with vast, nearly uninhabited areas, this item is less likely to express concern about the state of the environment. Regarding the "General Ecological Knowledge" (GEK) scale, when calibrated based on IRT, the reliability estimates for both samples ranged around .60. This result could be caused by the heterogeneity of the items. The scale was designed to tap varying facets from climate change to recycling and participants could know a lot about one topic, but little or nothing about another topic, resulting in a poor overall reliability. Nevertheless, although reliability was modest, the effect sizes obtained were respectable. The reliability of the "General Ecological Behavior" (GEB) scale based on a partial credit model was good and comparable to other studies (Scheuthle et al., 2005). As with all questionnaire studies, self-reported behavior has to be interpreted with caution and should be complemented with observational assessment methods, albeit difficult to implement in an intercultural setting.

4.2 Prevalence differences in Argentinean and German students

In line with former research (Hawcroft & Milfont, 2010) university students in both countries displayed equally high, relative strong pro-ecological worldviews. The present study corroborated levels of ecological worldview obtained in former studies in both cultures, with a fairly similar level for the Argentinean students (3.83; Schultz & Zelezny, 1999), and slightly lower levels (3.78) for the German students (4.02 and 4.08; Kaiser et al., 2005; Schultz et al., 2005). The comparable environmental attitudes of German and Argentinean students are noteworthy given that the two groups face very different life realities, such as different economic situations (reflected in the ratio of income and life costs), employment perspectives, job security, and economic stability of the country, to name just a few.

Regarding ecologically relevant knowledge, there was a large overall culture effect, Argentinean students responded less often correctly than their German counterparts, although the knowledge scale had been initially designed for Latin America. The prevalence of environmental knowledge among the Cordobese university students in our sample was comparable to the prevalence of 40 % found by Geiger et al. (2014) for a sample of the Gran Buenos Aires region. Having a detailed look on the cultural differences on the item level, the six questions where Argentinean students differed most from their German counterparts (See Table 5) were items concerning actions to save water, practices of organic agriculture, the seasonal times of fruit and vegetables, basic knowledge about greenhouse gases and environmentally friendly consumption. Only knowledge about potential sea level rise was more prevalent in Argentinean students. Some of these items reflect culturally dependent knowledge, i.e. the differences can be attributed to circumstances specific to a country, as flat rates payment system for water usage or little dissemination of organic agriculture in Argentina. Sea level

rise might be potentially more threatening to Argentina, with its capital (comprising more than 40 % of the nation´s population) in low laying coastal regions. A more general explanation for the cultural differences observed could lay in the education system. Whereas Argentinean natural science education emphasizes the students´ interest and critical reflection on environmental topics (Ministerio de Educación Ciencia y Tecnología, 2006), German curricula consider basic knowledge about humans and nature necessary for understanding sustainability issues (e.g., Hessisches Kultusministerium, 2012).

With regard to ecological behaviors, students in Argentina reported a lesser frequency than German students did, also implying a large culture effect (d= .87). However, looking at the specific item difficulties, only seven behaviors yielded cultural differences, three of them dealing with waste recycling (returning bottles and paper) or avoidance (using one-way shopping bags). This result highlights the influence of situational constraints for people´s ecological behavior. As there were only few (if any) recycling facilities accessible in Córdoba, Argentina in 2012, people face high behavioral costs for recycling. A further example for culturally dependent behavior is the more frequent use of insecticides, which in the modern agricultural state of Argentina is a widespread practice in general. As generally accessible behavioral options, Argentineans reported to read books, magazines, and/or other sources that deal with environmental problems more frequently and to buy fruit and vegetables based upon their seasonality more often than the German students. The analysis on the item level highlights the importance of considering qualitative differences in intercultural research, in addition to reporting mean differences. For both, knowledge and behavior, the study revealed culturally dependent items, as well as culturally independent ones.

4.3 Prediction of ecological behavior

The hierarchical regression analysis revealed that ecological worldview accounted for a small amount of variance in both countries (5 % and 6 %), corroborating other studies reporting a weak relationship of this general attitude measure and ecological behavior (Corral-Verdugo & Armendáriz, 2000; Dunlap & Van Liere, 1978). This finding adds to the heterogeneous results ranging from no variance (Poortinga et al., 2004) to a medium amount of explained variance (Davis et al., 2009). Instead of explaining ecological behavior as exhaustively as possible, our main focus lays in the cultural comparison and it is noteworthy that despite many situational differences, general attitude explains about the same amount of variance in general ecological behavior in both countries. This result contrasts the role of environmental knowledge that after controlling for attitude as well as age and gender, explained a grand proportion of variance in the German sample only (24 %), while none in the Argentinean sample. What could be the reasons for this difference? An obvious explanation is the presence of further factors that directly affect ecological behavior and thus overrule the influence of knowledge (Kaiser et al., 1999). A prominent example for this are *situational restrictions* that are thought to be stronger in Argentina especially for those behaviors, where the two samples differed most, namely recycling behavior. If there is no possibility to recycle paper and bottles, this will overrule any existing knowledge. Likewise, *economic limitations* could instantiate a further example of a stronger restriction in Argentina, relevant for e.g. the purchase of seasonal fruits, buying frozen and instant meals, etc. Generally

speaking, the results point to a significant role of environmental knowledge as a predictor of behavior, as long it is not overruled by direct restrictive parameters. Interestingly, situational restrictions overruled knowledge more than they overruled attitude, which speaks for the role of attitude in overcoming higher costs of restricted behaviors, an interpretation advocated by Kaiser et al. (2010). The further one has to bring bottles to the recycling facilities, the higher the behavioral costs of recycling, that have to be offset by a stronger pro-environmental attitude.

A further partial explanation for the observed differences is of statistical nature: with a lower level of knowledge, the relationship between knowledge and behavior is harder to detect because of restricted variance (Scheuthle et al., 2010). A weaker relationship between environmental knowledge and behavior in the less knowledgeable sample was also found by Geiger et al. (2014).

4.4 Limitations of the study

Results on the intercultural comparison are influenced by *characteristics of the sample*. Therefore, samples in cross-cultural comparisons should be as similar as possible (van de Vijver, 2007). Although quite comparable (see Table 2), the Argentinean participants were from a bigger city than the German participants were. Since urban residents have been found to be more environmentally concerned than rural residents (Fransson & Gärling, 1999), this could have biased the results.

Response tendencies could have influenced the results one-sidedly as well. McGorry (2000) claims for example – without referring to any empirical findings – that Latin Americans tend to select the extremes of a scale. Van de Vijver and Leung (2000) proposed to check for social desirability in attitudes research to explain possible cross-cultural differences. Especially the behavior measure might be a stronger case of social desirability in Germany, where environmentally sound conduct has become a more widespread social norm than in Argentina. On the other hand, Milfont (2009) could empirically show with a New Zealandean sample that social desirability did not moderate the relationship between ecological worldview and according behavior.

Finally, with regards to the *generalizability* of the results, the study drew convenience samples comprising young, well-educated adults in Argentina and Germany; they are not representative for their respective country. Nevertheless, for the purpose of cross-cultural comparisons and analyses, the similarity of the samples warrants the interpretation of differences in the life circumstances of the two samples without generalizing to the whole country. Prospective research should investigate the general public as well.

The generalizability of the results is restricted by the sample comprising young, well-educated adults in both Argentina and in Germany

5 Conclusions

Since sustainable development is an aspired goal across cultures, cross-cultural research on ecological behavior is a necessary scientific endeavor. The present investigation of students' worldviews, environmental knowledge, and their according influence on successive behavior in two different nations can be seen as a first inventory-taking. The large culture effect in the role of environmental knowledge for actual behavior is attributed to situational restrictions in Argentinean life circumstances preventing knowledge, though existent, to unfold its agency. Situational restrictions are thought to be especially strong in Argentina for those behaviors where cul-

tural differences were the largest, i.e. recycling behaviors. That cultural differences in knowledge and behavior are confined to some aspects of environmental issues, but are not general to all, was revealed in post-hoc analyses of different item functioning. Regardless of situational restrictions, environmental attitudes equally accounted for behavioral variance across cultures, which speaks for their universal role in offsetting behavioral costs. Future research should look further into the roles of environmental knowledge in different cultures and see whether the behavioral degree of freedom in deed moderates the influence of knowledge on behavior.

The large culture effect in the role of environmental knowledge for actual behavior is attributed to situational restrictions in Argentinean life circumstances preventing knowledge, though existent, to unfold its agency

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Endnotes

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5) The results have been presented as a poster at the 1st International Conference on Time Perspective, Coimbra, Portugal: Dombois, Claudia & Geiger, Sonja (2012). *Time perspectives and their relation to ecological worldview – A cross-cultural analysis.*

Appendix

General Ecological Behavior: Selection of 20 items for the current study.

1. I prefer to shower rather than to take a bath.*
2. I buy beverages in cans.*
3. I use an oven cleaning spray to clean my oven.
4. I wait until I have a full load before doing my laundry.
5. When doing the laundry, I forego the pre-wash cycle.
6. If I am offered a plastic bag in a store, I take it.*
7. I collect and recycle used paper.*
8. I bring empty bottles to a recycling bin.*
9. If I notice someone, who is acting in a manner that is ecologically harmful, then I call his or her attention to it.*
10. I buy frozen and/or instant (i.e., processed) meals.*
11. I buy items that come in refillable packaging.*
12. I buy fruit and vegetables based upon their seasonality.*
13. I use the tumble dryer for my laundry.
14. I read about environmental issues.*
15. I talk with friends about problems related to the environment.*
16. I kill insects with a chemical insecticide.*
17. I reuse my shopping bags.*
18. In the winter, I turn down the heat when I leave my house for more than 4 hours.
19. I drive to where I want to start my hikes.
20. In the winter, I leave the windows open for long periods of time to let in fresh air.*

Note: *Items which were a posteriori included in the compound measure for GEB.

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