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Ecological behavior and its environmental consequences: a life cycle assessment of a self-report measure

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Abstract

The environmental impact of individuals, namely, how much they pollute and what resources they consume, is of paramount importance. However, even environmental psychologists rarely study levels of pollution or resource and energy savings. The present paper aims to ecologically validate 52 behaviors of a well-established self-report measure of ecological conduct (i.e. the General Ecological Behavior scale; Kaiser, J. Appl. Social Phychol. 28 (1998) 395, using the items' environmental consequences. Our objective is to contrast a behavior's environmental consequences with the comparable effect of a reasonable alternative. By means of applying data from available Life Cycle Assessment (LCA) literature and databases, two LCA experts were able to compare each of 52 performance pairs' overall environmental impact. None of the 30 presumably ecological behaviors of the scale turned out to be less environmentally effective than its alternative, and none of the 22 unecological behaviors turned out to be more environmentally effective than its alternative. The correspondence between a behavior's environmental consequences and its scale-incorporated, presumed, impact falls between 79% and 100%, both being statistically significant.

1. Introduction

Landscapes turn into dumps, plants and animals become extinct and people sick in a world of noise, trash, and overconsumption; environmental conservation is of preeminent importance (*cf*. Maloney & Ward, 1973). As psychology focuses on behavior, the environmental *consequences* of human conduct represent a somewhat peripheral pursuit for many psychologists, even environmental psychologists. Still, it is this environmental impact that matters, and not conduct *per se* (cf. Stern, 2000a). Behavioral consequences such as levels of pollution, resource savings, and energy quantities, rather than human behavior, should be the prime targets in the environmental domain (*cf*. McKenzie-Mohr, 2000). While some studies actually measure certain environmental consequences, such as the amounts of energy or water consumed (e.g. Hayes & Cone, 1977; Becker, Seligman, Fazio, & Darley, 1981), they implicitly address an array of different behaviors, all of which result in a particular environmental consequence. By skipping behavior and taking the short-cut to environmental consequences, such studies ignore the double nature of human behavior—its subjective and its objective reality (*cf*. Stern, 2000b). By skipping behavior, its subjective reality, the goals that people try to achieve are totally ignored. Not surprisingly, these studies considerably underestimate psychology's significance for the promotion of ecological behavior and they discover that objective, contextual influences, such as season and insulation of homes, rather then subjective, psychological entities, such as values and attitudes, most prominently affect energy consumption and other environmental consequences (see Verhallen & Van Raaij, 1981).

Even when a certain behavior's consequences damage the environment (i.e. a behavior's objective reality), people generally do not intend to do damage (i.e. a behavior's subjective reality); at most, they are accepting the environmental impact as a side effect of some particular behavior. Someone who drives to the grocery store presumably accepts air pollution as a side effect

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while intentionally increasing his or her comfort level and decreasing transit time. It is unlikely that the person wants to pollute the air by using the car. When the environmental consequences of a behavior either go unnoticed or are not taken into account by a person, to what extent can subjective measures, such as environmental concern, values, and attitude, be predictive of whether or not that behavior is performed? Naturally, we expect a person's intention to save time or to increase comfort to be the most predictive. *Behavior cannot be skipped or substituted with its consequences as an outcome criterion in Psychology.* On the contrary, we need behavior measures that are established as unambiguous ('unidimensional'), indicators of people's *subjective* performance (Kaiser, 1998).

When it comes to practical relevance, the accompanying objective consequences of behaviors cannot be neglected either. In other words, behavior measures in the environmental domain have to address issues that go well beyond the quality indicators psychologists commonly use, such as construct, concurrent, predictive, discriminant, and external validity.[1] They have to address the question of a behavior's environmental impact as well (its ecological validity). However, most behaviors produce more than one environmental consequence, and many are barely recognizable or even imperceptible. The present paper's goal is to further validate, through environmental consequences, a well-established, general, self-report measure of ecological behavior. We aim to identify the relationship between 52 self-reported ecological performances and these behaviors' ecological consequences by applying data from available Life Cycle Assessment literature and databases to performance.

2. Measurement of ecological behavior

The vast majority of research uses self-reported, rather than objective, behavior as an outcome measure (Verhallen & Van Raaij, 1981; Oskamp, 1995). Logically, previous research on the validity of ecological behavior measures is primarily about this external validity issue. While some conclude that self-reports of ecological behavior cannot be trusted as proxies for objective behavior (e.g. Corral-Verdugo, 1997), others found self-reported behavior measures to be reasonably accurate indicators of people's ecological performances (e.g. Gamba & Oskamp, 1994), particularly, when self-reported behaviors represent dichotomized practices ('I do' or 'I don't') or circumstances ('I own' or 'I don't'; Hirst & Goeltz, 1985; for additional empirical evidence see Kaiser et al., 2001). Although self-reported measures' external validity remains controversial, self-reports are, nevertheless, indispensable for building conceptually redundant, composite measures that (a) reduce measurement error[2] and (b) produce more generalizable findings (e.g. Epstein, 1983). Aggregation across different behaviors (i.e. using compound measures) is one widely accepted means to achieve these two goals (Epstein, 1983; Kirkpatrick, 1997).

Ecological behavior measures that are traditionally aggregated—based on correlations, factor analyses and, thus, relatively homogenous endorsement probabilities—cannot cope with extremely different endorsement probabilities (see Ferguson, 1941). Thus, traditional approaches commonly fail to establish unambiguous, unidimensional, composite ecological behavior measures (Kaiser, 1998), measures representing only one single entity. Such a measure is achieved if all ecological acts under consideration can be compared purely *quantitatively*, representing more or less of the entity at issue (*cf*. Wright & Master, 1982).

In other words, multidimensional findings (e.g. Leonard-Barton, 1981; Scott & Willits, 1994) are most likely grounded in so-called difficulty factors or similar statistical artifacts, which are presumably caused by different behavior difficulties (*cf*. Ferguson, 1941). Due to the fact that the performance probabilities are too heterogeneous, a person's ecological behavior does not appear to be generalizable across different behavioral domains such as recycling, garbage avoidance, water/power conservation, consumerism, political activism, and car use. Hence, if someone recycles paper, he or she may or may not also conserve energy. Systematically using very different endorsement probabilities—and hence behavior difficulties—in the measurement of ecological behavior necessitates the application of an item response theory model, such as the Rasch model (e.g. Wright & Masters, 1982). The Rasch model distinguishes between behaviors solely on the basis of item difficulty (i.e. the first parameter) and assumes that all behaviors are equally discriminating (i.e. the second parameter). Therefore, within item response theory, the Rasch model represents a one-parameter model (see Embretson & Reise, 2000). By applying the Rasch model, the General Ecological Behavior (GEB) scale represents an achievement test of a person's overall ecological engagement (*cf*. Kaiser, 1998).

The difficulty of an ecological behavior, such as not using fabric softener, is estimated by considering the number of people who behave accordingly. A behavior's difficulty is therefore not based on its self-assessment. It is a function of the proportion of people who perform a particular ecological behavior and it relates to the likelihood that any given person from the sample will behave correspondingly, regardless of his or her general ecological behavior level. If only a few people behave in a certain ecological way (e.g. avoiding fossil fuel use), we are dealing with a difficult type of behavior. The probability is low that anyone would demonstrate this particular behavior. The easier a behavior is to perform, the fewer situational constraints have to be assumed, and the more likely it is that people will perform the behavior.

The difficulties that a person actually overcomes can, in turn, be used to measure a person's general behavior level. Note that this *objective* behavior difficulty should not be confused with its *subjective* assessment. While a subjective behavior difficulty can be inaccurate and is commonly based on a person's need and effort considerations, the number of people performing accordingly sufficiently defines the objective difficulty measure. The more difficult the tasks someone carries out, the more ecologically the person behaves and vice versa. In other words, a person's ecological behavior level is a function of the situational constraints he or she actually ignores. The bigger the barriers and the more numerous the difficulties a person overcomes, the higher his or her ecological behavior is. Conversely, the level of a person's ecological behavior tends to be low when the tiniest difficulties are enough to stop the person from acting ecologically.

We have applied the Rasch model to the measurement of ecological behavior in four independent studies: with German-speaking Swiss (Kaiser, 1998), in California with students (Kaiser & Wilson, 2000), in Sweden (Kaiser & Biel, 2000), and again with Swiss participants (Kaiser & Keller, 2001). Obviously, our research is neither restricted by language nor by any sample particulars. Furthermore, three different sets of behaviors representing the GEB scale were tested ranging from 30 to 65 different ecological performances. We found unanimous evidence that the Rasch model describes these composite measures of overall ecological behavior accurately and, thus, unidimensionally (for fit statistics see Kaiser, 1998; Kaiser & Biel, 2000; Kaiser & Wilson, 2000; Kaiser & Keller, 2001). Generally, our research reveals the GEB scale to be a reasonably reliable behavior measure: Item response theory-based reliability ranges from $r = 0.71$ (Kaiser, 1998) and 0.72 (Kaiser & Biel, 2000; Kaiser & Wilson, 2000) to 0.80 (Kaiser & Gutscher, in press; see also Kaiser & Keller, 2001). Internal consistency indicated by Cronbach's α ranges from $\alpha = 0.72$ (Kaiser & Wilson, 2000), 0.73 (Kaiser & Biel, 2000), and 0.74 (Kaiser, 1998) to 0.81 (Kaiser & Gutscher, in press). Test–retest–reliability information ranges from $r_{tt} = 0.76$ (Kaiser & Wilson, 2000) to 0.83 (Kaiser, Frick, & Stoll-Kleemann, 2001). Evidence for the GEB measure's concurrent and discriminant validity is provided in Kaiser (1998), external validity information can be found in Kaiser et al. (2001), and construct validity information is given in Kaiser, Wölfing and Fuhrer (1999) and Kaiser and Gutscher (in press). As no ecological validity information is available yet, the present paper aims to relate the items of the GEB scale to their environmental consequences by applying life cycle assessment (LCA) data to these performances.

3. Life cycle assessment

In industrialized societies, people's everyday existence heavily depends on the presence of goods and services. Goods and services, in return, require natural resources and energy. Not surprisingly, people's everyday behavior—as it relates to goods and services—also affects the environment in one way or another. LCA is a tool for estimating the overall environmental impact of goods and services (e.g. Heijungs et al., 1992; Goedkoop & Spriensma, 1999). It was developed as an environmental policy support measure in the past decade (e.g. Consoli et al., 1993; International Standardization Organization, 1997). LCA's goal is to compare the environmental impacts of different products and services that satisfy comparable needs. To do so, all stages of the life cycles of goods and services have to be considered, i.e. resource extraction, production, utilization, and disposal. LCA is sometimes referred to as eco-balance, in reference to financial balances. Contrary to economic balances, though, in LCA the energy and resource flows (rather than cash flows) necessary to provide certain services or to produce certain goods are considered.

Any LCA consists of four steps: First, a service or a product has to be defined operationally; second, a list of all the environmentally relevant aspects has to be made; third, the environmental impacts have to be quantified; and fourth, the quantitative findings have to be balanced with respect to the decision at hand. The operational definition of a particular service or a certain product basically means that it must be defined quite precisely, e.g. rather than defining a service as 'using a light bulb', the bulb's service must be described specifically as 'emitting 600 lumen for 10,000 h.' Listing the environmentally relevant aspects of a good or service entails indexing all the pollutants and resources, and calculating the net amounts that are emitted and used throughout the entire life cycle of the product or service, i.e. from production, utilization, to disposal. This indexing/calculating step is often the most time-consuming part of a LCA. Which becomes obvious, for instance, when we consider that the electricity that a light bulb uses has to be traced back through the distribution grid to power plants and their fuel supply channels; moreover, the production and the fates of the filament and the bulb's other components also have to be checked. By quantifying the total energy usage, the resources required (including land), and the pollutants (including noise) emitted throughout the life cycle of a certain good or service, the overall environmental impact is ultimately estimated by its effect on so-called safeguard subjects (i.e. the valuable part of the environment from a largely anthropocentric point of view). The three most common safeguard subjects are resource depletion, human health, and species diversity. All quantification is based on data from the environmental sciences (Hofstetter, 1998). Commonly, LCAs create a fairly comprehensive quantitative synopsis of a product's (or service's) environmental consequences, particularly when a LCA contains as many impact aspects as reasonably possible. In a final analysis, the basic assumptions are revisited and the central ones are acknowledged. The crucial processes and pollutants, the ones that contribute the most to the overall assessment, are identified and, finally, even the neglected but potentially significant environmental consequences, such as endocrine disrupters, are checked to provide a well-informed, most useful input to the decision at hand.

4. Research goals

As many behaviors relate to goods and/or services, LCA can be applied to ecological behaviors as well. The present study aims to compare the presumed environmental impacts of different behavioral alternatives that satisfy comparable needs. Strictly speaking, our objective is to ecologically validate, with available LCA data, 52 ecological behaviors of the most recent version of the GEB scale by contrasting each item's environmental consequences with the environmental achievement of a reasonable alternative.

5. Method

Since we explore the ecological validity of an already developed ecological behavior measure, there are, of course, no human participants or research designs to describe in this study. In the materials and the procedure sections, the behavior measure and the LCA approach are detailed.

5.1. Materials

The most recent version of the GEB scale consists of 65 items that are derived from six domains: energy conservation (behaviors #1–#14; see Table 1), mobility and transportation (#15–#28), waste avoidance (#29–#34), consumerism (#35–#47), recycling (#48–#52), and more vicarious, social behaviors toward conservation (#53–#65).

With 30 GEB items, a yes/no format was used when the behavior relates to one-shot decisions such as the adoption of a fuel-efficient car (i.e. #24). With the remaining 35 items, if behaviors are rather continuously performed, such as commuting (i.e. #28), responses were recoded from a polytomous to a dichotomous response format by collapsing 'never', 'seldom', and 'occasionally' to 'no' and translating 'often' and 'always' as 'yes' responses. Responses to negatively formulated items were appropriately recoded. Contrary to common expectations, prior research shows that the broader Likert response format is overly differential and makes participants' answers more arbitrary and less reliable (see Kaiser & Wilson, 2000). In 56 out of the 65 items, 'I don't know' is a response alternative when an answer is, for what ever reason, not possible, and such responses are coded as missing values. Statistically, ecological behavior is assessed using the dichotomous Rasch model (for item response theory details and formulas, see Wright & Masters, 1982). An example scale calibration and the fit statistics of the current version of the GEB scale can be found in Kaiser and Gutscher (in press).

5.2. Procedure

LCA data relevant for 52 ecological behaviors were screened and considered, using the unanimous judgments of two experts in the field (i.e. the second and the third authors). By applying data from the LCA literature and databases, they were able to estimate each performance's relative overall environmental impact. Of the 65 GEB items, 13 behaviors represent items that are primarily intended to induce others to behave environmentally soundly. However, they have to be seen as indirect rather than direct measures of conservation (e.g. being a role model). These 13 more vicarious, social behaviors toward conservation (#53–#65) were omitted for their environmental impact, because such mediated measures are generally beyond the scope of a LCA.

Because there is no available reference value or absolute standard for environmental soundness, benchmarking is required, i.e. pairs of behaviors had to be compared. For that purpose, a list of alternative behaviors for each GEB item was compiled. Based on some census data, but mostly using common sense, we chose a reasonable alternative for each GEB item (see Table 1). Despite the general lack of appropriate population data, we are confident that the chosen performances are, at least relatively, the most plausible alternatives.

Since general frequency, the necessary appliances, and modes of conduct affect a behavior's environmental outcome considerably, the performance context of any particular behavior pair needs to be specified rigorously. Therefore, each pair was detailed regarding its endorsement frequency and the ways in which it is commonly performed (i.e. its boundary conditions). While a shower compared to a bath has to be seen as being commonly environmentally more favorable, this only applies when both behaviors are performed comparably often and in accordance with average practices. For example: Two baths have a more favorable ecological outcome than

Table 1
Sixty-five ecological and unecological behaviors and their alternatives

	Ecological behavior	Alternative behavior
1.	I use energy-efficient bulbs.	I use conventional or halogen bulbs.
2.	I own energy-efficient household devices.	I own conventional household devices.
3.	I wait until I have a full load before doing my laundry.	I do my laundry whenever it fits my schedule, even when I have no full load.
4.	I wash dirty clothes without prewashing.	I wash dirty clothes with prewashing.
5.	*In hotels, I have the towels changed daily.*	*In hotels, I reuse towels.*
6.	*I use a clothes dryer.*	*I air-dry my laundry.*
7.	I bought solar panels to produce energy.	I use grid electricity.
8.	I use renewable energy sources.	I use grid electricity.
9.	*In the winter, I keep the heat on so that I do not have to wear a sweater.*	*In the winter, I keep the heat to 18°C to 20°C* (i.e. *65° to 68° F).*
10.	*In the winter, I leave the windows open for long periods of time to let in fresh air.*	*In the winter, I air rooms only for short periods of time.*
11.	The heater in my house is shut off late at night.	The heater in my house keeps going strong day and night.
12.	In winter, I turn down the heat when I leave my apartment for more than 4 h.	In winter, I do not turn down the heat when I leave my apartment for more than 4 h.
13.	I prefer to shower rather than to take a bath.	I prefer to take a bath rather than to shower.
14.	*I let water run until it is at the right temperature.*	*With tap water, I do not wait for the right temperature.*
15.	*I drive my car in or into the city.*	*I use public transportation or ride a bike in or into the city.*
16.	I drive on freeways at speeds under 100 kph (=62.5 mph).	I drive on freeways at legally enforced speeds.
17.	*I keep the engine running while waiting in front of a railroad-crossing or in a traffic jam.*	*I switch off the engine while waiting in front of a railroad-crossing or in a traffic jam.*
18.	*At red traffic lights, I keep the engine running.*	*At red traffic lights, I switch off the engine.*
19.	*I drive to where I want to start my hikes.*	*I refrain from driving to where I want to start my hikes.*
20.	I refrain from owning a car.	I own a car.
21.	I am a member of a carpool.	I own a car.
22.	When I need a car, I rent one.	I own a car.
23.	I drive in such a way as to keep my fuel consumption as low as possible.	When I drive, I do not care about my fuel consumption.
24.	I own a fuel-efficient car (less than 7 l per 100 km; i.e. less than 3 gallons per 100 miles).	I own a conventionally efficient car.
25.	*I like ordering take-out from restaurants.*	*I buy convenience foods.*
26.	*For longer journeys (more than 6 h), I take an airplane.*	*For continental journeys within Europe or the US, I take trains or cars.*
	Ecological Behavior	Alternative Behavior
27.	In nearby areas (around 30 km; i.e. 18.75 miles), I use public transportation or ride a bike.	In nearby areas (around 30 km; i.e. 18.75 miles), I use a car.
28.	I ride a bicycle or take public transportation to work or school.	I drive a car to work or school.
29.	I buy milk in returnable bottles.	I buy milk in one-way packaging such as paperboard carton.
30.	*If I am offered a plastic bag in a store, I take it.*	*I bring either my own bag or reuse old shopping bags.*
31.	For shopping, I prefer paper bags to plastic ones.	For shopping, I prefer plastic bags to paper ones.
32.	I reuse my shopping bags.	I take new bags each time I go shopping.
33.	*I buy beverages in cans.*	*I refrain from buying beverages in cans.*
34.	I buy products in refillable packages.	I refrain from products in refillable packages.
35.	*I use fabric softener with my laundry.*	*I refrain from using fabric softener with my laundry.*
36.	*I use an oven cleaning spray to clean my oven.*	*I refrain from using an oven cleaning spray.*
37.	*I kill insects with a chemical insecticide.*	*I kill insects mechanically.*
38.	*I use a chemical air freshener in my bathroom.*	*I refrain from using a chemical air freshener in my bathroom.*
39.	*I use a cleaner made especially for bathrooms, rather than an all-purpose cleaner.*	*I use an all-purpose cleaner, rather than a cleaner made especially for bathrooms.*
40.	I use biologically degradable laundry detergent.	I do not care whether I use biologically degradable laundry detergent.
41.	*I buy convenience foods.*	*I prepare food with fresh groceries.*
42.	I buy seasonal produce.	I do not care about seasons of produce.
43.	I use rechargeable batteries.	I use conventional batteries.
44.	*I buy bleached and tinted toilet paper.*	*I buy unbleached and untinted toilet paper.*
45.	I buy clothing made from all-natural fabrics (e.g. silk, cotton, wool, or linen).	I buy clothing made from synthetic fabrics (e.g. polyester, polyamide).
46.	I buy meat and produce with eco-labels.	I buy conventionally produced meat and produce.
47.	I buy domestically grown wood furniture.	I buy furniture made from tropical wood.

Table 1 (*continued*)

	Ecological behavior	Alternative behavior
48.	I collect and recycle used paper.	I put used paper in the garbage.
49.	I bring empty bottles to a recycling bin.	I put used empty bottles in the garbage.
50.	I use a compost bin.	I do not use compost bins.
51.	*I put dead batteries in the garbage.*	*I return dead batteries.*
52.	*After meals, I dispose of leftovers in the toilet.*	*After meals, I dispose of leftovers in the garbage.*
53.	I unwrap products and dispose of their packaging in the store where I bought them.	—
54.	After a picnic, I leave the place as clean as it was originally.	—
55.	When I do outdoor sports (e.g. hiking, jogging, horseback riding, skiing, biking) I stay within the allowed area.	—
56.	*In nature preserves, I leave designated paths.*	—
57.	*In nature preserves, I let my dog off the leash.*	—
58.	I am a member of an environmental organization.	—
59.	I read about environmental issues.	—
60.	I contribute financially to environmental organizations.	—
61.	I talk with friends about problems related to the environment.	—
62.	I have pointed out to someone his or her unecological behavior.	—
63.	I boycott companies with an unecological background.	—
64.	I have already looked into the pros and cons having a private source of solar power.	—
65.	I requested an estimate on having solar power installed.	—

Note: Items in italic indicate negatively formulated behaviors and their corresponding alternatives; thus, from such an unecological behavior, compared to its alternative, more negative environmental consequences are to be expected.
Darkly shaded pairs indicate behaviors with rather clearly comparable environmental impacts, according to LCA. Lightly shaded pairs indicate performances that *may* have comparable environmental impacts, but these behaviors are most likely in accordance with the item's presupposed environmental achievement (i.e., ecological/more positive or unecological/more negative).

five 20-min showers, but not when the shower practice is more representative.

Unsurprisingly, the boundary conditions of ecological behaviors, such as intensity, frequency, duration, and obligatory appliances, vary from one society to another. Evidently, findings from one societal context cannot easily be generalized to another. For our present analysis, Swiss boundary conditions to people's performances were incorporated, such as average Swiss automobile mileage per year (i.e. 15,000 km). While, strictly speaking, our results only apply to behavior in Switzerland, our main conclusions presumably prevail in other societies in the Western hemisphere or at least in Western and Central Europe. Differential conclusions must be expected, though, for some behavior pairs in other parts of the world. Behavior pairs that are presumed to be sensitive to contexts and the expected deviations from the Swiss performance conditions are highlighted in the appendix.

Of course, any behavior not being performed results in free assets, such as time and money, which could be spent otherwise. For example: By not owning a car, money is freed that can be spent on more extravagant vacations. Obviously, freed assets can lead to additional consumption and new environmental burdens. By contrast, performing one behavior can prevent people from worse behavior, environmentally speaking. These so-called 'trans-behavior' effects are usually not estimated in LCAs. For the 52 behavior pairs under consideration the Ceteris paribus *rule* applies, i.e. the assumption that, except for the behavior and its immediate consequences, everything else remains the same.

The present 52 LCAs are rough quantitative approximations on an ordinal data level (i.e. discriminating between more, similar, or less environmentally beneficial or detrimental behaviors). Given that confidence intervals for the particular LCA data were unavailable, and because the data heavily depend on boundary conditions, we base our interpretations and inferences solely on reliable, conclusive, and robust LCA data (see appendix).

6. Results

The present findings are reported in two sections. First, we detail the key considerations—based on LCA data—for two example GEB items and their alternatives. The first of these example pairs confirms the expectations incorporated in the GEB regarding relative environmental impact. The second example pair disconfirms this expectation and reveals that both a negatively formulated GEB item and its alternative result in comparable environmental consequences. Second, we statistically tested the correspondence between (a) the expectation—incorporated in the GEB—that led to a behavior being labeled either ecological or unecological, and (b) its effective environmental impact as appraised by the LCA.

6.1. Two examples of the environmental impact comparison

The LCA arguments and the detailed reasoning for each contrasted behavior pair can be found in the appendix (behavior/item numbers relate to the figures in Table 1). The first example compares the use of energy-efficient bulbs vs conventional incandescent or halogen bulbs (i.e. #1). As energy-efficient bulbs last about eight times longer and require about five times less power while emitting equal amounts of light, they are considered environmentally advantageous. However, they require slightly more energy for their production and they contain mercury. Mercury can pollute soil, air, and/or groundwater when incinerated or inappropriately discarded. Yet, even if all the mercury was released, this would lead to lower mercury emissions than the heightened power consumption by conventional or halogen bulbs (e.g. Frischknecht et al., 1996), particularly because power production by coal and other fossil fuels also produces mercury emissions. The diminished power consumption during use is found to easily compensate for the additional environmental burdens of energy-efficient bulbs. Thus, using energy-efficient light bulbs was both expected (i.e. in the GEB) and found to be environmentally beneficial by the experts, compared to its alternative.

The second example compares buying beverages in aluminum cans (behavior that is expected to yield environmentally damaging consequences) with refraining from purchasing beverages in such containers (i.e. #33). Alternatively, beverages in glass or polyethylene (PET) containers can be acquired. By reducing the can's weight and by using more and more recycled aluminum, the environmentally damaging impact of aluminum cans has been steadily reduced throughout the 1990s. Now, aluminum cans can environmentally compete with nonreturnable PET as well as returnable and nonreturnable glass bottles in all sizes from 2 to 5 dl; bigger containers, regardless of material, are generally environmentally more advantageous than smaller ones (*cf.* Schmitz, Oels, & Tiedemann, 1995).

The environmental consequences of beverage containers most significantly depend on the amount of recycled materials used, the post-consumption recycling rate, and all the involved transportation distances (cf. Schmitz et al., 1995). Not surprisingly, contextual influences become prominent, such as country size and national recycling policies. In Switzerland, for instance, with relative short transportation distances and moderate to high recycling rates, nonreturnable glass bottles have to be seen as the container with the most damaging environmental impact. All other containers—aluminum cans, nonreturnable PET, and returnable glass bottles—result in fairly comparable environmental consequences. In sum, our LCA findings leave us with a tie: aluminum cans and alternative beverage containers produce similar environmental effects, which is contrary to the GEB's expectation of more detrimental consequences for cans.

6.2. Comparing expected and effective impacts

From the 65 items of the GEB scale, 13 were, as mentioned, omitted from an assessment of their environmental impacts. For the remaining 52 behavior pairs, there was no single GEB item that was contrary to GEB-incorporated expectations. This means that none of the 30 purportedly ecological behaviors turned out to have more damaging, negative environmental consequences than the alternative behavior; and none of the 22 purportedly unecological behaviors (i.e. negatively formulated behaviors) turned out to be more positive than the alternative behavior. In other words, the correspondence between assessed and presumed environmental impact is 100%, a finding that is statistically significant (Kappa (κ) = 1.00, u = 7.2, p < 0.001).

Table 2
Fifty-two behaviors and their relative environmental consequences

		Environmental Consequences		
		More positive	More negative	
Type of Behavior	Ecological (positively worded)	**26**/22 (**50%**/42%)	**4**/8 (**8%**/16%)	**30**/30 (**58%**/58%)
	Unecological (negatively worded)	**2**/3 (**4%**/6%)	**20**/19 (**38%**/36%)	**22**/22 (**42%**/42%)
		28/25 (**54%**/48%)	**24**/27 (**46%**/52%)	**52**/52 (100%)

Note: Bold figures result, when behaviors with indistinguishably comparable environmental impacts, according to LCA, are considered contrary to a behavior's presumed environmental consequences. Roman figures result, when even behaviors with the mere chance of having comparable environmental impacts are considered contrary to a behavior's presumed consequences.

However, when behavior pairs—the GEB item and its designated alternative—with indistinguishably comparable environmental consequences (i.e. ties) are considered contrary to a GEB item's presumed impact, six such pairs become controversial: four ecological (#40, #43, #45, #50) and two unecological ones (#25 and #39). Nevertheless, 88.5% of the behavior pairs reveal environmental consequences in the GEB-incorporated direction; 26 ecological and 20 unecological behavior pairs (see Table 2). Statistically, the relationship between assessed and presumed environmental impact still is significant ($\kappa = 0.77$, $u = 5.5$, $p < 0.001$).

When behavior pairs with the mere chance of having equivalent environmental consequences are considered contrary to a behavior's presumed impact (i.e. including even less plausible ties), five more behaviors do not match the prediction. When a behavior's environmental achievement presumably is in accordance with the GEB-incorporated expectation, but could in some contexts turn out to be indistinguishable from its alternative, four additional ecological behaviors (#29, #31, #34, #47) and one unecological behavior (#33) can be considered controversial. The correspondence between assessed and presumed environmental impact thus drops to 78.8%—including 22 ecological and 19 unecological behavior pairs (see Table 2)—which still is statistically significant ($\kappa = 0.58$, $u = 4.3$, $p < 0.001$).

7. Discussion

The present paper demonstrates the GEB scale's ecological validity. Strictly speaking, our study validates 46 out of 52 ecological behavior items. Hence, it raises questions about six behaviors that should not be used as ecological performance indicators any longer. Applying LCA to 30 supposedly ecological and 22 unecological behaviors yielded a significant correspondence between the GEB item incorporated presumption and its actual environmental effect. Depending on the strictness of what is considered to be a mismatch between LCA data and item definition, the correspondence falls between 79% and 100%, and none of the 52 GEB items tested was contrary to the presumed expectation. Our data reveal that the majority (9 out of 11) of mismatches occurs with either consumption (i.e. consumerism; #39, #40, #43, #45, #47) or with waste avoidance items (#29, #31, #33, #34; see Table 1). By contrast, energy conservation, mobility and transportation, and recycling items were, with only two exceptions (#25, #50), in accordance with the GEB-incorporated expectations. More particularly, some packaging and some of the scrutinized products turned out to be environmentally less divergently than expected. More precise behavioral definitions might readily resolve these mismatches. Because of their broad scope, often the two compared behaviors could not be discriminated sufficiently by the LCA. When it comes to scale development, though, only behaviors with a clear cut, unanimous environmental benefit should remain part of the GEB measure. To our knowledge, this is the first time that a self-report scale that is designed to measure ecological behavior has been validated with respect to the environmental consequences of the behaviors.

Although remarkable, this substantive finding could be challenged because of its somewhat rough quantitative approximations of the available LCA data, and because of its dependence on the Swiss context. We tried to address both of these shortcomings by intentionally striving, at least in this preliminary approach, for a solely ordinal data level in our LCA measure (i.e. identifying more or less environmentally beneficial or detrimental behaviors) rather than attempting a fully fledged LCA of all the behavior items. While ordinal data carry a much higher risk for inconclusive results, ordinal data made it easier for the two LCA experts to appraise each of the 52 behavior pairs' overall environmental impacts and to reach a unanimous agreement. These unanimous judgments are yet another indicator of reliable reasoning. Nevertheless, the ordinal data level of the assessment of a behavior's environmental impact remains an issue that needs to be addressed more thoroughly, particularly because it is the magnitude of the environmental consequences that matters. However, going beyond a rough approximation to a more subtle quantification of people's environmental impacts requires reliable assessments of the intensity and frequency of people's ecological performances, rather than relying on simple yes/no responses. Unfortunately, a more sophisticated response format appears to be a significant methodological challenge for survey research, and that needs to be tackled first (see Kaiser & Wilson, 2000).

Different behaviors can differ markedly in their overall environmental consequences (*cf*. Stern, 2000a). Naturally, some behaviors have a significant impact, while others are almost negligible. For example: A fuel-efficient car contributes significantly more to conservation than driving curtailment does, on average (Gardner & Stern, 1996). Mobility, household energy use, and nutrition appear to be among the more environmentally influential behavior domains, at least in Switzerland (e.g. Jungbluth, 2000). Ideally, in addition to their use in the assessment of subjective behavior, self-reports of people's behaviors could be used to measure people's ecological footprints (*cf*. Oskamp, 2000). Thus, a more rigorous ecological validation of our behavior measures based on LCAs represents a worthy target. Otherwise, the goal of a significant contribution to environmental conservation will remain a remote pursuit for environmental psychologists.

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(1) *Construct validity* refers to a scale's accuracy in measuring a theoretical construct, such as a person's overall ecological behavior (*cf*. Anastasi, 1969; Roscoe, 1975). These data commonly derive from research that replicates—with a newly developed measure—findings in a well-established theoretical framework. *Concurrent or convergent validity* information is derived from a measure's shared variance with a practically relevant criterion or an alternative measure that is already in use. *Predictive* or *criterion validity* refers to a measure's success at predicting a theoretically or practically relevant criterion at a subsequent point in time. Instead of studying a future effect though, already differentially acting groups of people can be compared alternatively (i.e. known group approach). For example, differential ecological performances of Sierra Club and American Rifle Association members could provide some support for such a measure's *discriminant validity* (Roscoe, 1975; for an alternative interpretation of discriminant validity see Rosenthal & Rosnow, 1991). Finally, comparing observable, objective indicators of, for instance, ecological behavior refers to a self-report measure's *external validity.*

(2) According to classical test theory, each measure consists of two components of variance: a substantive or 'true' one and an error component that relates to the unreliability of a measurement instrument (Kirkpatrick, 1997).

Appendix

Due to space limitations, please find the extensive reasoning of the two LCA experts, the second and the third authors, for each contrasted behavior pair at: http://www.tm.tue.nl/mti/appendixJEP/

Note that the behavior/item numbers relate to the figures in Table 1.

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