MEASUREMENT AND DETERMINANTS OF ENVIRONMENTALLY SIGNIFICANT CONSUMER BEHAVIOR

BIRGITTA GATERSLEBEN, *Ph.D., is a research fellow at the Department of Psychology, University of Surrey, United Kingdom. Her main research interests are environmental risk perception, environmental attitudes and behavior, sustainable household consumer behavior, and sustainable transport.*

LINDA STEG, *Ph.D., is a research associate in the Department of Psychology at the University of Groningen, the Netherlands. Her main research interest is in individual and corporate behavior related to sustainable development from a multidisciplinary perspective. Her research projects focus on environmentally significant behavior, energy use, car use, social dilemmas, and corporate responsibility.*

CHARLES VLEK, *Ph.D., is a professor of environmental psychology in the Department of Psychology at University of Groningen, the Netherlands. His main research interests are environmental risk perception, mobility and transport, household energy savings, and sustainable corporate performance.*

ABSTRACT: Measures of proenvironmental behavior in psychological studies do not always reflect the actual environmental impact of a person or household. Therefore, the results of these studies provide little insight into variables that could be helpful in reducing household environmental impact. In this article, an environmentally significant measure of household consumer behavior (i.e., combined direct and indirect energy use) is presented and compared with a common social science measure of proenvironmental behavior (based on popular notions of environmentally significant behavior). Two large-scale field studies were conducted among representative samples of Dutch households. The results showed respondents who indicate they behave more proenvironmentally do not necessarily use less energy. Also, proenvironmental behavior is more strongly related to attitudinal variables, whereas household energy use is primarily related to variables such as income and household size. More multidisciplinary research seems necessary to identify variables that influence the actual environmental impact of household consumer behavior.

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Jan lives in a nice semi-detached house in a small village just outside a medium-sized town in the Netherlands. Jan owns a small car, but he tries to use his bike as much as possible. No matter what the weather is like, he always cycles to work. In his garden, he has a compost bin, and he makes sure that he always separates his glass, chemical, and paper waste. Usually, he buys organic food, and he does not eat meat more than twice a week. He recently replaced his old washing machine with a highly efficient one.

Mark lives in a small flat in the town center. He would like to own a car, but because he cannot park it anywhere, he does not buy one. He does not understand why people worry about the environment. In his view, environmental problems are highly exaggerated. Technological developments have made consumer goods more and more energy efficient and will continue to do so. Mark throws all his waste into the same bin. He prefers to buy frozen food, which he heats up in his microwave oven. Because his second-hand, energy-inefficient washing machine works perfectly well, he has no intention of replacing it.

Who would you believe to be more environmentally friendly, Jan or Mark? From a social scientific point of view, it is likely that Jan would be labeled "more environmentally sound" because he consciously tries to perform proenvironmental behavior. Mark, however, does not care about the environment. But from an impact-oriented definition (see Stern, 1999), Mark's household behavior may be less environmentally damaging because he does not own a car and lives in a small house that requires less energy to heat. And although he does not have an energy-efficient washing machine, his second-hand washing machine is a good example of recycling.

Many social scientific studies have been conducted to examine which people behave more or less environmentally harmful and why. The dependent variable in these studies, environmentally significant behavior, is usually measured via self-reported proenvironmental behavior and sometimes via meter readings. Most social scientific studies use the first type of measure. Although the goal of these studies is not to develop a measure of the actual environmental impact of persons' or households' behavioral pattern, it is often assumed they enable us to make valid distinctions between those who are more and those who are less environmentally harmful. However, this may not always be a valid conclusion. Although the actual environmental impact of people who indicate they behave more proenvironmentally is likely to be somewhat lower, common social science measures of proenvironmental behavior (based on popular notions of environmentally significant behavior) are often only weakly related to the actual environmental impact of people's behavior (Olson, 1981; Stern, 1999).

MEASURING PROENVIRONMENTAL BEHAVIOUR

In environmental psychology, common measures of proenvironmental behavior are based on a list of proenvironmental behaviors usually developed by the researcher. Respondents are provided with such a list, and they are asked to indicate how often (*never* to *always*) they perform each of these behaviors. Whereas some studies focus on one specific type of behavior, such as recycling (e.g., Guagnano, Stern, & Dietz, 1995; Porter, Leeming, & Dwyer, 1995; Schultz & Oskamp, 1996), transport (Steg & Vlek, 1997; Van Lange, Van Vugt, Meertens, & Ruiter, 1998), or political behavior (e.g., signing petitions, supporting an environmental organization; Cameron, Brown, & Chapman, 1998; Stern, Dietz, Kalof, & Guagnano, 1995), other scientists develop scales that combine different types of behavior (e.g., Berger, 1997; Kaiser, 1998; Karp, 1996; McKenzie-Mohr, Nemiroff, Beers, & Desmarais, 1995; Painter, Semenik, & Belk, 1983; Pelletier, Tuson, Green-Demers, Noels, & Beaton, 1998; Whitherspoon & Martin, 1992). By means of statistical techniques such as factor analysis and reliability analysis, researchers try to develop one or more scales of proenvironmental behavior.

According to Stern, Dietz, Ruttan, Socolow, and Sweeney (1997), many studies focus on relatively uninteresting variables from an environmental point of view, that is, behaviors that have only a small effect on energy or materials use. These are behaviors such as refusing plastic bags in shops or buying recycled paper. Consequently, an important disadvantage of common social science measures of proenvironmental behavior is that they focus on behaviors that do not significantly contribute to environmental problems; that is, they do not reflect the actual (lower) environmental impact of persons or households. Therefore, studies based on these measures provide little insight into the variables that could be helpful in significantly reducing the environmental impact of households.

Olson (1981) stated that four factors can lead to large discrepancies between such self-reported actions and the environmental impact of consumption patterns, for example, actual (energy) savings (or energy use). First, respondents may not give accurate reports of their behavior. Self-reported behavior reflects perceptions or beliefs about people's own behavior rather than their actual behavior. Factors such as social desirability and other types of (conscious or unconscious) response bias may result in inaccurate reports of actual behavior. Several studies, however, suggest that the difference between self-reported behavior and actual behavior is not systematic (Fuijii, Hennesy, & Mak, 1985; Warriner, McDougall, & Claxton, 1984). Moreover, in a study on proenvironmental behavior, Kaiser, Wölfing, and

Fuhrer (1999) showed that people are only marginally tempted to give socially desirable answers.

A second reason why discrepancies can be found between self-reported actions and the environmental impact of consumption patterns is related to environmental awareness (e.g., Baird & Brier, 1981). People may not always be aware of the environmental consequences (or energy use) of their behavior and therefore unknowingly perform actions that increase or decrease their energy use. It is therefore important to educate people about the actual environmental impact of their behavior.

The third reason why self-reports do not always reflect actual environmental impact is related to the way scales of proenvironmental behavior are usually constructed. Respondents reporting a large number of small conservation actions often receive a high score on an action index, although such actions may only have a marginal environmental impact or result in little energy savings.

Finally, Olson (1981) stated that when researchers sum self-reported proenvironmental behaviors into indices without taking into account differences in their environmental impact, such as their energy-saving potential, unrealistic scales may be constructed. Obviously, a household cannot be called *more environmentally sound* when it performs three rather than two of five behaviors when those two behaviors have a much higher environmental impact than the other three. Similarly, Jan cannot be called more environmentally friendly than Mark simply because he consciously performs several behaviors he knows are environmentally sound.

At this moment, little is known about the relationship between psychological variables such as environmental attitudes and the actual environmental impact of a household because not many studies focus on environmentally significant behavioral measures. Various studies did show that different types of environmentally significant behavior are related to different motivational variables (Black, Stern, & Elworth, 1985; McKenzie-Mohr et al., 1995). For instance, changing personal norms and attitudes is more effective for changing simple, repetitive, low-cost (effort and money as well as time) energy-saving behaviors such as temperature setting, whereas financial strategies have more impact on long-term choices and are more effective for changing high-cost behaviors such as car use (Black et al., 1985; Heberlein & Warriner, 1983; Stern, 1992). Most studies find that environmental attitudes are more strongly related to behaviors that do not have a high impact on people's daily lives (e.g., waste management, political behavior, food purchase; Grunert & Juhl, 1995; McKenzie-Mohr et al., 1995) than to behaviors with a high psychological and financial impact (e.g., transport and energy use; McKenzie-

Mohr et al., 1995; Painter et al., 1983). This can be problematic if the latter are exactly those behaviors that have a high environmental impact.

The ultimate goal of conservation programs, of which much of the research on proenvironmental behavior is part, is not only to induce people to take any conservation actions but also to actually reduce their environmental impact (Olson, 1981). If the final goal of psychological studies on environmentally significant behavior is to support discussions and policy making on environmental issues, it is necessary to develop and investigate environmentally significant measures of consumer behavior.

A (dependent) variable of environmentally significant behavior that does measure the actual environmental impact of household behavior is meter reading. In the 1980s, many such studies were conducted. Data on a household's gas, electricity, or water use were gathered by reading the relevant meters or studying records (e.g., Katzev & Johnson, 1984; Winett, Leckliter, Chinn, Stahl, & Love, 1985). A problem with these measures is that the relationship between people's actual behavior and the environmental impact (i.e., the energy use) of that behavior is not very clear. It is difficult to determine which behavioral changes result in which savings and which specific individual within a household is responsible for these savings. From an educational point of view, this may be problematic because people cannot receive clear feedback on the results of their behavior changes. These measures are also limited to the environmental impact related to the direct use of energy (or water) within a household and do not consider the environmental impact related to buying and disposing of goods, which requires energy use in the manufacturing process.

In this article, we try to address the problems previously described. In two large field studies among Dutch households, two different measures of environmentally significant consumer behavior are compared. How both measures are related to several behavior determinants–that is, environmental attitudes and beliefs and demographic variables such as income, age, and household type–is examined. One measure is based on psychological principles; that is, a (statistically reliable) scale was created on the basis of a number of questionnaire items asking respondents how often (on 5-point *never* to *always* scales) they perform certain environmentally sound consumer behaviors. The behaviors included in this measure do not significantly contribute to energy savings. The second scale was developed on the basis of environmental science principles. Respondents were asked which household goods they possess and how often they use these goods (times per day, month, and year). Responses were weighted by the average energy use that is involved with such behavior, and scores were added to form one measure of household energy use.

ENVIRONMENTALLY SIGNIFICANT MEASURE OF CONSUMER BEHAVIOUR

The direct and indirect use of energy related to household consumer behavior is used as an indicator of the environmental impact of that behavior (see Kramer, Wiersma, Gatersleben, Noorman, & Biesiot, 1998). Direct energy use refers to the natural gas, electricity, and car fuel that are used directly by households. Indirect energy use is the amount of energy that is used by the relevant production sector to produce and deliver goods (e.g., food) or services (e.g., public transport) to consumers. According to Dürr (1994), energy use is a good indicator of the environmental impact of human behavior. (Fossil) energy use not only is related to the exhaustion of resources but is also one of the major causes of air pollution due to the burning of fossil fuel (coal, petroleum, and natural gas). Dürr stated that there are enough natural resources available in the earth's crust to last us a long time, although at higher costs because the extraction will become more complicated. The main threat to survival, however, is not a shortage of fuel but rather "the general stress inflicted on the environment by the extreme intensity and acceleration of the anthropogenetic energy transformation processes" (Dürr, 1994, p. 50).

A system inventory and analysis revealed that in the Netherlands, about 45% of the total energy use by households involves direct energy use; 55% involves indirect energy use (Kramer et al., 1994; Noorman & Schoot Uiterkamp, 1998). The total average energy demand per household in the Netherlands in 1995 was 228.9 GJ,[1] of which 111.8 GJ were direct and 117.1 GJ were indirect energy use. About 25% of the direct energy use was for heating, about 13% was for transport, and about 12% was for electricity (Vringer & Blok, 1997; see also Vringer & Blok, 1995).

In this article, we measure the direct and indirect energy use of individual households on the basis of their possession and use of various household goods.[2] Unfortunately, such a measure does not describe 100% of a households' direct and indirect energy use because this would require that questionnaires include detailed questions about the possession and use of all possible consumer goods in Dutch households. Moreover, variations in energy use of specific household goods depends on many factors, such as type and age of the goods, frequency and intensity of use, and maintenance of the goods. In another study by Gatersleben (2000, 2001) in which a similar measure was used, a correlation of .45 was found between estimated and actual gas use (as indicated on the respondents' gas and electricity bill), which means that 20% of the variance in gas use was measured. Actual and estimated electricity use correlated at .51, which means that 26% of the variance in actual electricity use was measured. These correlations are not high

because only a limited number of consumer behaviors could be addressed and because the estimated energy use measure is based on the average energy use of different products, services, and behaviors. Furthermore, the measure is based on self-reported behavior. However, this could be less of a problem than for common measures of self-reported proenvironmental behavior because response options are much more specific than usual *never* to *always* questions. For the purpose of the study, it was decided that the measure provides a satisfactory indicator of the environmental impact of a household.

TWO STUDIES

Two large field studies were conducted to examine the relationship between—and determinants of—two different measures of environmentally significant household consumer behavior. Whether households of people who indicate they perform more proenvironmental behavior actually have a lower environmental impact (i.e., a lower energy use) is examined. Moreover, to what extent proenvironmental behavior and household energy use are influenced by environmental attitudes and demographic variables (i.e., income, age, household size, and level of education) is studied. Study 1 describes the results of a field study among 2,167 randomly selected households in the Netherlands. In Study 2, 1,250 households were surveyed. Both studies address the same research questions. The main differences between the studies lie in the measurement of variables.

STUDY 1

Study 1 aimed to examine to what extent the Dutch population behaves in an environmentally sound way and whether people are consistent in their behavior toward the environment as well as to detect important antecedents of environmentally significant behavior (see Steg, 1999).

SELECTION OF RESPONDENTS

In 1995, a written questionnaire was sent to 4,000 households in the Netherlands. The questionnaire was accompanied by a cover letter informing potential respondents about the goal of the study and by a Dutch national lottery ticket worth five Dutch guilders. A total of 2,167 respondents completed and returned the questionnaire (a response of 54%). The sample was not completely representative of the Dutch population: Only 37% of the respondents

were women. However, because the questionnaire mainly addressed household behavior, this should not be too much of a problem. Moreover, compared with a representative sample of the Dutch adult population (Central Bureau for Statistics, 1995), respondents aged 20 to 44 years old were somewhat overrepresented. The mean age was 48.2 (*SD* = 16.3). The mean household income was Dfl 3,350 (*SD* = 1555; in mid 1997, Dfl 100 = US$51 = £31). About 21% of the respondents lived alone, 37% lived with one other person, and 41% shared their household with two or more other people. The level of education in the sample was slightly higher than the average level of education of Dutch households in 1995 (see Steg, 1999).

MATERIAL: THE QUESTIONNAIRE

Respondents were asked to indicate how often they performed various proenvironmental behaviors, such as recycling paint, purchasing biological dairy products, and applying home insulation (see Steg, 1999, for a detailed overview). Other behavior questions addressed the possession and use of household goods (i.e., the possession of a car, freezer, dishwasher, or microwave oven and the use of a bath, central heating, and car). These were used to compute the total energy use of households. Furthermore, questions were asked on antecedents of household behavior: people's motivations (e.g., environmental awareness) and their perceived opportunities (e.g., availability of recycling facilities or environmentally sound products) and abilities (e.g., income, time pressure) to perform these behaviors (e.g., Gatersleben & Vlek, 1998). Here, we will focus on the relationships between environmental attitudes and demographics (i.e., income, household composition, level of education, and age) and proenvironmental behavior and energy use.

MEASUREMENT OF VARIABLES

Household energy use. In this study, we estimated direct energy use for home heating, bathing, using appliances (i.e., freezer, dishwasher, microwave oven, and tumble drier), and using cars. Indirect energy use was estimated for car possession, use of public transport, and holiday transportation. The appendix gives an overview of the calculation method used. Many of the use questions in this study were measured on interval scales and not on a ratio level (as was done in Study 2). For instance, respondents did not indicate the exact kilometers by car or public transport, but response categories were presented (i.e., less than 10,000 kms per car or 50 to 100 kms by public transport). Therefore, some adjustments were made to translate the behavior

questions into energy use numbers (see the appendix). The total energy use of the respondents' households was 140 GJ, on average, of which 116.1 GJ were direct (*SD* = 60.5) and 23.0 GJ were indirect (*SD* = 34.4). This is 61% of the mean total energy use of a Dutch household in 1995. More than 100% of the total direct energy use was measured, which indicates that there is an overrepresentation of energy-intensive households. Nearly 20% of the indirect energy use was measured.

Proenvironmental behavior. Respondents were asked to report how often they performed 33 proenvironmental behaviors. These were behaviors such as recycling paint, spray cans, and batteries; purchasing environmentally sound food products (e.g., unsprayed food and vegetables, biological dairies); applying energy-saving measures (e.g., insulation, water-saving shower head); using cars and water; and refusing plastic bags (see Steg, 1999, for an extensive overview). Some variables were recoded so as to make all scores vary from 1 (*never*) to 5 (*always*).

Environmental attitudes and beliefs. Environmental awareness was measured by means of a 12-item scale (Steg, 1999). Respondents indicated to what extent they were concerned about environmental problems, that is, "Environmental pollution affects my health"; "Environmental problems have consequences for my life"; "I worry about environmental problems"; "I can see with my own eyes that the environment is deteriorating"; "Environmental problems are a risk for the future of my children"; "Environmental problems are exaggerated"; "Too much attention is paid to environmental problems"; "The attention given to the greenhouse effect is exaggerated"; "Saving threatened species is unnecessary luxury"; "I am optimistic about the environmental quality in the future"; "A better environment starts with myself"; and "People who do not take the environment into account try to escape their responsibility." Each item was scored on a 5-point scale ranging from 1 (*totally disagree*) to 5 (*totally agree*). One scale was created measuring the respondents' average environmental awareness. The internal consistency (Cronbach's alpha) of this scale was .84. On average, environmental awareness in the Netherlands was high (*M* = 3.7, on a scale ranging from 1 (*low awareness*) to 5 (*high awareness*).

RESULTS

Below, we first examine the respondents' self-reported proenvironmental behavior and its relationship to household energy use. Next, which variables

best explain self-reported proenvironmental behavior and which variables best explain household energy use are examined.

Proenvironmental behavior. An explanatory principle components analysis (PCA) was used to identify the underlying dimensions that explain the reported frequency of proenvironmental behaviors. To interpret the factors, a Varimax rotation was applied. The analysis on 33 proenvironmental behavior items, including the items used to measure household energy use, revealed that a solution with six factors (with eigenvalues greater than 1) yielded clearly interpretable results. The six factors explained (a modest) 34% of the total variance (see Steg, 1999, for a detailed overview). All factors had eigenvalues higher than 1.9. The first factor explained 7.7% of the variance and referred to recycling behavior (i.e., paint, turpentine, spray cans, energy-saving light bulbs, cosmetics, batteries, and medicines). The second factor explained 6.5% of the variance and described the purchasing of environmentally benign food products (i.e., unsprayed food and vegetables, biological dairy products, eco-potatoes, free-range meat, milk in glass bottles, recycled paper, less meat consumption, and health food store shopping). The third factor explained 5.5% of the variance and referred to the possession and use of household goods (i.e., home heating and possession of freezer, microwave oven, and dishwasher). Factor 4 explained 5.1% of the variance and described the possession and use of a car. Factor 5 explained 4.6% of the variance and distinguished respondents who applied many or few energy-saving and water-saving devices. The last factor referred to purchasing environmentally sound products, refusing plastic bags, and bathing. This factor explained 4.4% of the variance.

Two scales were constructed on the basis of the first two factors of the PCA by computing the mean score of each respondent on the variables with a factor loading of .35 or more or –.35 or less on each of the factors. These scales were Recycling (scores vary from 1 = *never recycle* to 4 = *always recycle*; M = 2.8; Cronbach's alpha = .72) and Purchase of Environmentally Benign Food Products (scores could vary from 1 = *never buy environmentally benign food* to 5 = *always buy environmentally benign food*; M = 2.0; Cronbach's alpha = .75). No reliable scales could be constructed for the variables that correlated highly on factors 5 and 6. No scales were constructed on the basis of factors 3 and 4 because variables with high loadings on these factors were used to construct the measure of household energy use (see the appendix).

Next, the relationship was examined between the respondents' self-reported proenvironmental behavior and their estimated energy use. Table 1 reveals that household energy use is negatively related to recycling (r = –.24,

TABLE 1
Correlations Between Behavior Variables

	Mean	*Energy Use*	*Waste Management*
Energy use	140		
Waste management	2.8	–.24*	
		n = 1704	
Environmentally conscious food	2.0	–.04	.18*
		n = 1823	*n* = 1926

*$p < .01$.

$p < .01$) but not related to the purchase of environmentally benign food products. It appeared that respondents who recycle more also possess and use slightly fewer consumer goods (which results in slightly lower household energy use).

Antecedents of proenvironmental behaviors and energy use. Table 2 shows the results of a multiple regression analysis in which the purchase of environmentally benign food was regressed on four demographic variables (household income, household size, level of education, and age) and one attitudinal variable (environmental awareness). Only 12% of the variance in the purchase of environmentally benign food could be explained. Environmental awareness appeared to be the strongest predictor; the higher respondents' environmental awareness, the more often they said they buy environmentally benign food products. Moreover, older respondents and higher educated respondents more often said they buy environmentally friendly food. Income and household composition appeared not to be significantly related to the purchase of food products.

Table 3 reveals that the four demographic variables and environmental awareness explained only 9% of the variance in recycling. Especially older respondents and respondents having a higher environmental awareness reported more recycling. Income was also moderately related to recycling, whereas educational level and household composition were not significantly related to the extent to which households said they recycled.

Table 4 shows the results for the regression analysis, with total energy use of households as the dependent variable.[3] In total, 42% of the variance in energy use could be explained by the demographic variables and environmental awareness. Energy use appeared to be most strongly related to household characteristics, especially income. Respondents with a higher income and larger households used more energy compared with low income and smaller households. Environmental awareness did not matter much, whereas educational level was not significantly related to energy use.

TABLE 2
Variables Influencing the Purchase of Environmentally Conscious Food Products

	B	*Standard Error*	*Beta*	t	*Significance*
Constant	0.18	.14		1.29	.20
Household size	–0.01	.01	–.03	–1.1	.28
Age	0.00	.00	.09	3.9	.00
Income	–0.00	.00	–.05	–1.9	.06
Level of education	0.04	.01	.11	4.1	.00
Environmental awareness	0.41	.03	.31	13.61	.01

NOTE: All variables were entered simultaneously into the equation. R^2 = .12; adjusted R^2 = .12; $F(5, 1{,}723) = 46.04$; $p < .001$.

TABLE 3
Variables Influencing Recycling

	B	*Standard Error*	*Beta*	t	*Significance*
Constant	2.08	.09		23.06	.00
Household size	–0.00	.01	–.01	–0.50	.62
Age	0.01	.00	.21	8.03	.00
Income	–0.00	.00	–.12	–4.14	.00
Level of education	0.00	.01	.00	0.11	.91
Environmental awareness	1.15	.02	.19	7.93	.00

NOTE: All variables were entered simultaneously into the equation. R^2 = .09; adjusted R^2 = .09; $F(5, 1587) = 31.90$; $p < .001$.

TABLE 4
Variables Influencing Household Energy Use

	B	*Standard Error*	*Beta*	t	*Significance*
Constant	4.75	.08		58.81	.00
Household size	0.09	.02	.22	10.97	.00
Age	–0.00	.00	–.18	–9.08	.00
Income	0.00	.00	.53	23.44	.00
Level of education	–0.00	.01	–.03	–1.41	.16
Environmental awareness	–0.12	.02	–.13	–6.56	.00

NOTE: All variables were entered simultaneously into the equation. R^2 = .43; adjusted R^2 = .42; $F(5, 1{,}569) = 232.59$; $p < .001$.

It can be concluded that self-reported proenvironmental behavior and household energy use are two different constructs that are related to different motivational variables and demographics. Proenvironmental attitudes and beliefs appeared to be better predictors of proenvironmental behavior than of household energy use, whereas household energy use was better predicted by variables such as income and household size. However, there did appear to be a weak relationship between the two dependent variables. It was shown that respondents who said they recycle more also used less energy in their households. To verify these results, the environmentally significant measure of household behavior was applied to another study among Dutch households. The main difference between the two studies lies in the measurement of variables and the method of analysis. In the second study, to what extent respondents are aware of the environmental impact of their household energy use is also examined. As mentioned in the introduction, it is possible that proenvironmental attitudes are more strongly related to self-reported proenvironmental behavior than to household energy use because people are less aware of the environmental impact of household energy use than they are of behaviors such as recycling or purchasing biological food products (Baird & Brier, 1981; Gatersleben, 2000).

STUDY 2

In Study 2, data from a survey among 1,250 Dutch households on consumer behavior and quality of life were used to examine the research questions. For an extensive description of the study, see Gatersleben and Vlek (1998) and Gatersleben (2000).

SELECTION OF RESPONDENTS

About 3,000 addresses were randomly selected from the Dutch telephone directory. In May 1996, a written questionnaire was sent to each of these households. The questionnaire was accompanied by a cover letter informing the respondents about the goal of the study and promising them a gift voucher of 20 Dutch guilders if they returned the completed questionnaire. A total of 1,250 respondents returned the completed survey (a response of 42%), of which 50% were female. The mean age of the respondents was 46 (SD = 14.70). The average net monthly income of the respondents was 4.0 (Dfl 3,000-4,000; SD = 1.47) on a 7-point scale (1 = less than Dfl 1,000, 2 = Dfl 1-2,000, . . . , 7 = more than Dfl 6,000; in mid 1997, Dfl100 = US$51 = £31).

The average level of education was 4.4 on an 8-point scale (1 = primary school; 2 = secondary school, low vocational education; 3 = lower general; 4 = intermediate technological or vocational; 5 = higher general; 6 = preuniversity; 7 = high vocational; 8 = university). The sample was not completely representative of the Dutch population. The average monthly net income in 1996 was lower than in the study sample (Dfl 2,731; Central Bureau for Statistics, 1996). Respondents ages 40 to 64 years old were overrepresented. In the study sample, there were more families with children and less one-person households than in the national sample. The level of education in the sample was slightly higher than the average level of education of Dutch households in 1996.

MATERIAL: THE QUESTIONNAIRE

The questionnaire used consisted of 15 parts (see Gatersleben, 2000, for an overview of the complete questionnaire). Not all parts of the questionnaire are of interest for this article. Parts A (investigating the aspects that are important to people's quality of life), C (examining the perceived necessity of a set of household goods), M (willingness to change environmentally harmful behavior), and N (cultural perspectives) are discussed elsewhere (see Gatersleben, 2000; Gatersleben & Vlek, 1997). In Part B of the questionnaire, respondents were asked how many of each of 44 household goods they possessed (e.g., tumble driers, dishwashers, cars). In Part D, they were asked which of 13 proenvironmental behaviors they performed (e.g., recycling, eating wholesome food). In Parts E through K, they were asked several questions on the use of household goods (e.g., "How many times per week do you use the washing machine?" and "How many times per week do you and other members of your household take a shower and/or a bath?"). For a representative coverage of household consumption, questions were asked on home heating, preparation and storage of food, washing laundry, bathing, audiovisual entertainment, transportation, and holidays. In Part L, respondents were asked to evaluate the environmental impact of their own behavior related to those consumption categories and compared with that of other households. In Part N, they were asked four general questions on their attitude toward proenvironmental behavior. Part O focused on demographics.

MEASUREMENT OF VARIABLES

Household energy use. The answers to the questions in Parts B and E through K were used to estimate each household's direct and indirect energy use. Direct energy use was estimated for home heating, food storage and

preparation, washing, bathing, using television and video, and using a car. Indirect energy use was estimated for car possession and holidays. The appendix describes the methodology in more detail. Not all questionnaire items of the survey were used to measure household energy use because there was not enough environmental data available on the energy use involved in various activities. The average total amount of energy use of the respondents was 152.4 GJ (*SD* = 84.23), of which 120.8 GJ (*SD* = 66.9) is direct and 31.6 GJ (*SD* = 39.2) is indirect. As was said before, the total average energy use of a Dutch household in 1995 was 229 GJ, about 117.1 GJ indirect and about 111.8 GJ direct. This means that direct energy use was measured reasonably well. The fact that the average direct energy use was higher in our sample may be caused by the overrepresentation of larger households and higher income groups. About 28% of the average indirect energy use of Dutch households appeared to be measured (or possibly slightly less because high-income, energy-intensive households are overrepresented).

Proenvironmental behavior. In Part D, respondents were asked to report how often they performed 13 proenvironmental behaviors on a 5-point scale (1 = *never*, 5 = *always*). The following items were included: bring your own shopping bag, buy at a health food store, separate glass waste, separate compost waste, separate chemical waste, buy brown toilet paper, buy brown coffee filters, turn down thermostat 30 minutes before going to sleep, travel short distances by bike, do not use half-full washing machine, do not leave tap water running, do not leave audio and video on stand-by, and eat vegetarian and wholesome food.

Awareness of environmental impact. Respondents were asked to indicate on a 5-point scale (1 = *very low*, 5 = *very high*) how environmentally harmful they believed their consumer behavior was compared to that of other Dutch households. Respondents were asked to do this for the way they heated their homes, the way they washed and dried their laundry, the way they and other members of their households bathed themselves, the way they prepared and stored food, their television set and video recorder use, their car use, and their holidays.

Environmental beliefs. In Part N, respondents were asked to indicate to what extent they agreed with a number of statements on societal and environmental problems on a 5-point scale (1 = *totally disagree*, 5 = *totally agree*). This list included four items on proenvironmental beliefs: "People will not change their behavior unless shops sell more environmentally friendly products," "People will not change their behavior unless the government gives the

TABLE 5
Relationship Between the Perceived and Actual Environmental Impact of Household Consumption for Eight Consumption Categories

	Perceived Environmental Impact[a]	*Energy Use*	*Correlation*	n
Home heating	2.7	46.8	.14**	1226
Washing	2.9	7.2	.14**	1223
Bathing	2.8	12.4	.21***	1187
Cooking	2.6	12.9	.05	1177
Television and/or video recorder	2.5	2.5	.24***	1196
Computer	1.9	0.2	.48***	964
Transportation	2.8	55.2	.48***	1226
Holidays	2.4	24.0	.35***	1180

a. 1 = *very little*, 5 = *very much*. *N* varies due to missing values.
**$p < .01$. ***$p < .001$.

right example," "Proenvironmental behavior will only be useful if everybody cooperates and I do not think that will happen," and "We should be careful with our natural environment because we depend on it."

RESULTS

First, it is examined how respondents perceive the environmental impact of their households and how this is related to their household energy use. After that, respondents' self-reported proenvironmental behavior and how this relates to household energy use is studied. Finally, regression analyses are presented that aim to examine the antecedents of proenvironmental behavior and household energy use.

Household energy use and perceptions of environmental impact. Table 5 shows that on average, respondents believed that their behavior was no more or less environmentally harmful than that of others. To examine the extent to which respondents' perceptions of the environmental impact of their behavior is related to their energy use, a number of Pearson product-moment correlations were computed. Table 5 shows a highly significant correlation between respondents' energy use for car use and the perceived environmental impact of their transport. A reasonably strong correlation was also found for the computer use and holidays. This indicates respondents were reasonably aware of the higher (than others) environmental impact of their car use, computer use, and holidays. For other categories, however, correlations were

moderate or low. For cooking, there appeared to be no relationship at all between respondents' actual and perceived environmental impact.

Proenvironmental behavior. Second, the relationships among 13 self-reported proenvironmental behavior variables were examined by means of explanatory PCA (with Varimax rotation). Four factors could be distinguished that explained 49.4% of the total variance. The first factor explained 20.9% of the variance and referred to the extent to which respondents conserve energy and materials (buying coffee filters and toilet paper from recycled paper, using a bike for short distances, and refusing plastic bags). The second factor explained 10.8% of the variances and described recycling (i.e., glass bottles, compost waste, and chemicals waste). The third factor explained 9.9% of the variance and distinguished respondents who are more or less inclined to save water and energy (i.e., do not use a half-full washing machine, do not leave tap water running, do not leave audio and video on stand-by). The last factor explained 7.8% of the variance and described food-related behaviors (i.e., buy at a health food store and eat vegetarian meals). One item on home-heating behavior had no high loading (more than .50) on any factor. The factors showed a lot of similarity with those found in studies mentioned in the Introduction section. The internal consistency of these factors was examined by conducting reliability tests. The reliability of the second factor was the highest (Cronbach's alpha = .60). For the other factors, it was low (Cronbach's alpha is .50 or smaller). This indicates a low consistency of proenvironmental behavior for these different domains. It is therefore not possible to create new, reliable scales on the basis of the PCA solutions. Instead, one scale including all 13 items was created. The reliability of this scale was reasonable (Cronbach's alpha = .66).

To examine whether people who reported more proenvironmental behaviors also used less energy, the relationship between total household energy use and total proenvironmental behavior was examined. The correlation was only .22 ($p < .001$). This means that the more often respondents said they performed proenvironmental behaviors, the less energy they used. However, this relationship was only weak.

Antecedents of proenvironmental behaviors and energy use. To study how proenvironmental behavior and household energy use were related to personal and attitudinal variables, two regression analyses were conducted. Table 6 shows the results of the analysis in which proenvironmental behavior was regressed on four demographic variables (income, age, level of education, and household size) and four attitudinal items (depending on nature,

TABLE 6
Variables Influencing Proenvironmental Behavior

	B	*Standard Error*	*Beta*	t	*Significance*
Constant	2.46	.14		18.08	.00
Household size	0.03	.01	.11	3.68	.00
Age	0.07	.00	.21	7.16	.00
Income	–0.04	.01	–.11	–3.61	.00
Level of education	0.03	.01	.11	3.34	.00
We depend on nature	0.14	.02	.19	6.67	.00
Sell in shops	0.06	.01	.14	4.80	.00
Government example	0.03	.02	.05	1.22	.09
Cooperation by others	–0.03	.01	–.08	–2.61	.01

NOTE: All variables were entered simultaneously into the equation; $R^2 = .14$; adjusted $R^2 = .13$; $F(8, 1{,}103) = 24.16$; $p < .001$.

selling in shops, example of government, and cooperation of others; see Gatersleben, 2000).

As can be seen, only 13% of the variance in proenvironmental behavior could be explained. Table 6 shows that larger households (i.e., respondents with children), older respondents, respondents with a lower income, respondents with a higher level of education, and respondents who more strongly believed we depend on nature, more environmentally friendly products should be sold, and the cooperation of others is needed indicated they performed more proenvironmental behavior. Age and belief in our dependency on nature were most strongly related to proenvironmental behavior. The belief that the government should give the right example was not significantly related to proenvironmental behavior.

Table 7 shows that 28% of the variance in household energy use could be explained by attitudinal and demographic variables.[4] This time, environmental beliefs did not seem to matter much. Income and household size were the only significant predictors of household energy use. Respondents with higher incomes and larger households possessed and used more household goods, which resulted in higher household energy use. Level of education and age were not significantly related to household energy use.

As in Study 1, results showed that different variables influenced proenvironmental behavior and household energy use in different ways. Attitudinal variables were more strongly related to self-reported proenvironmental behavior, whereas respondent variables such as income and household size were more strongly related to energy use.

TABLE 7
Variables Influencing Household Energy Use

	B	*Standard Error*	*Beta*	t	*Significance*
Constant	4.50	.15		30.69	.00
Household size	0.08	.01	.21	8.09	.00
Age	–0.00	.00	–.05	1.84	.07
Income	0.17	.01	.44	15.45	.00
Level of education	–0.03	.02	–.05	–1.59	.11
We depend on nature	0.06	.02	–.07	–2.76	.01
Sell in shops	–0.00	.01	–.07	–2.57	.01
Government example	0.02	.02	.03	1.24	.22
Cooperation by others	0.00	.01	.00	0.11	.91

NOTE: All variables were entered simultaneously into the equation; R^2 = .28; adjusted R^2 = .28; $F(8, 1{,}133) = 57.00$; $p < .001$.

CONCLUSIONS

The results of this study suggest that it is worthwhile to distinguish two different measures of environmentally significant behavior: an intent-oriented measure and an impact-oriented measure (see also Stern, 2000). An intent-oriented measure focuses on behaviors that are environmentally significant from an actor's point of view (based on popular notions of environmentally significant behavior), for example, self-reported proenvironmental behavior such as recycling and buying whole food. Such measures generally do not reflect the actual environmental impact of behavior patterns. With this measure, what respondents do (more or less deliberately) to benefit the environment, why some people act more proenvironmentally than others, and what can be done to persuade people to behave more proenvironmentally, for instance, can be examined. An impact-oriented measure focuses on the actual environmental impact of behaviors (e.g., energy use, water use, or waste production). This measure enables researchers to identify target behaviors that significantly influence the environment and to examine how the environmental impact of behavior patterns might be reduced.

We argue that more attention should be paid to behaviors that contribute significantly to the main environmental problems with which societies and the world are confronted, especially problems related to (fossil) energy use. The final goal of most studies on proenvironmental behavior is to provide information that can be helpful in reducing the environmental impact of household consumption patterns. We therefore need to know more about the variables that influence the actual environmental impact of behavior.

Several studies have already shown that proenvironmental behavior is not always consistent (Dietz, Stern, & Guagnano, 1998; Kaiser, 1998) and that different types of behavior are influenced by different motivational variables (Black et al., 1985; McKenzie-Mohr et al., 1995; Painter et al., 1983; Stern, 1992). Our studies showed that self-reported proenvironmental behavior is only marginally related to household energy use. Moreover, different types of environmentally significant behaviors were related to different types of explanatory variables. Proenvironmental behaviors were especially related to attitudinal variables. Energy use was more strongly related to household size and household income. It appeared that general environmental attitudes are especially relevant when behaviors do not cost too much effort or change in comfort. In other cases, such as energy use, it appeared that as soon as people have the financial ability to perform the behavior, they are tempted to do so (see also Gatersleben, 2000). It seems important to expand the study of antecedents of environmentally significant behavior to nonmotivational variables such as behavioral opportunities and abilities (Gatersleben & Vlek, 1998; Ölander & Thøgerson, 1995).

However, these results do not imply that household energy use is only dependent on economic (and other demographic) variables. Other research has shown that more specific attitudes toward energy-related problems and energy saving may be better predictors of household energy use than are general environmental attitudes (Ester, 1984; Kaiser et al.,1999; Stern, 1992). Moreover, the differences between antecedents of proenvironmental behavior and household energy use may have been influenced by the way these variables were measured. Energy use is measured on the level of the household, whereas some explanatory variables, such as attitudinal variables, are measured on an individual level. Also, attitudinal variables may be better predictors of self-reported proenvironmental behavior because both measure psychological constructs, whereas household energy use, income, and household size are more objective household measures. It could be worthwhile to conduct a study in which attitudes are also measured on the household level (i.e., where data on proenvironmental attitudes are gathered from each household member) or where energy use is measured on an individual level. This may result in closer correspondence of dependent and independent measures.

Another reason for the low correlation between proenvironmental attitudes and household energy use may be found in variables such as knowledge and awareness. People may not always be aware of the environmental impacts of behaviors related to energy use and the environmental benefits of changes in these behaviors (e.g., Baird & Brier, 1981; Gatersleben, 2000). This is supported by the low and moderate correlations found between

respondents' actual and perceived (compared with others) environmental impact for several consumption categories. The development of information and education programs on the environmental impact of (high-impact) household consumer behaviors seems worthwhile. Indeed, studies have shown that information and education about energy-saving options can result in reductions in household energy use (e.g., Harland & Staats, 1995, 1997; Harland, Staats, & Wilke, 1999; see also Stern, 1992). To develop effective educational programs, more research into the antecedents of environmentally significant consumer behavior is needed.

The method of measuring a household's direct and indirect energy use described in this article can be a valuable instrument to examine the environmental impact of (Dutch) households. Similar measures could be developed for other environmental impacts, for example, waste disposal or water use. A disadvantage of the method is that it could require rather long questionnaires. Further environmental research is necessary to develop (better) measures that cover a substantial amount of variance in the actual environmental impact of a household without making questionnaires too long. However, the method has many advantages over common self-report measures of proenvironmental behavior. First, it is environmentally significant. Although it was not possible to measure all the variance in respondents' actual household energy use, the measure does give a better indication of the actual environmental impact of a household than do common self-report measures of proenvironmental behavior. Therefore, it provides a good instrument to examine variables that influence the environmental impact of a household.

A further advantage is that the measure enables better communication with environmental scientists and provides more understandable information for policy makers. By using dependent measures such as energy use in giga joules (CO_2 emissions would be another possibility), the effects of behavior changes can be expressed in quantifiable units that have a meaning for environmental scientists and policy makers. A third advantage of the method is that it can be applied to other already existing data files. Fourth, although it is based on self-reported behavior, the questionnaire items are very specific. Systematic error due to social desirability and anchoring effects is therefore minimized. The error variance is more likely to be random (see Fuijii et al., 1985; Warriner et al., 1984). A fifth advantage is that the methodology can be used for other types of studies. In a study by Gatersleben (2000), for instance, the methodology was used in face-to-face computer-based interviews. During these interviews, respondents could be given direct feedback on their household energy use, necessary savings in their energy use to reach a sustainable level of energy use, and the potential reduction in household energy use due to different intended behavioral changes. In another study, the

method was used to estimate the environmental and social impacts of different future household behavior scenarios (Poortinga et al., 2000). Respondents were asked to evaluate future household consumption scenarios. The scenarios differed systematically in type of energy savings (home versus mobility), amount of savings (small versus large savings), and solution strategies (behavior versus technology) used to achieve a reduction of household energy use. It was also investigated how respondents evaluated these different types of behavior changes.

Finally, the methodology can be used as a feedback instrument to guide educational programs. It was shown that people are not always aware of the environmental impact of their behavior. A computer program could be developed to measure a household's environmental impact on the basis of people's reported possession and use of household goods. In an interactive process, they could then register planned (or actual) behavior changes and receive direct feedback on the potential environmental savings in which such changes would result. This way, people could learn more about the environmental consequences of their behavior changes, which may help to reduce the actual environmental impact of households.

APPENDIX
Estimations of Energy Use (in giga joules) Related to Household Consumer Behavior

The table below shows the estimates of the direct and indirect energy use related to different consumption behaviors, the answers of the respondents were multiplied with a constant with the SPSS procedure COMPUTE. This constant represents the direct and/or indirect energy use that is related to a certain consumption behavior (i.e., the possession or use of a good or service). To estimate direct energy use, two different procedures were used, depending on the kinds of questions that were asked (i.e., possession or use questions). For each household good, the total number of goods respondents said were present in the household was multiplied by the average annual energy use (in giga joules) of such a good in an average Dutch household. The same method was used for questions about the use of household goods. The reported use of a household good was multiplied by the average amount of energy that is used by an average Dutch household to perform that behavior. For indirect energy use, the possession of a good or the respondents' purchase of a good or service was multiplied by the average amount of energy used by a producer to produce and deliver the good or service (see Kramer, Wiersma, Gatersleben, Noorman, & Biesiot, 1998; Schneider, 1994; Vringer & Blok, 1995).

The tables below show the estimates of household energy use for nine different consumption categories, six for direct energy use and three for indirect energy use.

The first column shows the questionnaire items that were used. As can be seen, most variables referred to the possession of household goods and relatively few items referred to the use of household goods. This was mainly due to the limited availability of (natural-technical) environmental data on the use of household goods.

The columns marked *Study 1* and *Study 2* show the energy use (in giga joules) per response unit (e.g., number of goods, times per week) for each of the two studies. When a horizontal line is marked in a column, the variable is not measured in the relevant study. The variables measured in the two studies are not completely similar.

		Study 1	*Study 2*
Home heating			
What type of heating equipment do you have?			
Central heating	Apartment	36.5	36.5
	Terraced	48.5	48.5
	Semi-detached	61.58	61.6
	Detached	84.83	84.8
Local heating (all types)	1 stove	—	30.0
	2 stoves	—	41.3
	3 stoves	—	49.3
	4 stoves	—	55.2
Shared heating (all types)			24.6
Extra electric stoves (per stove)		—	1.7
At what temperature do you normally set your thermostat?			
Temperature every °C more or less than 20°C		3.3	3.3
Washing			
How many of the following goods are present in your household?			
Possession of washing machine		—	4.5
Possession of tumble drier		5.4	5.3
Bathing			
How many times per week do you and other people in your household take a shower?			
Showers per person per week		0.6	0.6
How many times per week do you and other people in your household take a bath?			
Baths per person per week		1	—
Food storage and preparation			
How many of the following goods are present in your household?			
Possession and use of gas stove		—	(20 + [8.0 * hh size] + [4.6 * times used/ week] * 31.65) / 1000
Possession and use of electric stove		—	4.7
Possession and use of oven		—	(28 + [9.7 * hh size] + [2.5 * times used/ week] * 31.65) / 1000
Possession of refrigerator		—	4.7 per refrigerator

	Study 1	*Study 2*
Possession of dishwasher	3.1	3.6
Possession of freezer	3.8	3.8
Possession of electric kettle	—	0.5
Possession of microwave oven	1.0	1.0
Use of audio and video		
How many of the following goods are present in your household?		
Possession of one (first) television set		1.4 per set
Possession of more sets		1.3 per set
Possession of video recorder	—	1.3 per video
Car use		
How many kilometers are driven per year with the car that is used most in your household?		
Annual kilometers	2.9 per 1,000 km	2.9 per 1,000 km
Indirect energy use		
Car possession		
Number of cars owned	8.3 per car	8.3 per car
Use of public transport		
Annual use of public transport	1.22 per 1,000 km	—
Holidays		
Far destination (outside Europe)		
Flying	20.4 per flight independent of the destination	28.8 pp
European destination		
Flying		12.0 pp
Car		7.1 pp
Bus		0.7 pp
Train		2.5 pp
The Netherlands		
Car		1.1 pp
Bus		0.2 pp
Train		0.4 pp
Bike		0.2 pp

NOTE: Cells containing a "—" mean the variable was not measured in this study. When respondents did not own a certain good, the average energy use was set at 0. The formulas are copied from the computer program used in another field study (see Gatersleben, 2000). For an explanation of these formulas, see Kramer et al. (1998).

NOTES

1. One giga joule is equivalent to about 30 m^3 of natural gas, 400 car km, or 278 kWh.

2. We would like to thank the Centre for Energy and Environmental Studies, University of Groningen, the Netherlands (IVEM) and especially Klaas-Jan Kramer and Gerwin Wiersema for developing the measures of direct and indirect energy use of household behavior.

3. Residual plots of the regression analysis showed clear (linear) model violations (Cohen & Cohen, 1983). This is not surprising because (unexplained) variance can be expected to be greater for higher income groups. A multiplicative model fitted the data better than did an additive model because two people do not use twice as much energy as one person does, and the expenditure of 2000 guilders does not result in twice as much energy use as the expenditure of 1000 guilders. In this study, the dependent variable was therefore logarithmically transformed. This model proved to represent the data well.

4. Although there were no linear model violations, the data shown in the table are logarithmically transformed. This was done to make the results of both studies comparable. Transformation of the variables did not alter the solution of the regression analysis. This means that the relationship between the dependent and independent variables in the first study is nonlinear, whereas this relationship is linear in the second study. The dependent variable (household energy use) is skewed to the right in the first study but normally distributed in the second study. This is probably due to differences in the distribution of income and household size. In the first study, household income and household size are skewed; that is, most respondents fall within two standard deviations of the average income and family size, but for both variables, there is a long tail to the right indicating a small number of large households and high-income groups.

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