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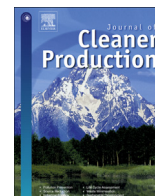
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# Measuring consumers' product care tendency: Scale development and validation



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## ABSTRACT

Product care is defined as all activities initiated by consumers that encourage an extension of product lifetimes, such as repair, maintenance, and/or careful handling. A product care scale was developed and validated in a set of four related studies. In study 1, we asked experts to examine the face validity of a set of 35 items. In study 2, we reduced the initial set of items to 10 items using exploratory factor analysis. A subsequent confirmatory factor analysis supported a three-factor solution. Study 3, a nomological network study, demonstrated that the construct measured by our scale is related but still distinguishable from existing concepts, such as frugality, use innovativeness and attachment towards the product. Study 4 was a known-groups test with participants from two different countries and with various previous experiences in repairing. The final 10-item product care scale includes three factors: relevance, easiness and positive experience.

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## 1. Introduction

Product care is defined as “any activity initiated by the consumer that helps to prolong the lifetime of a product” (Ackermann et al., 2018). It comprises active components, such as repair and maintenance activities, as well as passive components, such as preventive care measures, e.g., using a smartphone cover to prevent damage.

Product care is a relevant approach for the Circular Economy (CE). In a CE, materials are kept in the system for a longer time (e.g., through reuse) or by extending the products' lifetimes (den Hollander et al., 2017). Strategies to extend the time of use should be preferred over other approaches, such as improving recycling (see also Ghisellini et al., 2016; Geissdoerfer et al., 2017; Wieser and Tröger, 2018) and product care is one of these strategies. Product care needs to be considered in the development of new products and services in order to implement it on a wide range. Research in the field of Circular Product Design (CPD) has shown that design

strategies to extend the lifetime of products are those that need to be incorporated more into product design (Bovea and Pérez-Belis, 2018).

Because product care requires mainly the consumers' initiative, time and effort, their role in the transition towards a CE need to be considered in more depth (Ghisellini et al., 2016; Wastling et al., 2018).

Research related to product care consists mainly of qualitative reports of consumers (e.g., Cox et al., 2013; Young, 2017). From a sustainability perspective, it is important to understand interpersonal differences and their determinants in order to stimulate product care through products and services. Quantitative studies, that would allow for testing and thus generalization of these qualitative findings, are difficult, because no scale that can measure product care in a reliable and valid manner has been developed. A product care scale will deepen the theoretical knowledge about product care as a specific kind of sustainable consumer behaviour.

## 2. Consumers' product care

Aspects that can influence consumers' motivation for performing product care are: (1) attributes of the consumer, (2) the relationship between consumer and product and (3) characteristics related to the product (Ackermann et al., 2018). Prior research

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shows that consumers vary greatly in their product care behaviour (Ackermann et al., 2018): While some people conduct product care behaviour on a regular basis, others prefer to replace broken items. Some people only look after certain products, others take care of most products. Some people take care of their product by themselves, others prefer professional service providers. Intrapersonal attributes that influence product care include for example a general positive attitude towards product longevity or frugality (Lefebvre et al., 2018). Some people also show a kind of rebellion against brand policies that try to prohibit consumers from repairing their products, leading to enhanced effort spent on product care (Ackermann et al., 2018). The relationship between consumer and product refers to the perceived pleasure, functionality and aesthetics of the product (see also Ackermann et al., 2017). In general, a positive experience with the product increases the probability of product care. Finally, product-related characteristics include the price and complexity of a product as well as the availability and price of spare parts and tools (Cooper, 2004; Dewberry et al., 2017; Diddi and Yan, 2019). A high price of the product can stimulate product care, whereas expensive spare parts reduce the motivation to repair the product (see also Scott and Weaver, 2014).

Nevertheless, motivation is not enough for a behaviour to occur (see also Davies et al., 2002): Consumers should also have confidence in their own abilities for product care. Ability factors for product care include time, money, physical and cognitive effort (Ackermann et al., 2018), as well as tools, space, knowledge and skills (Cooper and Salvia, 2018).

### 3. Development of a scale to measure product care

The aim of the current study is the development and validation of a scale to measure the tendency for product care. Based on previous research, we assumed that this tendency is determined by attitudes (Fujii, 2006), motivation and perceived ability (Fogg, 2009), which are dimensions that do not necessarily correlate with each other. In addition, previous behaviour seems to be relevant for future behaviour (see e.g., Kollmuss and Agyeman, 2002), so it makes sense to include current product care behaviour as well as its relevance for the consumer into our scale.

In line with other publications on scale development (e.g., Kaiser, 2007; Haws et al., 2014; DeVellis, 2017), we conducted four related studies to develop the scale (see Fig. 1): First, we generated items based on previous research on product care and validated these with experts. In Study 2, we used a survey to gather consumer responses on potential items for our scale. After conducting an exploratory and a confirmatory factor analysis, we ended up with a 10-item product care scale, consisting of three factors. We compared our product care scale with existing, related scales to assess the nomological validity in Study 3. Study 4 was a known-groups test in which we analysed the responses of specific groups of participants for which we expected different levels of product care. All studies were conducted in English, except from the items presented to the Austrian participants in Study 4.

#### 3.1. Study 1: Item generation

The aim of this study was the generation of a first set of items and the evaluation of their face validity by experts (see also Hardesty and Bearden, 2004). We expected current product care, attitudes and perceived ability to play an important role for product care. Therefore the items (see Appendix A) refer to financial motivations (e.g., "One reason why I take care of my products is to save money."), emotions associated with product care (e.g., "Taking care of my products is something I enjoy."), the relevance of product care (e.g., "It is important for me to take care of my products.") and the

perceived ability to take care of products (e.g., "I am capable of looking after my products."). At this stage, items were oversampled to allow the selection of the best items during the next steps. Each item was presented in two versions: The first version referred to products in general, e.g., "I look after my products regularly". Second, we asked the experts to imagine a specific product and respond to the item based on this product. This version was presented, for example, as "I look after my [product] regularly". In addition to these items, we included open questions, in which we asked to give feedback. The experts were also asked to evaluate each of the 126 items for its representativeness with the construct on a 3-point Likert scale (1 = "very", 2 = "somewhat", 3 = "not"). We sent our online questionnaire to 13 experts (see Appendix B). We received 9 completed questionnaires.

The overall feedback of the experts on our product-focused items was positive and the different perspectives towards product care that were included in the items were considered relevant for the product care scale. Specifically, items that focus on the ability of the consumer, such as "I know how to protect my [product] from possible damage." or "I am capable of looking after my [product]." were considered as relevant for the scale, as well as items describing the motivational aspects of product care (e.g., "I keep my [product] in a good condition so I can use it for an extra-long period time."). In addition, the experts considered items that merely describe the care activities being conducted as representative for the scale (e.g., "I look after my [product] regularly." or "I clean my [product] regularly."). This feedback highlighted the relevance of ability as well as of attitudes and current care behaviour.

In the qualitative section, experts mentioned that product care differs strongly between different products, even for the same person. As a consequence, it is difficult, if not impossible, to answer the items on a general level (e.g., "I look after my products regularly"). Consequently, the experts preferred the items in the scale referring to a specific product to ensure face validity.

Based on this feedback, we decided to make the following changes: First, as explained above, items should refer to a specific product. Second, based on the experts' responses, we questioned whether there would also be differences among various care activities, such as repair and maintenance for a specific product. To test this possibility, each item of the scale was revised so that it refers either to care, repair and maintenance. In the next study, we will analyse if these aspects lead to independent factors or if they can be summarized under product care as a general factor. For example, the item "I often postpone maintenance activities for my [product] as long as possible" was changed into three new items: (1) "I often postpone care activities for my [product] as long as possible", (2) "I often postpone repair activities for my [product] as long as possible" and (3) "I often postpone maintenance activities for my [product] as long as possible". Third, some items were rephrased slightly based on the experts' feedback. These considerations led to a new set of 100 items.

#### 3.2. Study 2: Exploratory and confirmatory factor analysis

The goal of this study was to reduce the new set of 100 items to a scale with a reasonable and applicable number of items. We started with an Exploratory Factor Analysis (EFA), which aimed at identifying the latent factors of product care. It was followed by a Confirmatory Factor Analysis (CFA) to examine the construct validity of our underlying model.

##### 3.2.1. Sample and procedure

For the data collection, we contacted the members of a Dutch consumer panel and asked them to answer the set of items as well

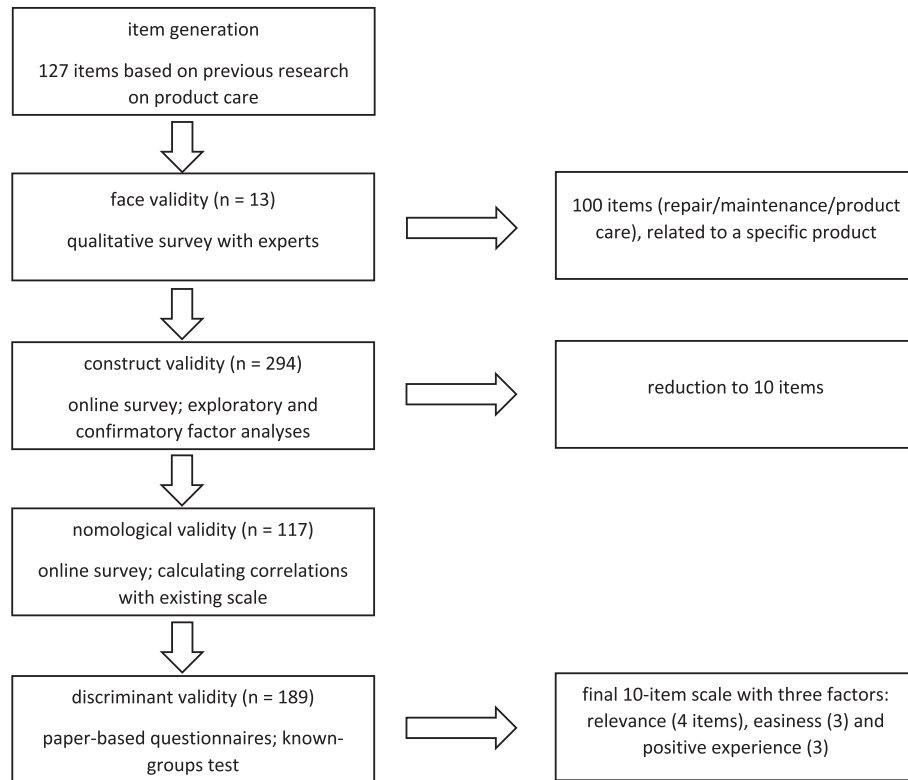


Fig. 1. Overview of the research process.

as questions on demographic data via an online survey. Based on the experts' feedback, we decided to refer to one specific product within all items. We selected a product that consumers can take care of easily and that is common in the Netherlands: a bicycle. For example, the [old] (new) item is: "It is important for me to take care of my [product] (bicycle)". Each item was presented as three versions: One relating to care in general, one relating to repair and one relating to maintenance. Participants indicated their level of agreement on a 7-point scale, ranging from 1 = strongly disagree to 7 = strongly agree. We contacted 600 people in order to reach a large sample size according to Kline (2005). Based on the panel information, we selected participants with a great variety in gender and age. As an incentive, they were offered 4,15€, which they could receive as stamps or donate to a charity organization. Two-hundred and forty-nine participants (52% female,  $M_{age} = 50$  years,  $SD = 12$ ) completed the questionnaire within two weeks. We analysed the data using the open-source software RStudio 1.1.463 (RStudio, 2018).

### 3.2.2. Results

As a first step, we analysed the items related to care, repair and maintenance. We observed very high correlations between these three set of items (care – repair:  $r = .93$ , care – maintenance:  $r = 0.93$ , maintenance – repair:  $r = 0.95$ ). This indicates that consumers do not differentiate between different care activities: If they maintain their bicycle, they also repair it and they take care of it in general, for example by handling it carefully. In addition, some care activities cannot be categorized easily. For example, tightening the bike chain can be seen as maintenance, because the bike can still be used at this time, but it can also be seen as repair, because a loose chain is a faulty chain. We therefore decided to develop a scale that assesses product care as a whole, including repair and maintenance, but also cleaning, careful handling etc. Consequently, all

further analyses are conducted only on the 35 items (see Appendix C) that were referring to care in general.

**Exploratory Factor Analysis.** The Kaiser–Meyer–Olkin (KMO) criterion of sampling adequacy ( $KMO = 0.90$ ) and the Bartlett test of sphericity ( $\chi^2(34) = 195.82, p < .001$ ) both indicated that the data was well used for conducting an EFA. An examination of the criteria of skewness and kurtosis (see West et al., 1995) revealed that normality was not severely violated, as no item had a skewness value  $> 2$  or a kurtosis value  $> 7$ . The Maximum Likelihood (ML) extraction method was used because it is assumed to produce the best results (Fabrigar et al., 1999; Costello and Osborne, 2005). Furthermore, ML is the preferred method if a CFA with ML is planned afterwards (Bühner, 2011). An oblique rotation method, CF-varimax (Crawford and Ferguson, 1970), was chosen because we assumed that the different factors that we expected to contribute to product care, such as motivational factors and ability, influence each other. For example, the importance of product care can be based on rational considerations, but emotional aspects can also play an important role. Consequently, we expected these factors to correlate to a certain degree. To determine the number of factors to be extracted, a parallel analysis (Hayton et al., 2004) and a scree plot were conducted (see also Fabrigar et al., 1999). Both indicated that either 3 or 6 factors should be retained. Because the latter led to factors with less than 3 items per factor, which is considered to be weak (Costello and Osborne, 2005), we went for a three-factor solution. During the EFA, only items with loadings  $> 0.32$  and without cross-loadings (as defined by Tabachnick and Fidell, 2001) were retained (see also Costello and Osborne, 2005), which reduced the number of items from 35 to 10. Thus, the final output of the EFA was a three-factor solution with 10 items (see Table 1).

The first factor, *easiness*, describes the perceived ability of the participants to take care of their bicycle. Factor loadings range from

**Table 1**  
Remaining items with factor loadings after EFA.

	easiness	relevance	positive experience
I am experienced in looking after my bicycle.	<b>0.964</b>	-0.025	0.033
I can look after my bicycle well.	<b>0.581</b>	0.307	0.083
I have the necessary equipment for care activities on my bicycle.	<b>0.463</b>	0.009	0.020
It is important for me to take care of my bicycle.	0.029	<b>0.735</b>	0.076
I look after my bicycle.	0.138	<b>0.731</b>	0.056
I try to prevent my bicycle from failure.	0.117	<b>0.709</b>	0.051
I clean my bicycle.	0.037	<b>0.474</b>	0.236
Taking care of my bicycle gives me a good feeling.	0.001	0.019	<b>0.928</b>
It makes me proud that I am able to take care of my bicycle.	0.125	0.041	<b>0.713</b>
In general, looking after my bicycle is a positive experience.	0.181	0.090	<b>0.624</b>

Note: Bold numbers illustrate items with a strong loading on this factor.

0.46 to 0.96. It is based on former experiences (*"I am experienced in looking after my bicycle"*) and the general self-esteem of being capable to take care of the product (*"I can look after my bicycle well"*). Another aspect of easiness is the availability of equipment that may be needed to repair or maintain the bicycle, such as special tools, spare parts etc. (*"I have the necessary equipment for care activities on my bicycle"*). The second factor, *relevance*, describes the general care behaviour and its importance for the consumer. Factor loadings range from 0.47 to 0.73. This factor includes three care activities (*"I look after my bicycle"*, *"I try to prevent my bicycle from failure"* and *"I clean my bicycle"*) as well as one item regarding the importance of care activities (*"It is important for me to take care of my bicycle."*). The third factor, *positive experience*, refers to the emotional aspects of product care, such as the experience (*"In general, looking after my bicycle is a positive experience"*) and the feeling of taking care (*"Taking care of my bicycle gives me a good feeling"*). Factor loadings range from 0.62 to 0.93.

**Confirmatory Factor Analysis.** To test the goodness of fit of this factor structure, we defined a model with product care as a general factor and the three factors *easiness*, *relevance*, and *positive experience* as latent factors within RStudio and ran a CFA (see also DeVellis, 2017). The fit statistics for this final three factor-solution with 10 items were on a good level ( $\chi^2/df$  ratio = 1.597, RMSEA = 0.049, CFI = 0.984, SRMR = 0.040; see also Hu and Bentler, 1999; Hooper et al., 2008).

To assess the convergent validity of our model, we analysed the average variance extracted (AVE). The AVE of each factor is above the cut-off of 0.50 defined by Fornell and Larcker (1981), see Table 2, while the total AVE is 0.57. For the discriminant validity, we compared the squared correlations between two factors with their AVE. The AVE should always be greater than the squared correlations (Fornell and Larcker, 1981). All three factors fulfill the criterion; thus, discriminant validity between the three factors of the product care scale was confirmed. Scale inter-correlations were in general on a satisfactory level (relevance – easiness: 0.63, relevance – positive experience = .57, easiness – positive experience = .56), indicating that the factors are correlated, but at the same time not too similar. To assess internal consistency of each factor, we calculated Cronbach's alpha (easiness: 0.74, relevance: 0.81,

**Table 2**  
Analysis of the convergent and the discriminant validity.

AVE easiness	.52
AVE relevance	.51
AVE positive experience	.68
total AVE	.57
squared correlation easiness – relevance	.36
squared correlation positive experience – relevance	.29
squared correlation easiness – positive experience	.31

positive experience: 0.86) as well as the composite reliability (between 0.77 and 0.86, see Table 3 for studies 2, 3 and 4). This three-factor solution enables the assessment of product care tendency, which consists of the current care behaviour and its importance (e.g., *"I clean my bicycle"*), but also of the consumer's perceived easiness (e.g., *"I can look after my bicycle well"*) and his/her feelings associated with product care (e.g., *"Taking care of my bicycle gives me a good feeling"*).

### 3.3. Study 3: Nomological network

For the validation of the 10-item product care scale through a nomological network study, we selected several related scales. We expected the product care scale to correlate on a moderate level with these other scales, indicating that our product care scale assesses related, but not the same constructs as these scales (Evans, 1996).

The first construct is *environmental concern* (Weigel and Weigel, 1978; Chuah et al., 2020) that describes the extent to which a person is concerned with sustainability issues, that is how much he or she cares about the environment. In the context of product care behaviour, we expected that people with a high environmental concern realize that it is important to take care of products to extend their lifetimes.

*Frugality* can be defined as the "careful use of resources and avoidance of waste" (DeYoung, 1986, p. 285). Research indicated that frugality can be an effective means to stimulate pro-environmental behaviour (Fujii, 2006). As product care behaviour reduces the need to buy new products and thus helps to save money and waste, we expect product care behaviour to positively correlate with frugality.

*Use innovativeness* (Price and Ridgway, 1983; Girardi et al., 2005) explores a personality trait that refers to the innovative ways in which a person uses products. Use innovativeness was already found to be a determinant of product lifetime extension (Price and Ridgway, 1983) and of repair propensity (Scott and Weaver, 2014), and as such we expect that it will enhance product care tendency.

We also expect scales that refer to the product or to the relationship between consumer and product to be related but still distinct from product care: For example, a *strong connection* or *attachment* between the product and its owner is likely to motivate product care behaviour (Kleine and Baker 2004; Mugge et al., 2010).

*Involvement* describes the personal meaning or relevance a consumer attributes to a product category (Antil, 1984). Involvement can lead to the perception of greater product importance (Howard and Sheth, 1969), which may subsequently result into enhanced product care.

*Satisfaction* (Crosby and Stephens, 1987; Spreng et al., 1996) concerning the product can also be an important driver for product care: The more satisfied the consumer is, the more he/she wants to

**Table 3**  
Construct measurement summary: Factor loadings from CFA and reliability scores (CR = composite reliability).

Factor	Item	Study 2		Study 3				Study 4			
		bicycle		coffee machine		leather shoes		bicycle		coffee machine	
		factor loading	reliability	factor loading	reliability	factor loading	reliability	factor loading	reliability	factor loading	reliability
easiness	I am experienced in looking after my bicycle.	.81	$\alpha = .74$	.89	$\alpha = .87$	.89	$\alpha = .87$	.09	$\alpha = .84$	.89	$\alpha = .89$
	I can look after my bicycle well.	.78	CR = .77	.90	CR = .87	.87	CR = .88	.87	CR = .70	.92	CR = .90
	I have the necessary equipment for care activities on my bicycle.	.45		.73		.72		.87		.79	
relevance	It is important for me to take care of my bicycle.	.73	$\alpha = .81$	.88	$\alpha = .90$	.83	$\alpha = .90$	.50	$\alpha = .78$	.77	$\alpha = .86$
	I look after my bicycle.	.82	CR = .82	.95	CR = .91	.89	CR = .91	.71	CR = .83	.89	CR = .85
	I try to prevent my bicycle from failure.	.76		.78		.84		.90		.68	
positive experience	I clean my bicycle.	.61		.75		.81		.81		.72	
	Taking care of my bicycle gives me a good feeling.	.87	$\alpha = .86$	.96	$\alpha = .92$	.86	$\alpha = .89$	.81	$\alpha = .85$	.11	$\alpha = .85$
	It makes me proud that I am able to take care of my bicycle.	.87	CR = .86	.87	CR = .93	.79	CR = .89	.84	CR = .88	.87	CR = .72
	In general, looking after my bicycle is a positive experience.	.82		.87		.92		.87		.92	

keep the product for a longer time, and thus the more likely a person will be to perform care behaviours for this product.

Closely related to satisfaction is the product's *quality* (Grewal et al., 1998) as well as its *usefulness* (Cox and Cox, 2002). The latter describes the extent to which a product is perceived to be practical by the consumer. In addition, the *attitude towards an object* scale (Ahluwalia and Burnkrant, 2004) asks for a more general evaluation of the product.

While these constructs are all related to a positive attitude towards the product and are therefore stimulating product care, *disposal tendency* (Harrell and McConocha, 1992) refers to the fact that the consumer does not want to keep a product although it can still be used, what will be seen in a negative correlation with product care behaviour.

### 3.3.1. Sample and procedure

Two versions of the questionnaire were created, of which only one was presented to each participant: One in which the product care scale as well as the scales that are referring to a specific product (attitude, quality, satisfaction, attachment, disposal tendency, usefulness) were related to leather shoes, and one in which these items were related to a coffee machine. The consumer-related scales (environmental concern, frugality, use innovativeness) were the same in both versions. We selected other products than in the previous studies to explore the applicability of the 10-item product care scale to different kinds of products. Coffee machines and leather shoes were chosen because 1) they are owned and used by most people, 2) they need to be taken care of, and 3) product care activities for these products are relatively easy to conduct. In addition to the 10 items from the product care scale which were assessed on a 7-point Likert scale, 49 items from existing scales were used (see Appendix D).

The questionnaire was sent out to participants via an existing consumer panel. Participants were randomly assigned to one of the two versions of the questionnaire. If they did not own the product, they were forwarded to the other version respectively. After 2 weeks, 117 participants had finished the questionnaire on the leather shoes (52% female;  $M_{age} = 53$  years,  $SD = 12$ ) and 118 participants completed the questionnaire on the coffee machine ( $n = 118$ ; 53% female;  $M_{age} = 56$  years,  $SD = 10$ ), respectively.

### 3.3.2. Results

The psychometric analysis of this study confirmed the scale

structure found in Study 2: A CFA on the data provided a good model fit for a three-factor solution (coffee machine:  $\chi^2/df$  ratio = 2.95, RMSEA = 0.129, CFI = 0.939, SRMR = 0.063; leather shoes:  $\chi^2/df$  ratio = 2.40, RMSEA = 0.109, CFI = 0.951, SRMR = 0.050), with only the RMSEA value being higher than the recommended cut-off, which might be caused by the small sample size in our study (see Chen et al., 2008 for a discussion of this issue). The total AVE was 0.71 for coffee machines and 0.74 for coffee machines. In addition, the three factors led again to good values for composite reliability (see Table 3).

To assess the construct validity of our scale, we calculated the correlations between the product care scale and the selected existing scales. As an analysis of skewness and kurtosis suggested that our data does not deviate strongly from normal distribution as defined by West et al. (1995), Pearson correlation coefficients were calculated.

Our product care scale demonstrates good internal consistency ( $\alpha = 0.93$  for coffee machines,  $\alpha = 0.94$  for leather shoes). Although there is no official cut-off for construct validity (DeVellis, 2017), the results of our study (see Table 4 for an overview) seem to be promising:

Two product-related scales correlate on a significant level with product care for coffee machines as well as for leather shoes: Attachment ( $r_{\text{coffeemachine}} = 0.46$ ,  $p < .001$ ;  $r_{\text{leathershoes}} = 0.33$ ,  $p < .001$ ) and quality ( $r_{\text{coffeemachine}} = 0.33$ ,  $p < .001$ ;  $r_{\text{leathershoes}} = 0.35$ ,  $p < .001$ ). These moderate levels of correlation mean that these scales measure constructs that are related to product care, but still distinct. For coffee machines, but not for leather shoes, three additional scales correlate on a moderate level with the product care scale: involvement ( $r_{\text{coffeemachine}} = 0.41$ ,  $p < .001$ ), attitude ( $r_{\text{coffeemachine}} = 0.29$ ,  $p = .001$ ), and satisfaction ( $r_{\text{coffeemachine}} = 0.29$ ,  $p = .002$ ). Again, these correlations are on a moderate level, indicating a related but still distinct relation to product care. The other product-related scales (usefulness and disposal) do not significantly correlate with product care. They can be interpreted as distinct from the construct of product care; just because a product is seen as useful does not mean that consumers take care of it and taking care of their product does not necessarily reduce the chance that individuals dispose of their product.

From the consumer-related scales, frugality was significantly related to product care ( $r_{\text{coffeemachine}} = 0.26$ ,  $p = .004$ ;  $r_{\text{leathershoes}} = 0.35$ ,  $p < .001$ ). Use innovativeness only had a significant correlation with product care for coffee machines

**Table 4**  
Correlations between the product care scales and selected existing scales.

	Coffee Machine		Leather Shoes	
	Cronbach's alpha	Correlation with product care scale	Cronbach's alpha	Correlation with product care scale
Involvement	$\alpha = .91$	.41**	$\alpha = .92$	.24
Attitude	$\alpha = .96$	.29*	$\alpha = .98$	.14
Usefulness	$\alpha = .96$	.19	$\alpha = .99$	.09
Satisfaction	$\alpha = .93$	.29*	$\alpha = .90$	.17
Attachment	$\alpha = .88$	.42**	$\alpha = .84$	.33**
Quality	$\alpha = .88$	.33**	$\alpha = .86$	.35**
Disposal	$\alpha = .82$	-.15	$\alpha = .70$	-.04
Environmental Concern	$\alpha = .88$	.12	$\alpha = .89$	.10
Frugality	$\alpha = .82$	.26*	$\alpha = .84$	.35**
Use Innovativeness	$\alpha = .79$	.37**	$\alpha = .82$	.09

Note: \* significant at 0.01 level, \*\* significant at 0.001 level.

( $r_{\text{coffeemachine}} = 0.37, p < .001$ ), and environmental concern was not significantly related.

This means that product care is higher for products that people are emotionally attached to and that are regarded as high quality. Frugality is also related to product care, which could mean that saving money is a motivational source for product care. Use innovativeness was only significantly related to taking care of coffee machines, but not of leather shoes. The higher complexity of coffee machines requires more technical knowledge and skills, which might be related to use innovativeness.

The results do not only confirm our three-factor solution from Study 2, but also demonstrate that our scale is able to measure product care for different kinds of products, thus proving its usefulness for practitioners. The findings confirm previous research that proposed that attributes of the consumer (e.g., frugality, use innovativeness) as well as product characteristics (quality, satisfaction) and the emotional attachment towards a product are related to product care behaviour (Schifferstein and Zwartkruis-Pelgrim, 2008; Lefebvre et al., 2018), but also shows that all these constructs are still distinct from product care. In addition, the study demonstrated that scales such as involvement (with the product category) and attitude are at least for certain product categories related to product care. Higher scores on all these scales result also in higher levels of product care.

In conclusion, the product care scale measures a construct that is related to but still distinct from other scales.

### 3.4. Study 4: Known-groups test

The final study was a known-group comparison to assess the construct validity of our product care scale. According to Hattie and Cooksey (1984), proving a scale to be valid requires scale scores to discriminate across groups that are expected to differ based on a priori considerations. We therefore defined a priori groups of participants for which we expected differences in product care behaviour. These groups were based (1) on previous visits to a repair café and (2) on the country the participant is living in, assuming that different products are not equally relevant for the respective residents of different countries.

#### 3.4.1. Sample and procedure

The study was conducted by approaching people in person and asking them to fill in the paper-based questionnaire (see Appendix E). For this study, we used a convenience sample: We approached students in Austria and the Netherlands, as well as people from the street and visitors of a fab lab in Austria to cover a broad range of the population. A candy bar was offered as an incentive. Each participant answered the product care scale for his/her bicycle and for his/her coffee maker. We selected these products because they are owned by most people, and people use them regularly. In

addition, these products differ strongly in complexity, with product care for a bicycle being easier and requiring less technical skills than product care for a coffee maker.

We asked the participants if they had ever visited a repair café. We expected previous visitors of repair cafés (at least one visit) to have a higher product care score, because they had already demonstrated a certain interest in repair activities before. In addition, we assumed that people from the Netherlands score higher on product care for their bicycles than people from Austria, because they are in general using their bicycles more often and are thus more dependent on them staying in a functional state. We did not expect a similar effect for coffee machines, as this product is equally important in both countries. We collected questionnaires from 189 participants (48% female,  $M_{\text{age}} = 27, SD = 11$ ; see Appendix F).

#### 3.4.2. Results

A *t*-test comparison revealed that participants who had at least once visited a repair café demonstrated a significantly higher level of product care for both products than participants who had never visited a repair café before ( $M_{\text{previous}} = 3.39, M_{\text{never}} = 2.93, t = 3.00, df = 113, p = .003, d = 0.47$ ). Because only two participants had visited a repair café more than once, it was not possible to calculate an effect of the number of visits on product care. A Mann-Whitney-U test showed a significant difference in product care for bicycles between participants from the Netherlands and from Austria ( $M_{\text{Austria}} = 2.77, M_{\text{Netherlands}} = 3.09, W = 3172, p = .043$ ).

In conclusion, the known-groups study demonstrated that our product care scale can discriminate between groups of participants for which we expected these differences a priori. In addition, we again tested the internal consistency and model fit of our scale based on the data of Study 4. Corresponding to the findings of the other studies, the product care scale demonstrated good internal consistency ( $\alpha = 0.90$  for bicycles,  $\alpha = 0.92$  for coffee machines), and a subsequent CFA of the data on the three-factor model provided a good model fit (bicycle:  $\chi^2/df$  ratio = 1.77, RMSEA = 0.065, CFI = 0.980, SRMR = 0.043, coffee machine:  $\chi^2/df$  ratio = 3.15, RMSEA = 0.108, CFI = 0.958, SRMR = 0.050.). The total AVE was 0.62 for bicycles and 0.70 for coffee machines. The factor loadings as well as the reliability values for the three factors of the scale were again on a good level (see Table 3).

## 4. Discussion

Our goal was to develop a scale to measure product care tendency in a valid and efficient way. The psychometric analyses of our scale are promising: Results are indicating that our scale is a valid measure for care of products within different categories (leather shoes, coffee machine, bicycles). Independent from the fact that these products differ in their technical complexity as well as in their importance for consumers in daily life, the care behaviour for these

products can be assessed in a valid way. We were able to show that product care tendency is determined by easiness, positive experience and relevance. This three-factor structure of the scale which was developed in Study 2 was confirmed in Studies 3 and 4, with good reliability measures as well as factor loadings (see Table 3).

Our scale consists of items such as “I look after my [product]” or “I try to prevent my [product] from failure” that assess the actual product care behaviour. It also includes items that are related to sources of motivation (e.g., “Taking care of my [product] gives me a good feeling”) and the ability to take care of products (e.g., “I am experienced in looking after my [product]”). The latter items confirm the consideration of motivation as well as easiness as described in Fogg’s behaviour model (Fogg, 2009) and studies based on this model (e.g., Ackermann, 2018; Scurati et al., 2020) in order to influence behaviour. Previous studies in the field of product repair have already described different aspects of motivation and easiness: For example, Terzioglu (2020) identified technical aspects (mostly related to the easiness of repair), emotional aspects and value aspects as sources of motivation and barriers for repair. A lack of ability and/or equipment has been identified as a barrier towards repair and maintenance (Cooper and Salvia, 2018; Dewberry et al., 2017; Diddi et al., 2019; Young, 2017). Laitala and Klepp (2020) found that consumers who know how to sew wear their garments 12 more times than consumers who do not know how to sew. The individual importance of product care for the consumer (as in the item “It is important for me to take care of my [product].”) has been shown to be a strong predictor of the intention for future pro-environmental behaviour (see e.g., Abouelmaged, 2021).

In summary, our scale enables the quantitative assessment of previously identified factors for product care. It provides a scale for a specific pro-environmental behaviour compared to methods that measure pro-environmental behaviour in general (see e.g., Alisat and Riemer, 2015; Lange and Dewitte, 2019; Markle, 2013) and to the qualitative assessment of repair and maintenance (e.g., Cox et al., 2013; Young, 2017).

A specific assessment of product care was seen to be necessary because research has shown that people differ greatly in their pro-environmental behaviour (Kaiser, 1998; Gatersleben et al., 2002; Steg and Vlek, 2009) and researchers cannot infer from the presence of a specific pro-environmental behaviour, such as recycling, that the same individuals would also show another pro-environmental behaviour, e.g., choice of transport means. Our scale has the potential to explore a behaviour that cannot be assessed through already existing scales, proving its unique contribution to research of pro-environmental behaviour.

## 5. Conclusion

### 5.1. Implications for theory, limitations and future research

Our scale can be used to assess the product care tendency among a large number of individuals. The items of the scale cover sources of motivation as well as aspects of ability and current product care activities, thus facilitating further research on drivers, barriers and further determinants of pro-environmental behaviour.

There are a few limitations of our research. First, our scale does not measure a behaviour but instead the tendency to conduct a behaviour. Although one study (Ackermann and Tunn, 2020) has already shown that our scale correlates with the frequency of conducted product care activities, it might be worth to explore the relationship between tendency and actual behaviour in future studies. Second, the scale provides an efficient way to assess product care tendency, but it does not allow to explore sources of motivation or attitudes in more depth. Third, another limitation of our research may be the limited representativeness of our

convenience sample in Study 4. We believe that this does not undermine the value of our scale. In fact, our product care scale has been used in a recent publication (see Ackermann and Tunn, 2020) in which further support is given for the scale’s likelihood to differentiate between groups on their tendency to take care of products. Despite these limitations, we believe that our scale provides a valid and helpful instrument for future research in the field of pro-environmental behaviour.

For future studies, we suggest including the cultural background of the consumers. Research has for example already shown that the acceptance of Circular Economy practices is in general low in Asia (Kuah and Wang, 2020) and that many consumers in Brazil are not aware of sustainability issues (Jugend et al., 2020). Next, we want to highlight the necessity to translate the items carefully when using the scale in other languages. For example, the German translation of ‘taking care’ (‘kümmern’) led to some confusion among our participants in Study 4, because it is an uncommon word in this context. This did not influence our study because participants filled the questionnaires in while we were present, but it may be worth to be considered in future studies.

Our scale facilitates the testing of design strategies for product care (Ackermann et al., 2019) in future studies, which can then lead to recommendations on how design and communication can foster product care. It can also be used for research on product-service systems, in which products are often not owned by the consumer but rented (see also Tukker, 2015; Bocken, 2016; Elzinga et al., 2020). Consumers seem to take less care than for owned products than for rented ones (Ackermann and Tunn, 2020), and further research may explore the effect of ownership on product care in more depth.

### 5.2. Managerial implications

We provide a scale that enables the efficient assessment of product care tendency. The scale can be used during the development of new products and/or during the re-design of existing solutions in order to measure if consumers would take better care of the new/re-designed products. As the reparability of product has been shown to be a strong predictor of future purchase decisions and recommendations (Sabbaghi et al., 2016), product care is a relevant topic to consider in product development.

The three factors relevance, easiness and positive experience present possible points of actions for companies: First, the relevance of product care for the consumer can be strengthened by highlighting the need for product care: Life cycle assessment (LCA; see e.g., Klopffer 2008) measures the ecological burdens that come with all lifecycle steps of a product, from creation until end of life. This information could make consumers aware of their responsibility to take care of their products during the usage stage, thereby reducing the environmental impact of their products. Second, product care should be made as easy as possible, for example through a design that allows consumers to take care of the product themselves. This applies, as an example, to products that are easy to repair because they can be opened with standard tools and because spare parts are made available by the manufacturer (see also Mashhadi et al., 2016). Third, the product care behaviour itself should be associated with positive experiences to enhance the chances of reoccurrence in the future. Positive experiences, such as pride after solving a challenge, can be fostered by the manufacturer, for example by organizing challenges.

The facilitation of product care is supported by initiatives, such as the Right to Repair movement<sup>1</sup> or the Repair Association,<sup>2</sup> who

<sup>1</sup> <https://repair.eu>.

<sup>2</sup> <https://repair.org>.



are fighting for legal actions by the government to ease repair for consumers. The European Union launched a 'right to repair' directive in October 2019 (European Commission, 2019; Hernandez et al., 2020). By 2021, the directive will empower consumers by requiring manufacturers to design products for longer life and by making spare parts available for up to 10 years. These developments highlight the relevance of product care for practitioners in the future, and we hope that our scale can help to develop products that consumers will take care of.

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## Data management

Research data is available online via Mendeley Data.

## CRedit authorship contribution statement

**Laura Ackermann:** Conceptualization, Methodology, Formal analysis, Investigation, Writing - original draft. **Jan P.L. Schoormans:** Conceptualization, Methodology, Writing - review & editing. **Ruth Mugge:** Conceptualization, Methodology, Writing - review & editing.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Appendix A. First set of items (product-specific version) and their evaluation by 9 experts (rated from 1 = very representative to 3 = not representative)

Item	Mean	SD	
1	It is important for me to take care of my [product].	1.22	0.44
2	I have the tendency to look after my [product] more than other people.	1.56	0.73
3	I look after my [product] regularly.	1.44	0.53
4	I try to prevent my [product] from failure.	1.56	0.73
5	I use my [product] only as long as it does not require any care.	2.33	0.87
6	I often postpone maintenance activities for my [product] as long as possible.	2.00	0.71
7	I know how to protect my [product] from possible damage.	1.56	0.53
8	If I do not know how to take care of my [product], I will look for information.	1.67	0.71
9	I am capable of looking after my [product].	1.33	0.50
10	I am confident I can protect my [product] from damage.	1.78	0.44
11	I am afraid I will damage my [product] while taking care of it.	2.44	0.73
12	If I treat my [product] in a bad way, it gives me a bad conscience.	2.11	0.78
13	I have a bad conscience when I do not protect my [product] good enough from damage.	2.11	0.78
14	It is ok for me to spend my time maintaining my [product].	2.00	0.50
15	Taking care of my [product] is too much effort for me.	2.11	0.78
16	In general, looking after my [product] is a positive experience.	2.00	0.87
17	Taking care of my [product] is something I enjoy.	2.33	0.87
18	It makes me proud that I take care of my [product].	2.00	0.87
19	I keep my [product] in a good condition so I can use it for an extra-long period time.	1.22	0.44
20	I treat my [product] in a way so it is useable for an extended time.	1.33	0.50
21	Because of my careful handling, I can use my [product] for a longer period of time.	1.33	0.50
22	One reason why I take care of my [product] is to save money.	1.78	0.67
23	By preventing my [product] from breaking down, I save money.	1.44	0.73
24	When I buy a new [product], I check how it should be taken care of.	2.00	0.71
25	I do my best to protect my [product] from damage.	1.33	0.50
26	I conduct different activities that extend the lifetime of my [product].	2.00	0.71
27	If special care equipment is needed for my [product], I will buy it.	1.67	0.71
28	Family members or friends increase my motivation to look after my [product].	2.33	0.71
29	Repairing my [product] is an important activity for me.	1.89	0.93
30	I own a [product] that I repair, even if that requires a lot of time.	2.00	0.87
31	I repair my [product] regularly.	2.33	0.71
32	I repair my [product] only if I need it urgently.	2.00	0.71
33	I repair my [product] promptly when it is broken.	1.78	0.67
34	I am experienced in repairing my [product].	2.11	0.78
35	I do not repair my [product] even though I know how to do it.	2.22	0.83
36	I look for information to understand how I can fix my [product].	1.44	0.53
37	I enjoy gaining the knowledge that I need to restore my [product].	1.56	0.73
38	I can restore my [product] well.	1.89	0.60
39	I am sure I can fix my [product].	2.11	0.78
40	I fear making things worse when I repair my [product].	2.33	0.71
41	I am willing to reduce overall waste by repairing my broken [product].	1.44	0.53
42	When I have enough time, I repair my broken [product].	1.33	0.50
43	Fixing my [product] is too much effort for me.	2.33	0.71
44	It is embarrassing to have my [product] repaired.	2.78	0.44
45	I remember my prior repair experience on my [product] as negative.	2.56	0.73
46	Fixing my [product] gives me a good feeling.	1.33	0.50
47	It makes me proud that I am able to repair my [product].	1.56	0.73
48	If my [product] breaks down, I generally replace it by a new one.	2.11	0.78
49	I fix my broken [product] because I do not want to buy (a new one).	1.22	0.44
50	I extend the lifetime of my [product] by repair activities.	1.78	0.67

(continued)

	Item	Mean	SD
51	I repair my broken [product] because I do not want to spend money on a new one.	1.33	0.50
52	I fix my broken [product] because it is cheaper than buying a new one.	1.56	0.73
53	When I buy a new [product], it is important for me that it can be repaired easily.	1.89	0.60
54	The repairability of a [product] is important for my purchase decision.	1.89	0.78
55	I do my best to restore my [product] to a sound state.	1.56	0.53
56	Comments from family members or friends push me to repair my products.	2.33	0.71
57	I enjoy gaining new skills for the care of my [product].	1.67	0.71
58	I improve my [product] regularly.	2.22	0.67
59	I clean my [product] regularly.	1.56	0.88
60	I look after my [product] regularly.	2.11	0.60
61	I invest time into the care of my [product].	1.78	0.67
62	I put a lot of effort into the care of my [product].	2.11	0.93
63	I have enough space for repair activities on my [product].	2.22	0.67

Open questions.

- Do you think there are items missing to assess product care affinity?
- Do you have any comments or further input on the items or the scale in general?

care-related items

- 1 It is important for me to take care of my bicycle.
- 2 I have the tendency to look after my bicycle more than other people.
- 3 I look after my bicycle.
- 4 I clean my bicycle.
- 5 I try to prevent my bicycle from failure.
- 6 I do my best to protect my bicycle from damage.
- 7 I often postpone care activities for my bicycle as long as possible.
- 8 If I do not know how to take care of my bicycle, I will look for information.
- 9 I enjoy gaining the knowledge that I need to take care of my bicycle.
- 10 I enjoy gaining new skills for the care of my bicycle.
- 11 I can look after my bicycle well.
- 12 I am experienced in looking after my bicycle.
- 13 I do not keep my bicycle in a good state, even though I know how to do it.
- 14 In general, looking after my bicycle is a positive experience.
- 15 It makes me proud when I take care of my bicycle.
- 16 It makes me proud that I am able to take care of my bicycle.
- 17 I am confident I can protect my bicycle from damage.
- 18

**Appendix B. Overview of the experts involved in study 1**

	gender	Age	years working in the field of Circular Economy
expert 1	female	30–39 years	1–3 years
expert 2	female	30–39 years	1–3 years
expert 3	male	30–39 years	more than 5 years
expert 4	female	20–29 years	1–3 years
expert 5	female	20–29 years	1–3 years
expert 6	male	40–49 years	3–5 years
expert 7	female	40–49 years	more than 5 years
expert 8	female	30–39 years	more than 5 years
expert 9	female	20–29 years	1–3 years

**Appendix C. Items for the exploratory and confirmatory factor analyses in study 2**

(continued on next page)

(continued)

care-related items
I am afraid I will damage my bicycle while taking care of it.
19 Taking care of my bicycle gives me a good feeling.
20 It is ok for me to spend my time taking care of my bicycle.
21 Taking care of my bicycle is not too much effort for me.
22 Taking care of my bicycle does not take too much time.
23 I invest time into the care of my bicycle.
24 I put effort into the care of my bicycle.
25 I treat my bicycle in a way so it is useable for an extended period of time.
26 Because of my careful handling, I can use my bicycle for a longer period of time.
27 I am motivated to keep my bicycle in a good condition, because that reduces waste.
28 By preventing my bicycle from breaking down, I save money.
29 I take care of my bicycle because it is cheaper than buying a new one.
30 When I buy a new bicycle, it is important for me that I can look after it easily.
31 If special care equipment is needed for my bicycle, I will buy it.
32 I take care of my bicycle early enough so it is useable when I need it.
33 I look after my bicycle after a certain amount of time has passed.
34 I have enough space for care activities on my bicycle.
35 I have the necessary equipment for care activities on my bicycle.

## Appendix D. Items used in study 3 (nomological network)

### A. Product care scale (coffee machine/leather shoes)

1. It is important for me to take care of my coffee machine/my pair of leather shoes.
2. I look after my coffee machine/my pair of leather shoes.
3. I try to prevent my coffee machine/my pair of leather shoes from damage.

4. I clean my coffee machine/my pair of leather shoes.
5. I have the necessary equipment for care activities on my coffee machine/my pair of leather shoes.
6. I am experienced in looking after my coffee machine/my pair of leather shoes.
7. I can look after my coffee machine/my pair of leather shoes well.
8. In general, looking after my coffee machine/my pair of leather shoes is a positive experience.
9. Taking care of my coffee machine/my pair of leather shoes gives me a good feeling.
10. It makes me proud that I am able to take care of my coffee machine/my pair of leather shoes.

### B. Consumer-related scales

#### Subscale "Environmental concern" (Kilbourne and Pickett, 2008)

1. I am very concerned about the environment.
2. Humans are severely abusing the environment.
3. I would be willing to reduce my consumption to help protect the environment.
4. Major political change is necessary to protect the natural environment.
5. Major social changes are necessary to protect the natural environment.
6. Anti-pollution laws should be enforced more strongly.

#### Frugality (Lastovicka et al., 1999)

1. If you take good care of your possessions, you will definitely save money in the long run
2. There are many things that are normally thrown away that are still quite useful
3. Making better use of my resources makes me feel good
4. If you can re-use an item you already have, there's no sense in buying something new
5. I believe in being careful in how I spend my money
6. I discipline myself to get the most from my money
7. I am willing to wait on a purchase I want so that I can save money
8. There are things I resist buying today so I can save for tomorrow

#### Use innovativeness scale (Girardi et al., 2005)

1. Even if I don't have the right tool for the job, I can usually improvise.
2. I never throw something away that I might use later.
3. In general, I would rather alter an old product to work in a new situation than purchase a new product specifically for that purpose.
4. After the useful life of a product, I can often think of ways to use its parts for other purposes.
5. I do not enjoy a product unless I can use it to its fullest capacity.
6. I use products in more ways than most people.
7. It's always impossible to improve on a project by adding new features.
8. After purchase of a product, I try to keep track of new accessories that come out in the market.
9. I enjoy reading and adding on to projects in which I'm involved on a continuing basis.

C. Scales related to the specific product or the product category

Attachment (Schifferstein and Zwarthuis-Pelgrim, 2008)

1. I am very attached to my coffee machine/my pair of leather shoes.
2. My coffee machine/my pair of leather shoes has/have no special meaning for me\*.
3. My coffee machine/my pair of leather shoes is/are very dear to me.
4. I have a bond with my coffee machine/my pair of leather shoes.

Attitude towards coffee machine/pair of leather shoes (Ahluwalia and Burnkrant, 2004)

1. Good/bad
2. Pleasant/unpleasant
3. Positive/negative
4. Useful/useless
5. Excellent quality/poor quality

Disposal Tendency (Mugge, 2007)

1. I would like to get rid of my coffee machine/my pair of leather shoes.
2. If it was possible, I would sell my coffee machine/my pair of leather shoes.
3. I expect to have my coffee machine/my pair of leather shoes in possession for a long time.
4. I will soon discard my coffee machine/my pair of leather shoes.

Involvement (Bower and Landreth, 2001; Zaichkowsky, 1985)

To me, my coffee machine/my pair of leather shoes is:

1. Unimportant – important

3. My coffee machine/my pair of leather shoes appears/appear to be reliable.

Satisfaction (Crosby and Stephens, 1987)

1. Satisfied – dissatisfied
2. Pleased – displeased
3. Favourable – unfavourable

Usefulness (Cox and Cox, 2002)

- 1 . Not useful – useful
- 2 . Not functional – functional
- 3 . Not practical – practical

Appendix E. Items used in study 4 (known-groups test)

- A. Own scale (bicycle/coffee machine): see Appendix C, from 1 = strongly disagree to 5 = strongly agree
- B. Environmental attitude (based on environmental concern sub-scale by Kilbourne and Pickett, 2008) from 1 = strongly disagree to 5 = strongly agree
  1. I am very concerned about the environment.
  2. Humans are severely abusing the environment.
- C. Have you ever visited a repair café? (1 = yes, regularly, 2 = once or twice, 3 = never)
- D. How would you judge your level of expertise ... (from 1 = low to 5 = high)
  - 1 ... In repairing complex technical products, such as a coffee maker?
  - 2 ... in repairing clothes?
  - 3 ... in repairing simple products such as a bicycle?

Appendix F. overview of the different groups in study 4 (known-groups test)

	number of participants	care for bicycle	care for coffee machine	care for both products
design students (NL)	33	2.87	2.97	2.92
humanities students (NL)	33	2.95	2.92	2.88
design students (AT)	35	2.90	2.85	2.79
humanities students (AT)	33	3.30	3.30	3.28
people from the street (AT)	36	3.84	3.80	3.71
fab lab (AT)	19	2.44	2.45	2.43

2. Of no concern – of concern to me
3. Irrelevant – relevant
4. Does/do not matter – matters/matter to me

Quality (Grewal et al., 1998)

1. My coffee machine/my pair of leather shoes appears/appear to be of good quality.
2. My coffee machine/my pair of leather shoes appears/appear to be durable.

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