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Abstract: Product attachment, the emotional bond experienced with a product, is an emerging concept for sustainable production and consumption. The logic behind it is that when people are attached to any product, they are more likely to handle the product with care and to postpone its replacement or disposal. Some types of product have been studied regarding product attachment in past research but the focus has been on the perspectives of professional designers and manufacturers rather than on consumers' 'everyday creativity' activities such as 'individual upcycling'.

Individual upcycling, creation out of used materials resulting in a higher quality or value product than the compositional elements, is particularly relevant to product attachment. This is because upcycling, as a creative, participatory user activity, may offer the experiences of self-expression, group affiliation, special memories and pleasure, all of which are possible product attachment determinants.

Recent evidence suggests that the number of upcycling practitioners have increased, possibly as a response to the contemporary 'maker movement' and aided by readily available physical and digital resources. Despite this growth and its potential as a means for sustainable production and consumption at household level, individual upcycling has not been investigated extensively, especially its relation to product attachment and product longevity.

This study used an exploratory questionnaire with 23 UK-based upcycling practitioners to investigate the links between individual upcycling, product attachment and product longevity. The results show the correlations amongst the degree, determinants and consequences of product attachment as well as aesthetic and functional satisfaction from the emotionally attached, upcycled products. The paper further explains how different demographic characteristics and product categories moderate the strength of the aforementioned variables.

Introduction

Product attachment, the emotional bond experienced with a product (Schifferstein & Pelgrim, 2003), is an emerging concept with the potential to engender sustainable consumption (Cooper, 2005; Mugge, Schifferstein, & Schoormans, 2004; Van Hinte, 1997). The logic behind it is that so long as people are attached to any product, they might be more likely to handle the product with care, to postpone its replacement or disposal, and to repair it when it breaks down (Cramer, 2011; Ramirez, Ko, & Ward, 2010; Mugge R., Product Attachment (PhD thesis), 2007; Van Hinte, 1997), while not necessarily requiring people to commit themselves to pro-environmental behaviour (van Nes, 2010).

Some types of product have been studied regarding product attachment: for example, consumers' most favourite or most cherished possessions (e.g. family heirlooms and jewellery) (Schultz, Kleine, & Kernan, 1989; Wallendorf & Arnould, 1988) or mass-produced, ordinary consumer durables (Mugge, Schifferstein, & Schoormans, Product attachment and satisfaction: understanding consumers' post-purchase behaviour, 2010; 2006a; 2006b; 2005). Past studies have shown interests in product personalisation, mass customisation and participatory design to increase product attachment (i.e., strengthening the person-product relationship) as design strategies for sustainable consumption (Cramer, 2011; Mugge,

Schoormans, & Schifferstein, Emotional bonding with personalised products, 2009a; Incorporating consumers in the design of their own products. The dimensions of product personalisation, 2009b; Fletcher, 2008; Chapman, 2005). Despite such emphasis on consumer involvement in design, past studies have not yet paid attention to 'everyday creativity' activities (Gauntlett, 2011) without involving manufacturers, such as consumers' individual making, crafting or upcycling at household level.

Individual upcycling, creation or modification of any product out of used materials in an attempt to generate a product of higher quality or value than the compositional elements (Sung, Cooper, & Kettley, 2014) at household level, is particularly relevant to product attachment since practitioners may often utilise old products with which they have already developed the emotional bond. Upcycling, as a creative, participatory user activity, may offer the experiences of self-expression, group affiliation, special memories and pleasure, all of which are possible product attachment determinants (Mugge, Schifferstein, & Schoormans, A longitudinal study of product attachment and its determinants, 2006a). In other words, individual upcycling is likely to create strong product attachment and lead to product longevity.

The evidence suggests that the overall number of upcycling practitioners have been increased or at least have become more visible, possibly as a response to contemporary Maker Movement (AndersonChris, 2012; LangDavid, 2013) and aided by readily available physical resources (e.g. Maker Faire, Hackspace/Makerspace) and digital resources (e.g. Instructables, Etsy). Despite this growth (or increased visibility) in the practice and its potential as a strategy for product longevity (and sustainable consumption), individual upcycling has not been fully investigated, especially in terms of its relation to product attachment and product longevity.

The main aims of the paper, therefore, are twofold. The first is to address the links between

individual upcycling, product attachment, and its determinants and consequences including product longevity. The second is to pinpoint some possible group differences in the strength of the aforementioned variables according to demographic characteristics and product categories.

Research methodology

A questionnaire was administered to 23 UK-based upcycling practitioners. The data was collected between April and July 2014.

Procedure and measures

The upcycling practitioners were first asked to select up to three products to which they had the most emotional attachment from a list of upcycled products. They were then asked to fill in up to three identical questionnaires based on their selection.

The questions addressed (1) product attachment determinants (self-expression, group affiliation, memories and pleasure¹) from the emotionally attached product made by upcycling; (2) aesthetic and functional satisfaction from the emotionally attached product made by upcycling; (3) product attachment; and (4) product attachment consequences (disposal tendency, product care, expected product longevity, irreplaceability, and expected product lifetime years). Measures for these variables were obtained on seven-point Likert scales (1= "strongly disagree", 7= "strongly agree"), except for the expected product lifetime years (for which an absolute figure was given). See Table 1 for the descriptions of variables used in the questionnaire.

Sampling

Hackspace was considered to be an appropriate starting point for the recruitment of upcycling practitioners based on its facilities

¹ These four possible product attachment determinants were used in the study by Mugge, et al. (2006a). Their findings demonstrated that product attachment is positively affected by self-expression, memories and pleasure for ordinary consumer durables. Though group affiliation proved to be non-

significant in their study, this study included it as a possible determinant because upcycling practitioners may feel affiliated to other upcyclers, makers, or material/product providers (e.g. family inheritance).

and service,² and growing numbers in the UK.³ Ten workshops in ten different cities of nine different regions in England were selected.⁴ A recruiting advertisement was posted on Google groups or forums of the ten workshops. Thirteen respondents directly reacted to the advertisement and another ten were identified by snowball sampling.

Self-expression	This product that I made reflects who I am.
Group affiliation	This product that I made indicates that I am a maker/ crafter/ upcycler/ hacker.
Memories	This product reminds me of people or events that are important to me.
Pleasure	I feel good when I use this product.
Aesthetic satisfaction	I am happy with the appearance of this product.
Functional satisfaction	I am happy with the functionalities of this product.
Product attachment	This product has special meaning to me and I have an emotional bond with this product.
Disposal tendency	I would like to get rid of this product.
Product care	I take good care of this product.
Expected product longevity	I hope that this product will last for a long time.
Irreplaceability	This product is irreplaceable to me.
Expected product lifetime years	For how many years would you like to use the product?

Table 1. Variable items.

Respondents

Respondents were from nine different cities and aged between 24 and 66 years old. 17 (74%) were British and 6 (26%) were non-British. 15 (65%) were male and 8 (35%) were female. 12 (52%) worked in science and engineering, 7 (30%) in art and design, and 4 (17%) in other areas (health service, business and management) or were unemployed.

² Hackspaces provide any local residents (e.g. craft hobbyist, hackers, makers, tinkers, artists, entrepreneurs, etc.) with a membership including the access to tools, materials and expertise.

³ Hackspaces have increased in numbers since 2009 and are now available in 53 different locations (UK Hackspace Foundation, 2015).

⁴ The selected workshops included (1) Nottingham Hackspace (Nottingham, East Midlands); (2) Makespace (Cambridge, East of England); (3) London Hackspace (Greater London); (4)

Analysis

44 questionnaires from 23 respondents were analysed by employing descriptive statistics, correlational analysis (Spearman's Rank Order Correlation) and non-parametric tests (Mann-Whitney U Test and Kruskal-Wallis H Test), using SPSS (Statistical Package for the Social Sciences) version 22.0.

Results

Descriptive statistics

When respondents selected certain products as their most emotionally attached products after upcycling ($M=5.41$, $SD=1.59$), they reported high mean values of self-expression ($M=5.27$, $SD=1.56$), group affiliation ($M=5.66$, $SD=1.45$), pleasure ($M=5.59$, $SD=1.30$), aesthetic satisfaction ($M=5.75$, $SD=1.26$), functional satisfaction ($M=5.82$, $SD=1.45$), product care ($M=5.09$, $SD=1.36$), and expected product longevity ($M=5.37$, $SD=1.53$), and a low mean value of disposal tendency ($M=1.45$, $SD=.92$). Memories and irreplaceability data showed slightly lower mean values with a larger standard deviation (memories: $M=4.41$, $SD=2.37$; irreplaceability: $M=3.61$, $SD=2.34$). The expected product lifetime years ranged between 1 year and over 50 years, resulting in the mean value of 11.67 ($SD=13.23$).

Correlations between product attachment (PA) determinants, aesthetic and functional satisfaction, and PA based on the most emotionally attached, upcycled products Spearman's Rank Order Correlation revealed that PA is positively correlated with all four PA determinants (self-expression, group affiliation, memories and pleasure) ($r=.45$ to $.66$, $p<.001$), but not with satisfaction from aesthetic or functional qualities. PA determinants are mostly positively correlated with each other: only group affiliation and pleasure are not significantly correlated. Pleasure is positively correlated with functional satisfaction but not with aesthetic satisfaction, although there is significant

MakerSpace (Newcastle upon Tyne, North East England); (5) HACMan (Manchester, North West England); (6) Build Brighton Hackspace (Brighton, South East England); (7) Reading Hackspace (Reading, South East England); (8) OxHack (Oxford, South West England); (9) Potteries Hackspace (Newcastle-under-Lyme, West Midlands); and (10) Leeds Hackspace (Leeds, Yorkshire and the Humber). The selecting criteria were accessibility to and activeness of the Hackspace members.

correlation between functional and aesthetic satisfaction (see Table 2).

	SE	GA	M	P	AS	F S	P A
Self-expression	-						
Group affiliation	.51 5**	-					
Memories	.63 1**	.46 1**	-				
Pleasure	.69 2**	.35 1	.5 19 **	-			
Aesthetic satisfaction	.28 8	.33 7	.0 59	.36 1	-		
Functional satisfaction	.23 6	.22 4	.1 05	.49 0**	.55 8**	-	
Product attachment	.66 4**	.45 1**	.6 27 **	.64 4**	.30 9	.2 1 3	-

Table 2. Spearman's rho between PA determinants, satisfaction, and PA based on the most emotionally attached, upcycled products ** $p < .001$ (2-tailed).

	DT	PC	EL	I	E Y	P A
Disposal tendency	-					
Product care	-.34 3	-				
Expected product longevity	-.36 5	.679 **	-			
Irreplaceability	-.12 2	.442 **	.479 **	-		
Expected product lifetime years	-.36 3	.252	.445 **	.237	-	
Product attachment	-.27 4	.371	.364	.516 **	.36 3	-

Table 3. Spearman's rho between PA and PA consequences based on the most emotionally attached, upcycled products. ** $p < .001$ (2-tailed).

Correlation between product attachment (PA) and PA consequences based on the most emotionally attached, upcycled products

Spearman's Rank Order Correlation showed that PA is positively correlated with irreplaceability ($r = .516, p < .001$) but there is no statistically significant correlation of PA with disposal tendency, product care, expected product longevity, or expected product lifetime years. Irreplaceability, however, is positively correlated with product care ($r = .44, p < .001$) and expected product longevity ($r = .48, p < .001$) as well as PA. Expected product longevity is also positively correlated with expected product lifetime years ($r = .45, p < .001$) (see Table 3).

Group difference based on demographic characteristics

Gender difference

A Mann-Whitney U Test revealed a statistically significant differences between male and female answers in PA, self-expression, group affiliation, memories, pleasure, product care, expected product longevity, irreplaceability, and expected product lifetime years.

	U	Z	Sig.	r	Md	n
Self-expression	76	-2.89	.000**	.57	M: 4 F: 7	27 17
Group affiliation	12	-2.72	.007**	.41	M: 6 F: 7	27 17
Memories	11	-2.92	.003**	.44	M: 4 F: 7	27 17
Pleasure	14	-2.08	.038**	.31	M: 5 F: 7	27 17
Product attachment	11	-2.89	.004**	.44	M: 5 F: 7	27 17
Product care	92	-3.21	.001**	.49	M: 4 F: 6	27 16
Expected product longevity	87	-3.34	.001**	.51	M: 5 F: 7	27 16
Irreplaceability	10	-2.97	.003**	.45	M: 2 F: 6	27 17
Expected product lifetime years	13	-1.96	.050**	.30	M: 4 F: 15	27 16

Table 4. Mann-Whitney U Test, effect size, and median scores with significant difference across gender groups. ** $p < .05$.

In all cases, the median scores from female respondents are higher than males. A large effect was shown in self-expression ($r = .57$) and expected product longevity ($r = .51$). Aesthetic and functional satisfaction, and disposal tendency did not show gender difference (see Table 4).

Age difference

A Kruskal-Wallis Test revealed a statistically significant difference across three different age groups (Gp1, $n=23$: 20-29yrs, Gp2, $n=13$: 30-49yrs, Gp3, $n=8$: 50+yrs) in group affiliation: $X^2(2, n=44)=7.12$, $p=.028$; pleasure: $X^2=6.75$, $p=.034$; and functional satisfaction: $X^2=7.37$, $p=.025$. The older the age group, the higher was the median score. Self-expression, memories, aesthetic satisfaction, PA and all PA consequences did not show age difference (see Table 5).

	X^2	Sig.	Md	n
Group affiliation	7.12	.028**	Gp1: 5 Gp2: 6 Gp3: 7	23 13 8
Pleasure	6.75	.034**	Gp1: 5 Gp2: 6 Gp3: 7	23 23 8
Functional satisfaction	7.37	.025**	Gp1: 6 Gp2: 7 Gp3: 7	23 13 8

Table 5. Kruskal-Wallis Test and median scores with significant difference across three age groups $p<.05$**

Occupational difference

A Kruskal-Wallis Test revealed a statistically significant difference across three different occupational groups (Gp1: art and design, Gp2: science and engineering, Gp3: other – see above in Respondents) in self-expression, memories, product care, expected product longevity and irreplaceability.

	X^2	Sig.	Md	n
Self-expression	7.72	.021**	Gp1: 7 Gp2: 5 Gp3: 6.5	13 23 8
Memories	8.36	.015**	Gp1: 7 Gp2: 3 Gp3: 6.5	13 23 8
Product care	10.17	.006**	Gp1: 5.5 Gp2: 4 Gp3: 6.5	12 23 8
Expected product longevity	12.74	.002**	Gp1: 7 Gp2: 4.5 Gp3: 7	13 22 8
Irreplaceability	18.56	.000**	Gp1: 5 Gp2: 2 Gp3: 7	13 23 8

Table 6. Kruskal-Wallis Test and median scores with significant difference across three occupational groups. ** $p<.05$.

For self-expression and memories, 'art and design' reported the highest median scores (both $Md=7$). For product care and irreplaceability, 'other' reported the highest median scores ($Md_{CARE}=6.5$, $Md_{IRRE}=7$). For expected product longevity, 'art and design' and

'other' reported the same higher median score (both $Md=7$) than 'science and engineering'. 'Science and engineering' reported the lowest median scores in all five variables (see Table 6).

Group difference based on product categories

A Kruskal-Wallis Test revealed a statistically significant difference in irreplaceability levels across five different product category groups (Gp1, $n=14$: experimental and/or artistic projects, Gp2, $n=10$: inside-the-home furniture, Gp3, $n=8$: garden, shed, workshop and/or outdoor products, Gp4, $n=6$: small home products and/or decorations, Gp5, $n=6$: other personal belongings), $X^2(4, n=44)=11.02$, $p=.026$ (See Appendix for item examples of each product category group). Small home products and/or decorations recorded the highest median score ($Md=6.5$), followed by other personal belongings ($Md=5.5$) and inside-the-home furniture ($Md=3.5$). Experimental and/or artistic projects ($Md=2$) and garden, shed, workshop and/or outdoor products ($Md=1.5$) showed lower median scores than other product categories.

Discussion

The statistically significant correlation between PA and PA determinants confirms findings from past studies on ordinary consumer durables (e.g., (Mugge R. , Product attachment, 2007; Schifferstein, Mugge, & Hekkert, 2004). This might suggest that the causal relationship between PA determinants and PA in consumer durables can also be applied to upcycled products.

The positive correlation between pleasure and functional satisfaction but lack of statistically significant correlation between PA and satisfaction from appearance or functionalities also partially corroborate the results from Mugge, et al. (Product attachment and satisfaction: understanding consumers' post-purchase behaviour, 2010). One difference is that pleasure in this study is not significantly correlated with aesthetic satisfaction, which implies that the sampled makers' (or upcyclers') pleasure from their upcycling outcomes may be a result of satisfactory functions but not necessarily a result of superior appearance.

The correlation between PA and PA consequences in this study is limited, unlike findings from other existing studies (i.e.

irreplaceability, product care, expected product longevity, etc.) (Ramirez, Ko, & Ward, 2010; Mugge R., Product attachment, 2007; Govers & Mugge, 2004). Only one significant correlation was found between PA and irreplaceability. Considering the positive correlation between irreplaceability and product care, and between irreplaceability and expected product longevity, however, it might be the case that irreplaceability for makers/upcyclers mediates the effect of PA on product care and expected product longevity. Irreplaceability as a crucial condition for a long-lasting relationship was also pointed out by Mugge and her colleagues (Design strategies to postpone consumers' product replacement: The value of a strong person-product relationship, 2005).

Older age groups' higher scores in group affiliation, pleasure and functional satisfaction as well as women's higher scores in PA, all four PA determinants, and part of PA consequences partially correspond with past research that group affiliation and memories are more relevant for women and older consumers, whereas pleasure from functionality is more relevant for men and younger consumers (Dyl & Wapner, 1996; Kamptner, 1991; Chikszentmihalyi & Rochberg-Halton, 1981; Furby, 1978 cited in Mugge, 2007). One original finding on demographic difference might concern occupational difference: the science and engineering group showed lower median scores in self-expression, memories, product care, expected product longevity and irreplaceability. This, however, could be explained by the fact that almost 90% of science and engineering group respondents were male. These group differences based on demographic characteristics may suggest which group of people has to be targeted (or not targeted) in the case that individual upcycling is considered for scaling up to make a bigger impact on environment and society.

The higher median scores in irreplaceability from small home products and decorations, and other personal belongings than from inside-the-home furniture, experimental and artistic projects, or garden, shed, workshop and outdoor products conform with the study by Schifferstein, et al. (Designing consumer-product attachment, 2004), which found that PA is higher for ornaments than functional products (e.g. lamp, clock and car). Such product

category difference should also be taken into account when scaling up is considered.

Conclusion

This exploratory study has described how product attachment determinants and level of satisfaction from the aesthetic and functional qualities of the emotionally attached, upcycled products are correlated with the extent of product attachment; and how the extent of product attachment is correlated with the consequences of product attachment. The paper further explained how different demographic characteristics and product categories moderate the strength of product attachment and, its determinants and consequences as well as aesthetic and functional satisfaction.

The results are, however, based on a limited sample. Moreover, as respondents were not asked questions about every upcycled product, potentially interesting areas have not been addressed, such as identifying the proportion of all upcycled products that exhibit meaningful levels of product attachment. Future research can also take into account the possible rebound effect (e.g. using more materials and energy for the purpose of upcycling) and the actual environmental impact accordingly (i.e. in terms of total materials and energy involved, and waste and emissions produced during upcycling).

Notwithstanding these limitations, this study has demonstrated that individual upcycling has the potential as a means towards sustainable production and consumption at household level by strengthening product attachment, and explained demographic characteristics and product categories to consider for possible scaling up.

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Appendix: Item examples of each product category group.

Gp	Group name	Item examples
Gp1	Experimental and/or artistic projects	Raspberry pi project Tour robot Sculpture
Gp2	Inside-the-home furniture	Nest of tables Side board TV stand
Gp3	Garden, shed, workshop and/or outdoor products	Bug boxes Patio and path Bird box Compost bin
Gp4	Small home products and/or decorations	Lamp Kettle Cushion
Gp5	Other personal belongings	Jumper Prom dress Jewellery