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Circular consumption to reduce environmental pressure: Potential of behavioural change in the Netherlands

Julia Koch [a,b,*], Kees Vringer [b], Ellen van der Werff [a], Harry Wilting [b], Linda Steg [a]

[a] Faculty of Behavioural and Social Sciences, Department of Environmental Psychology, University of Groningen, the Netherlands
[b] PBL Netherlands Environmental Assessment Agency, the Netherlands

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ABSTRACT

The European Union and various individual countries strive for a more circular economy to reduce environmental pressure. The transition towards a circular economy requires a change in what and how we consume. We argue that a realistic estimation of the environmental mitigation potential depends on 1) the environmental benefit that results from a certain circular behaviour, referred to as the 'theoretical reduction potential' (TRP), and 2) the behavioural plasticity, reflecting the share of consumers who are not yet engaging in the behaviour but would be willing to do so if circular goods and services are easily accessible and affordable.

The aim of this study was to provide insight into the environmental mitigation potential of circular consumer behaviour by assessing both their TRP and behavioural plasticity. To do so, we conducted a large-scale survey in the Netherlands (n = 2542) in which we examined the current adoption rate and willingness of consumers to engage in 92 circular consumer behaviours. Furthermore, we made a rough estimate of the TRP of these behaviours in terms of greenhouse gas emissions and land use.

Our results show that many behaviours with a large TRP (mainly related to consuming less and saving energy) have a rather low behavioural plasticity, either because most consumers are not willing to adopt such a behaviour or because they are already engaging in it. Behavioural plasticity is relatively high when it comes to prolonging product lifetimes and purchasing more sustainable product alternatives, but these behaviours tend to have a relatively small TRP. Our findings demonstrate that the TRP is a limited indicator of the actual environmental mitigation potential of circular consumer behaviour and suggest that behavioural plasticity is an important additional indicator to identify the types of behaviour relevant for research and policymaking.

1. Introduction

Many environmental problems, such as climate change, environmental degradation, and biodiversity loss, are largely due to the large amounts of resources used in the production of goods and services. The expected growth in resource use will lead to further increases in environmental pressures and associated social costs (IRP, 2019; OECD, 2019). To counter this trend, the European Union (EC, 2020) and various individual countries (EMF, 2021; OECD, 2022), such as the Netherlands (IenM and EZK, 2016), have set the ambition to achieve a circular economy (CE). This refers to a restorative and regenerative economic system that 'aims to keep products, components, and materials at their highest utility and value at all times' (EMF, 2015, p. 2). In essence, a circular economy involves as few material resources and as little waste as possible. One of its main purposes is to ultimately reduce environmental pressures linked to resource extraction, processing and use, as well as waste management (EC, 2020; Hanemaaijer et al., 2021; Kirchherr et al., 2017). The transition towards a circular economy requires fundamental changes in all societal subsystems and considerable efforts of all societal actors (Ghisellini and Ulgiati, 2020; Van Langen et al., 2021). Companies, for example, can drive changes related to product design and business models, such as more resource-efficient production, design for durability, and product repair or provision of services instead of product ownership (Bocken et al., 2016). Consumers can support the CE transition by changing their perceptions of and behaviour towards circular products and services, such as the types and quality of goods and services they consume, how and for how long goods are being used, and how they are discarded (e.g., Camacho-Otero et al., 2020; Mugge, 2018).

To effectively promote the CE transition, it is critical to understand

* Corresponding author at: Faculty of Behavioural and Social Sciences, Department of Environmental Psychology, University of Groningen, the Netherlands.
E-mail address: julia.koch@pbl.nl (J. Koch).

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which behavioural changes are most effective in mitigating the negative environmental pressures of consumption, as this is the end goal of a circular economy. Various studies have assessed the environmental benefits of changes in consumer behaviours that may contribute to a circular economy, such as dietary changes (e.g., Hallström et al., 2015; Rosi et al., 2017; Sun et al., 2022), second-hand clothes (Farrant et al., 2010; Trzepacz et al., 2023), lifetime extension of electrical household appliances (Prakash et al., 2016) and mobile phones (Rizos et al., 2016), and energy-saving behaviours (e.g., Beal et al., 2012; Chini et al., 2016; Mata et al., 2018). Other studies have assessed the environmental gains of a range of consumer options across various domains (e.g., Carlsson Kanyama et al., 2021; Ivanova et al., 2020; Moran et al., 2020). These studies offer valuable insights into the extent to which different behaviours can reduce environmental pressures when adopted by all consumers. However, generally, these studies do not account for the fact that some circular behaviours are more likely to be adopted by consumers than others (e.g., Bjelle et al., 2018; Carlsson Kanyama et al., 2021; Van de Ven et al., 2018), or they use very rough estimates of the adoption potential (e.g., IGES et al., 2019; Moran et al., 2020; Vita et al., 2019). Certain behaviours may have a high environmental mitigation potential in theory; however, this mitigation potential will not be achieved in practice if consumers are not willing to adopt these behaviours. Hence, evidence-based data on the proportion of consumers who could be induced to adopt circular behaviour are needed for realistic estimations of the environmental mitigation potential.

We aim to address this gap in the literature by providing insight into the environmental mitigation potential of various types of circular consumer behaviour based on both the theoretical environmental reduction potential related to a circular behaviour as well as the possible adoption rate. By considering both factors, we can give an indication of which circular consumer behaviours would have the highest potential to mitigate environmental pressures. We addressed the following research questions (RQ):

RQ1. What is the possible adoption rate of various types of circular behaviour? To answer this question, we look at the extent to which consumers currently engage in various types of circular behaviour and the extent to which consumers are willing to adopt various types of circular behaviour in the future, if main obstacles would be removed.

RQ2. To what extent could various types of circular consumer behaviour reduce environmental pressures, compared to the currently common non-circular behaviour?

RQ1 sheds light on the extent to which circular behaviours could be adopted by consumers if critical obstacles were removed, while taking into account the current uptake of the behaviours. RQ2 concerns the theoretical environmental reduction potential. We addressed RQ1 by measuring current uptake of and willingness to engage in 92 consumer behaviours that contribute to a circular economy. This was done by means of a survey amongst a representative sample of the Dutch population. RQ2 was addressed through a rough estimation of the theoretical environmental benefits of the same 92 behaviours based on previous literature. Combining the findings of the two RQs allows us to identify which types of behaviour would be most promising to target in the CE transition, because of their environmental benefits and their likelihood of being adopted, provided critical barriers are removed.

Section 2 defines the main concepts used in this study based on literature. Section 3 describes how the circular consumer behaviours were selected for this study, how we measured the current adoption rate of circular behaviours and consumers' willingness to engage in these behaviours, and how we estimated the extent to which these behaviours could reduce environmental pressures. Section 4 presents the results from our study. Section 5 discusses the main findings and limitations of the study and elaborates what the results mean for policy-making and further research. Section 6 presents a summary of the main conclusions.

2. Literature review

Our study builds on previous streams of literature about the CE concept and about the assessment of environmental mitigation potential of consumer behaviour. We use the CE literature to develop a conceptual framework to identify various types of circular consumer behaviour (Section 2.1). Furthermore, we build our approach to provide more realistic estimates of the environmental mitigation potential of consumer behaviour on previous studies in the energy domain (Section 2.2).

2.1. Circular consumer behaviour

We define circular consumption behaviour as the individual acts performed by people to satisfy their needs in various areas of life, in which they acquire, use and dispose of goods and services that contribute to the principles of a circular economy (based on Geiger et al., 2018). The four principles of a circular economy are: 1) narrow resource flows (reduce the use of material resources and the environmental pressures linked to their production and consumption), 2) slow down resource flows (extend product life), 3) close resource loops (recycle products at the end of their life span), and 4) substitute resource flows (replace products with alternatives that are made of renewable materials or materials with less environmental impact; Hanemaaijer et al., 2023, based on Bocken et al., 2016). Within these four main principles, several circular strategies can be distinguished, commonly referred to as R-strategies. The R-strategies are an operationalization of the CE concept based on its core idea of value retention of resources (Reike et al., 2018). They represent different ways to facilitate a circular economy. In literature, the R-strategies are often presented in a hierarchical order, with 'Refuse' being the strongest contributor to a circular economy and 'Recycle' or 'Recover' being the weakest (Reike et al., 2018). The hierarchy is built on the rough assumption that higher R-strategies lead to a larger decrease in resource use and related environmental pressure (Potting et al., 2017), the ultimate goal of the CE transition (EC, 2020; Hanemaaijer et al., 2021; Kirchherr et al., 2017). In literature, 38 different R-strategies can be found (Reike et al., 2018). For this study, we use the R-strategies described by Potting et al. (2017, based on RLI, 2015).

By combining the R-strategies (based on Potting et al., 2017 and RLI, 2015) with the three consumption phases (i.e. acquire, use and dispose of), we developed a conceptual framework to distinguish different types of consumer behaviours based on how they affect material resource use (Table 1). Consumers can contribute to different R-strategies during each of the three consumption phases. In the acquiring phase, consumers may, for instance, contribute to the R-strategy 'Rethink' by renting products rather than buying them, or they may contribute to the R-strategy 'Recycle' by buying products made from recycled materials or recyclable products. The empty cells in Table 1 indicate that we could not identify consumer behaviour for these combinations. For example, consumers are able to contribute to the R-strategy 'Refuse' only in the phase of acquiring a product (by forgoing a product or purchasing a digital alternative) and not in the use and disposal phases.

2.2. Environmental mitigation potential of circular consumer behaviours

As described above, we suggest that calculating the environmental reduction potential without accounting for the adoption potential does not reflect an accurate estimate of the extent to which a certain circular consumer behaviour can reduce environmental pressures because it is unlikely that all consumers would take up the behaviour. Other researchers refer to this realistic reduction potential as 'Reasonably Achievable Emissions Reduction (RAER)' (Dietz et al., 2009). We build on the approach that Dietz et al. (2009) used to assess energy behaviours and apply it to circular consumer behaviours. Following their research, we suggest that the realistic reduction potential depends on two factors: The theoretical environmental reduction potential of a behaviour and

Table 1
Conceptual framework of circular consumer behaviours.

		Consumption phases		
CE principles	R-strategies	Acquire	Use	Dispose of
Narrow resource flows	REFUSE: Make a product obsolete by abandoning its function, or use a radically different product to provide the same function	Refrain from buying a product or purchase a digital product alternative	–	–
	RETHINK: Intensify product use	Purchase a multifunctional product; borrow, rent, or lease a product; purchase a product together with others (co-ownership)	Lend or rent out a product or use a product together with others (co-use, e.g., car sharing or carpooling)	–
	REDUCE: Reduce resource use in the production of the product or in its use phase	Purchase a product that is made from fewer resources or that requires fewer resources during its use phase (e.g., energy-efficient appliances)	Use a product efficiently (e.g., wash clothes at low temperature or reduce car use)	–
Slow down resource flows	REUSE: Continue to use a product as long as it is still in good condition (by a different user)	Purchase a durable, reusable or second-hand product	Use a product with care, maintain it well, and use it until the end of its technical lifetime	Sell or donate a product for reuse
	REPAIR: Repair a broken product to enable continuation of its original function	Purchase a modular/repairable product	Repair a broken product	Sell or donate a broken product so that its parts can be used to repair a similar product
	REFURBISH: Refurbish/modernise an old product	Purchase a refurbished product	–	Sell or donate a product for refurbishing
	REMANUFACTURE: Use parts of a discarded product in a new product that has the same function	Purchase a product made of an old product that has the same function (e.g., a carpet made from pieces of old carpet)	–	Sell or donate a product so that parts can be used to make new products that have the same function
	REPURPOSE: Use (parts of) a discarded product in a new product that has a different function	Purchase a product made of an old product that has a different function (e.g., a house made from old tires)	–	Turn a product or part of it into a product that has a different function (e.g., a purse made from an old pair of trousers)
Close resource loops	RECYCLE: Use materials of a discarded product in a new product	Purchase a product that is made from recycled materials or that can be recycled	–	Hand in a broken product for recycling
Substitute resource flows	–	Purchase a product that is made from renewable materials or materials with a lower environmental impact or one that uses renewable resources during its use phase (e.g., an electric instead of a petrol car)	–	–

the share of current non-adopters who are expected to take on the behaviour. We refer to the first factor as the 'theoretical reduction potential' (TRP) and define it as the environmental benefit that results from engaging in a certain circular consumer behaviour, compared to the current non-circular standard behaviour (e.g., buying a second-hand mobile phone instead of a new one). It represents the environmental benefits that could be attained by a consumer changing from non-circular to circular behaviour. The TRP multiplied by the number of consumers who have not adopted the circular behaviour in question, compares to what other studies refer to as 'potential emissions reduction' (Dietz et al., 2009), 'technically feasible potential reduction' (Moran et al., 2020) or 'full implementation impacts' (IGES et al., 2019).

The second factor describes the proportion of consumers who have not yet adopted a given circular behaviour but would be willing to do so. We refer to this with the term 'behavioural plasticity', which we define as the proportion of people that could be induced to change their behaviour under a particular set of policies, opportunities and constraints (Dietz, 2023). Dietz et al. (2009) conceptualise behavioural plasticity as the share of the population who would adopt a behaviour voluntarily, when the most effective documented interventions that do not involve new regulation of technology or behaviour would be implemented. In their study, Dietz et al. (2009) based plasticity estimates regarding energy saving behaviours on empirical data of individuals' and households' responses to past interventions. However, interventions on certain types of circular consumer behaviour in the Netherlands are scarce (e.g., repair or purchase of durable goods) and little is thus known about the effects such interventions can achieve. We therefore estimated behavioural plasticity by assessing the share of consumers who do not currently engage in a certain behaviour but report to be willing to do so if critical obstacles they currently face would be removed. As price and inconvenience are currently two main barriers for many types of circular behaviour (EC, 2018; Zeiske, 2021; Zibell et al., 2021), we assessed individuals' willingness to use circular goods and services if these would be more easily accessible and not more expensive than currently common non-circular alternatives. By doing so, we provide an indication of the proportion of people that might adopt circular behaviour voluntarily if price and convenience were comparable to current non-circular alternatives. Our approach differs from previous research (on energy-efficiency behaviour, Allen et al., 2015) that measured behavioural plasticity without any change of obstacles, simply as the extent to which consumers consider themselves likely to perform a given behaviour in the future.

Combining the TRP and behavioural plasticity gives insight into the potential of different circular behaviours to mitigate negative environmental pressures. A circular behaviour with a large TRP and high level of behavioural plasticity has most likely a high environmental reduction potential. The outcome for behavioural plasticity may differ substantially from the outcome for the TRP. Indeed, behavioural plasticity appears to be higher for behaviour related to the adoption of more energy-efficient equipment (e.g., low-flow showerheads, energy-efficient appliances, and fuel-efficient vehicles) than for behavioural changes in daily equipment usage, while the potential emission reduction (described as TRP) does not differ much between the two types of behaviour (Dietz et al., 2009). This illustrates that behaviours with a small TRP may lead to more reduction in actual environmental pressures than behaviour with a large TRP, if considerably more people adopt the behaviour (i.e., it has a higher behavioural plasticity). In this study, therefore, we assessed both TRP and behavioural plasticity related to

circular consumption to determine what types of behaviour would be most effective in reducing environmental pressures.

3. Method

Section 3.1 describes the selection procedure for the circular consumer behaviours assessed in this study. Section 3.2 explains how we assessed behavioural plasticity through a quantitative survey amongst a representative sample of the Dutch population and descriptive statistics. Section 3.3 describes how the TRP of circular consumer behaviour was estimated based on greenhouse gas (GHG) emissions and land-use data on Dutch households and from the literature.

3.1. Selection of circular consumer behaviours

In a first step, we made a longlist of circular consumer behaviours by applying the framework in Table 1 to a range of different product groups. To keep the number of behaviours manageable, we selected 11 product groups that are responsible for a relatively large share of the current environmental impact within various consumption domains. We define a consumption domain as part of the total consumption pattern that satisfies specific consumer needs. The consumption domains covered are furnishings, clothing, food, housing, vacations, leisure, and personal care and health (based on Vringer et al., 2001). We determined the most environmentally relevant product groups per domain, based on data on the GHG emissions and land-use footprints of the goods and services consumed by Dutch households in 2017 (based on a hybrid model combining Input–Output and LCA data by Benders et al. (2021), see Supplementary material S1):

- Furnishings domain:
  1) Furniture
- Clothing domain:
  2) Clothes
  3) Washing machine
- Food domain:
  4) Food and packaging
- Housing domain:
  5) House, encompassing energy and water use
- Vacations domain:
  6) Holiday trips, encompassing transport and accommodation
- Other domains:
  7) Car, encompassing the vehicle itself and car use
  Small electric appliances, divided into 8) small household appliances, 9) tools and 10) smartphones

11) Gifts, which were not included as a separate category in Benders et al. (2021). We added them as a product group to distinguish between purchases consumers do for themselves or for others.

The longlist encompassed 168 circular consumer behaviours for these 11 product groups. In a second step, a narrower selection was made, based on independent ratings by six experts on four criteria: feasibility, environmental benefits, convenience, and affordability of a certain behaviour. These criteria were chosen to eliminate circular consumer behaviours that are technically unfeasible or very inconvenient for consumers to carry out (e.g., lending furniture to others or not owning a mobile phone), not affordable for most consumers, or that have a negligible environmental benefit. For each criterium, the behaviours with a very low average rating were eliminated from the list. Ultimately, some excluded behaviours were included again, either because they are often mentioned in the literature and in discussions on circular economy, or because they are potentially interesting for comparisons between product groups (an aspect not explicitly addressed in this article). This selection process resulted in 98 behaviours that were included in our survey.

3.2. Behavioural plasticity

In order to assess the behavioural plasticity of the selected 98 behaviours (RQ1), we assessed the extent to which consumers engage them (current behaviour) and the extent to which consumers are willing to adopt them if two critical barriers — convenience and price — would be removed (willingness). We describe the data collection, survey sample and the data analysis in the following Sections 3.2.1–3.2.3.

3.2.1. Data collection

Data on current behaviour and willingness were collected via an online survey amongst a representative sample of the adult Dutch population (18 years and older). The Netherlands provides a suitable context for this study, as the country has high levels of consumption (Eurostat, 2023; World Bank, 2023) and environmental effects related to consumption (EEA, 2022; Global Footprint Network, 2023). At the same time, Dutch consumers have a wide range of products and services to choose from, which provides the opportunity for consumers to make their own choices regarding the acquisition, use and disposal of products and potentially adopt circular behaviour. The data collection for this study took place in September and October 2021 via the *Kantar NIPObase* panel (Kantar, 2021). The full survey can be found in the Supplementary material (S2). Ethical approval for the survey was granted by the University of Groningen. The survey was pretested in qualitative interviews of 12 people with a predominantly lower educational background. This led to minor changes in the wording and inclusion of examples and additional explanations (e.g., adding the definition of 'refurbished', and adding examples of seasonal fruits and vegetables). The survey was sent out to a representative sample of the Dutch population of 3532 people and was followed up by two reminders. Participants were compensated for their participation in points that could be exchanged for shopping vouchers.

The survey consisted of two parts. The first part included questions on the extent of respondents' current circular behaviour and the second part on respondents' willingness to engage in the same circular behaviours. In both parts, the questions were divided into 11 sub-sections according to the product groups listed in Section 3.1. To limit the survey time to a maximum of 20 minutes, each participant was presented with a maximum of five product groups for which they filled out both parts of the survey. A selection question was asked at the beginning of the survey to determine which product groups the respondent was responsible for within their household. This was done to ensure respondents were presented only with questions related to their own behaviour (e.g., excluding washing machine-related questions for people who do not do their own laundry). The sample size per product group varied between 941 and 2542 respondents.

3.2.1.1. Current behaviour. A common way of measuring behaviour is to ask participants how often they exhibit a particular behaviour. However, self-reporting of frequency measures may be flawed as respondents may base them on fragmented recall or flawed estimation strategies (Kormos and Gifford, 2014). We aimed to reduce such biases by asking respondents about their current product used or the last product purchased or discarded where possible, so that respondents can recall their behaviour more easily and accurately. Examples are 'What is the fuel consumption of your car?' to determine the fuel-efficiency of respondents' cars, 'What is the brand name of your smartphone?' to determine whether they have a phone that is easily repairable or made from recycled materials or 'In what condition did you buy or receive your last vacuum cleaner/water kettle/coffee machine/iron?' to determine whether small household appliances are bought new, second hand or refurbished. In order to improve data accuracy, we also included 'don't know' options for questions to which we assumed that, based on the pretests, some respondents may not know the answer (e.g. the material composition of products they would purchase or the share of

organic foods amongst their groceries).

3.2.1.2. Willingness to engage in circular behaviour. Willingness to engage in circular behaviour was measured with the question 'To what extent are you open to…' on a 4-point scale from 'definitely no' to 'definitely yes'. The respondents were presented with the questions about willingness for all product groups for which they also had filled in questions measuring current behaviour, no matter whether they already engage in the behaviour or not. This approach was chosen since it is possible that respondents who have engaged in a circular behaviour recently are not willing to do so again in the future. We asked willingness under the condition that the mentioned circular goods and services are easily accessible and not more expensive than the currently common non-circular alternatives. This condition was presented to the respondents after every question ('Please assume that the mentioned products are easily available and not more expensive than the currently common alternatives.').

3.2.1.3. Behavioural plasticity. The behavioural plasticity of the circular consumer behaviours was calculated based on respondents' current behaviour and their willingness to engage in that behaviour. Specifically, in line with our definition of behavioural plasticity (Section 2.2), we calculated the share of consumers who do not currently engage in a certain behaviour but are willing to do so if critical obstacles they currently face would be removed. Hence that, behaviour plasticity for each behaviour was calculated by computing the difference between the share of respondents that would be willing to engage in a particular circular behaviour and the share of respondents that are already engaging in the behaviour (for more details, see Section 3.2.3).

3.2.2. Sample description

Of the 3532 people invited to participate in the survey, 2542 responded. This is a 72 % response rate. Table 2 gives an overview of the socio-demographic composition of the sample. The comparison of this sample against the *Dutch Golden Standard* (data about the current structure of the Dutch population provided by Statistics Netherlands (MOA, 2022)) shows that the sample was representative of the population in the Netherlands in terms of gender, education level and place of residence (see Supplementary material S3). The 18–24 age group was slightly under-represented. This under-representation applies to the product groups furniture, small household appliances, tools, washing machine, car, house, and gifts, and is likely due to the fact that young respondents are more likely to still be living with their parents and are therefore less often responsible for these product groups. Due to the selection question at the beginning of the survey, these types of questions were excluded for them. For the other product groups in the survey, the age distribution of the sample was representative of the Dutch population.

Table 2
Socio-demographic characteristics of the survey sample in comparison to the non-responders and the Dutch Golden Standard.

	Sample (n = 2542)	Non-responders (n = 990)	Dutch Golden Standard
Gender:			
Male	49.6 %	48.0 %	50.6 %
Female	50.4 %	52.0 %	49.4 %
Age:			
18–24	8.7 %	13.7 %	10.9 %
25–34	15.1 %	17.8 %	15.9 %
35–44	14.7 %	17.3 %	14.9 %
45–54	19.4 %	17.6 %	18.2 %
55–64	18.4 %	13.1 %	16.9 %
65+	23.7 %	20.5 %	23.3 %
Level of education:			
Lower	22.0 %	22.9 %	21.3 %
Medium	40.7 %	40.1 %	39.7 %
Higher	37.4 %	37.0 %	39.0 %
Place of residence:			
3 biggest cities (Amsterdam, Rotterdam, The Hague)	11.6 %	13.4 %	11.9 %
Suburban municipalities	4.1 %	3.6 %	4.0 %
Western part of the Netherlands	29.5 %	29.8 %	29.4 %
Northern part of the Netherlands	9.5 %	10.7 %	10.0 %
Eastern part of the Netherlands	22.2 %	18.8 %	20.8 %
Southern part of the Netherlands	23.1 %	23.6 %	23.8 %

A short second survey was sent to the 990 non-responders of the survey. The aim was to find out their reasons for not participating and to get an idea of whether their current behaviour and their willingness to engage in circular behaviour differed from that of the initial group of respondents. We limited this second survey to four questions: One on their reason for not participating, one on their current behaviour (the extent to which they save energy at home) and two on their willingness to adopt circular behaviour (the extent to which they are willing to get furniture repaired and to buy few new clothes, respectively). This second survey was completed by 291 people (a 29 % response rate). The most frequently mentioned reasons for not participating in the first survey were 'no time, too busy' (50 %), 'the topic mentioned in the invite did not appeal to me' (11 %) and 'no desire or interest' (9 %). The answers regarding saving energy and repairing furniture did not differ from those by the initial respondents. However, we found a slightly higher level of willingness to buy few new clothes compared to the initial respondents in the 65+ age group (Supplementary material S4). Because the deviation was only small, we presumed that systematic differences between initial respondents and this second group were unlikely — assuming that the 291 respondents in the second group would be representative of all 990 non-respondents to the initial survey.

3.2.3. Data analysis

The data analysis was carried out using descriptive statistics in SPSS (IBM Corp., 2021). For each behaviour, we calculated the share of participants who were already engaging in a certain behaviour ('current behaviour') and the share of participants willing to do so ('willingness'). For these calculations, we made some additional assumptions:

i. We recoded the data to a dichotomous scale (yes/no). For current behaviour, this meant that the answers of the respondents who were displaying a particular type of circular behaviour were recoded to 'yes' and the answers of those who were not to 'no'. For willingness, 'definitely yes' and 'rather yes' were recoded to 'yes', and 'definitely not' and 'rather not' were recoded to 'no'.
ii. For a few behaviours, the share of 'don't know' responses was relatively high (62 % for buying clothing made from recycled materials, 50 % for buying furniture made from recycled materials and 15 %–18 % for organic food). Recoding 'don't know' answers as missing values would lead to an unrealistically high uptake rate for these product groups, such as 17 % for the purchasing of clothes of recycled materials. This percentage seems unrealistic compared to that of recycled materials in consumer clothing in the Dutch market (around 1 %, Royal Haskoning DHV, 2021). For products for which the current standard is the non-circular option (e.g. clothes made of virgin fibres rather than recycled material), we therefore assumed that 'don't know' answers would indicate that respondents were most likely to have engaged in non-circular behaviour. As the choice for circular alternatives to these types of products would have been made consciously, we counted 'don't know' responses as 'non-circular' for the following behaviours: buying organic food products, local and seasonal food, and clothing and furniture made from recycled materials.

iii. For 10 behaviours, no share of current behaviour could be calculated for several content-related and methodological reasons. For example, probably due to misinterpretation of the selection question at the beginning of the survey, vehicle owners were overrepresented. We suspect that many non-car owners amongst the respondents would have indicated not to be responsible for car-related decisions made in their households, which is why they did not get assigned this part of the survey, but they may very well have been responsible for deciding *against* car ownership. For four behaviours, we were able to use data on current behaviour from other studies on the same year with Dutch samples, and the remaining six behaviours were left out for further analysis, leading to a net result of 92 behaviours for the analysis (see Supplementary material S5 for a detailed overview).

iv. Recoding survey responses to a dichotomous scale (see point i) was straightforward for most circular behaviours. For example, owning a second-hand mobile phone was recoded to 'yes' and a new mobile phone to 'no', and having implemented insulation measures was recoded as 'yes' and not having done so to 'no'. For 12 behaviours, however, we had to determine the point at which we would consider them circular. For example, for the behaviour of 'eating meat only rarely', respondents would indicate how often they would eat meat, and we recoded 'less than once a week' to 'yes' and more than that to 'no' (see Supplementary material S5 for more detailed descriptions of all behaviours). For these 12 behaviours, we adjusted the willingness variable accordingly. For example, the answers from all respondents who said to be eating meat at least once a week were recoded according to the procedure described under point i, while eating meat less than once a week was recoded to 'yes', as these respondents were thus already engaging in the circular behaviour.

v. Regarding the willingness to buy durable products, we expected that, if circular products would be as easily available as currently common alternatives and would not be more expensive (see Section 3.2.2), all respondents would be willing to do so. We therefore did not include this question in the survey and, instead, assumed the level of willingness to buy durable products to be 100 % for all product groups.

To display the results, we plotted all analysed 92 behaviours on a chart with the share of current circular behaviour on the y-axis and that of willingness on the x-axis. Next, we explored several ways of classifying the behaviours into groups according to R-strategies, consumer phases, consumption domains, product groups and a combination thereof. The goal was to make it easier to grasp what types of behaviours are mainly located in the different parts of the chart.

3.3. Theoretical reduction potential

We made rough estimates of the TRP in terms of GHG emissions and land use. GHG emissions are the main driver of climate change, and changes in land use the main driver of biodiversity loss (Jaureguiberry et al., 2022; Newbold et al., 2015). The combination of GHG emissions and land use forms a suitable set of indicators for assessing TRP because of the limited overlap between the two, as goods and services that require a lot of land often require few fossil resources and thus emit relatively few GHG emissions and vice versa (Steinmann et al., 2016). For the analysis, we looked at the entire footprints of GHG emissions and land use related to each behaviour, encompassing the extraction of raw materials, the production of goods, their transportation, trade, use, and disposal.

In a first step, for each circular behaviour, we estimated the potential positive impact in terms of both GHG emissions and land use, compared to the currently common non-circular behaviour (in %). This was done based on the literature and our own estimations (see Supplementary material S6 for more details). In a second step, these reduction percentages were applied to the annual GHG emissions and land use of the average Dutch household for the corresponding product category (for the year 2017, according to the Environmental Analysis Program (EAP) by Benders et al., 2021). An example: If a vegetarian rather than a meat-based diet reduces food-related GHG emissions by 20 % to 35 %, this reduction rate was applied to the absolute total of GHG emissions related to the annual food consumption of the average Dutch household according to EAP. This results in the absolute reduction in GHG emissions and land use for each circular consumer behaviour per household.

Subsequently, we recoded the resulting environmental gains per behaviour to five categories, as shown in Table 3. The coding was chosen so that each category would encompass an equally large range for the reduction in environmental pressure. The resulting scores for the 92 behaviours were distributed over all five categories. The coding enabled us to combine both GHG emissions and land use into one measure. We calculated an unweighted average from the two values for GHG emissions and land use for each circular behaviour. This means that behaviours that score high on one environmental indicator but low or even negative on the other were thus assigned an average score. For example, taking the train instead of a car or aeroplane when going on vacation would result in a large reduction in greenhouse gas emissions, but only a small reduction in land use and thus scores in the middle (3). The behaviours that score high are associated with high reductions in both GHG emissions and land use.

4. Results

In this section, we first present the results on the extent to which the survey participants currently engage in circular consumer behaviour and on their level of willingness to adopt such behaviour (Section 4.1). After that, we report the findings on the TRP and show how the TRP and the behavioural plasticity vary between different behaviour types (Section 4.2).

4.1. Current behaviour and willingness to adopt circular behaviour

The 92 circular behaviours are plotted in Fig. 1 on the two dimensions 'current behaviour' and 'willingness'. Every dot represents a certain circular behaviour. The coordinates for all individual behaviours displayed in Fig. 1 can be found in the Supplementary material (S7). We classified the circular consumer behaviours into nine types, based on a combination of R-strategies, consumer phases and consumption domains. Alternative attempts to group behaviours based on R-strategies, consumer phases, consumption domains and product groups, separately, were abandoned as they revealed a less clear picture (see Supplementary material S8). The coloured oval areas support the visual interpretation of the results. They indicate the main location and dispersion of the behaviours per behaviour type. Their location is based on mean of the coordinates of all behaviours of a behaviour type, and their size is based on the variance (the length and the width represent two standard deviations of the x- and y-coordinates, respectively). Behaviours related to saving energy when travelling (mobility) and lower levels of consumption are highly dispersed in Fig. 1 and are therefore not highlighted with

Table 3
Classification of the theoretical reduction potential.

Ranking	Theoretical reduction potential	Greenhouse gas emissions (kg CO_2 eq per household, per year)	Land use (m^2 per household, per year)
1	No reduction or an increase	<10	<1
2	Small reduction	11–150	1.1–15
3	Medium reduction	151–300	15.1–30
4	Large reduction	301–450	30.1–45
5	Very large reduction	>450	>45

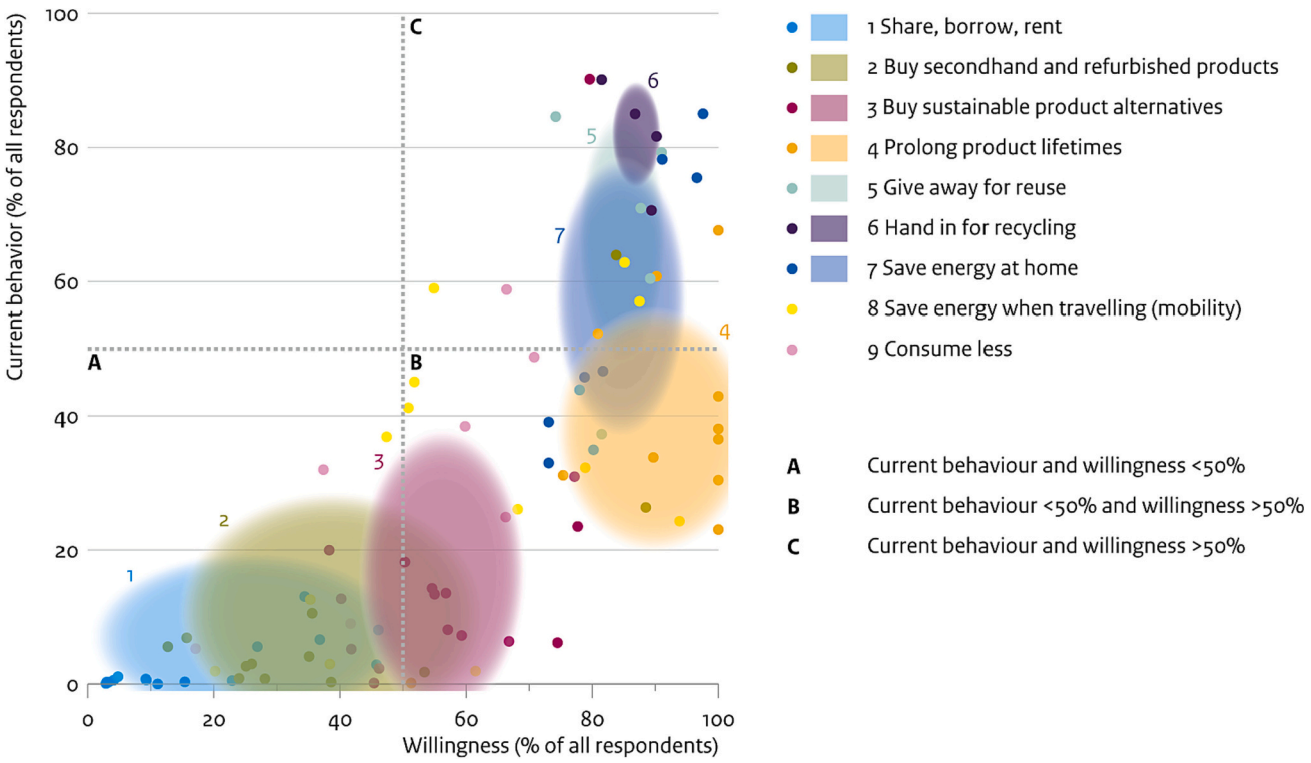

Fig. 1. Current adoption of and level of willingness to engage in different types of circular consumer behaviour.

a coloured area.

We can roughly divide Fig. 1 into three parts, indicated with boxes A, B, and C. Circular consumer behaviours in box A, on the bottom left, are exhibited by a minority of respondents, and only a small group indicated to be willing to adopt such behaviours. Behaviours in box B, on the bottom right, are also exhibited by a minority of respondents, but — in contrast to box A — most respondents indicated to be willing to engage in these circular behaviours. The behaviours in box C, on the top right, are engaged in by most respondents and most are also willing to do so. The upper left half of the figure is empty. This makes sense because it is unlikely that the share of consumers engaging in a certain behaviour is larger than the share of those being willing to engage in it — unless a certain behaviour is forced on consumers (e.g., through rules and regulations).

4.1.1. *Box A: low engagement in circular behaviour and low level of willingness to do so*

Box A mostly contains behaviours related to sharing, borrowing and renting, and to buying second-hand and refurbished products. Most respondents were not engaging in such circular behaviour nor were they willing to do so, even if it would be easily accessible and not more expensive than non-circular alternatives.

- *Sharing, borrowing and renting*: <1 % of respondents were found to rent, borrow, or lease products rather than owning them. Depending on the product, 4 % to 15 % were willing to rent, borrow or lease them. The willingness is relatively high for renting tools from a hardware store or renting privately owned apartments or rooms during holidays (both at 46 %). Yet, only between 3 % and 11 % of respondents indicated to be willing to rent out their own property (e.g. clothes, tools or car) to strangers, via a platform. The willingness to share goods with friends and family is greater: 27 % of respondents said they were willing to share clothes, 34 % cars, and 80 % tools with their family and friends.
- *Buying second-hand and refurbished products* is not common yet: Around 90 % of respondents said they bought their last piece of furniture, clothing, smartphone or electrical appliance new rather than second hand or refurbished, with second hand being slightly more common than refurbished. The willingness to buy second-hand or refurbished products varies between 13 % for second-hand washing machines and 53 % for restored furniture. The car is an exception, with 64 % of car owners already having a second-hand car and 84 % being willing to buy one (box C). Across all product groups, respondents were slightly more willing to buy refurbished products than second-hand products.
- *Other types of behaviour*: A few other types of behaviour can also be found in box A, namely buying sustainable product alternatives (e.g., a smartphone made from recycled materials or sustainable gifts), saving energy when travelling (e.g., taking the train or bus when going on holiday), and consuming less (e.g., eating little meat or dairy or not owning a car).

4.1.2. *Box B: low engagement in circular behaviour but a high level of willingness to do so*

Box B mostly contains behaviours related to buying sustainable product alternatives and prolonging product lifetimes. Most respondents were not buying products made from more sustainable materials (e.g., clothes made from kenaf or linen or furniture made from recycled materials), nor were they engaging in behaviours that would contribute to longer product lifetimes, such as buying durable products or repairing them when broken. However, most respondents indicated that they would be willing to do so if circular products and services were easily accessible and would not be more expensive than non-circular alternatives.

- *Buy sustainable product alternatives*: About 6 % of respondents reported that their most recently purchased piece of furniture or clothing was made from recycled materials, while between 8 % and 14 % said most of the food they buy was organic. The willingness to buy sustainable product alternatives varies between 38 % (camping instead of staying at a hotel) and 80 % (buying fresh instead of frozen fruits and vegetables).

- *Prolong product lifetimes*: Most respondents indicated that they were not yet engaging in behaviour that would contribute to prolonging the lifetime of products, but many would be willing to do so. For example, around one third of respondents said they had their broken washing machine or small electrical appliances repaired and have relatively durable small electric appliances, clothes and furniture. The majority of respondents (75 % or more) were willing to engage in such behaviour. An exception is the purchase of repairable phones (modular phones, such as a Fairphone or Shiftphone), with <1 % of participants owning such a phone and 51 % being willing to buy one in the future.
- *Other types of behaviour*: Moreover, some other types of behaviour can be found in box B, such as buying food and beverages in reusable packaging, taking holidays close to home, buying few new clothes and washing clothes at lower temperatures.

4.1.3. Box C: high level of engagement in circular behaviour and high level of willingness to do so

In box C, we mostly find behaviours related to giving products away for reuse, handing broken products in to be recycled, and saving energy at home. Most respondents reported to engage in these types of behaviour.

- *Giving away for reuse and handing in for recycling*: The majority of respondents (59 %–85 %, depending on the product) reported having given away or sold their most recently replaced product for second-hand use rather than discarding it, if it was still in good condition, and handed in broken products for recycling instead of discarding them (68 %–90 %). The general level of willingness to give products away to be reused and recycled was 74 %–90 %.
- *Saving energy at home*: The majority of respondents reported to already engaging in energy-saving behaviours at home, such as insulating the house (85 %), taking measures to save energy used for heating the house (78 %), or owning an energy-efficient washing machine (75 %), and nearly half of respondents said they reduce warm water use (47 %) and wash clothes at low temperature (46 %). The level of willingness to engage in such energy-saving behaviour varies between 79 % and 98 %. Exceptions are the installation of solar panels and using washing machines in eco mode, with a lower share of respondents engaging in such behaviour (39 % and 33 %) and a slightly lower level of willingness (73 %) to do so in the future (box B).
- *Other types of behaviour*: Box C also contains other types of behaviour, such as owning a durable washing machine, a second-hand car, or eating fish only occasionally.

4.1.4. Types of behaviour that are dispersed in Fig. 1

With regard to saving energy when travelling, most respondents indicated to drive in a fuel-efficient manner, to do their grocery shopping close to home or to take an aeroplane for long holidays only (i.e., at least two weeks). Choosing destinations closer to home for leisure activities and holidays and owning an electric or energy-efficient car are examples of travelling behaviour that most respondents were willing to adopt but mostly are not yet engaged in. Furthermore, most respondents were not willing to take a train or bus instead of a car or aeroplane when they go on holiday. Most respondents reported that they had not yet reduced their level of consumption. A minority of them indicated to eat dairy products (5 %) or meat (9 %) less than once a week, to buy food with less packaging material (24 %) or few new clothes (fewer than 5 pieces per year (25 %)), to not own a car (32 %), or to live in a small apartment (smaller than 40 m^2 per person (38 %)). The willingness to engage in these behaviours varied widely, from 17 % for eating dairy products only rarely to 78 % for buying food with less packaging material.

4.2. Theoretical reduction potential and behavioural plasticity

Fig. 2 depicts the TRP (a combination of GHG emissions and land use, ranging between 1 and 5 points, see Section 3.3) for each behaviour. Amongst the 10 behaviours with the largest TRP (all shown in Fig. 2), five are related to consuming less (namely eating meat and dairy only rarely, not owning a car, buying few new clothes, and living in a small apartment), two are energy-related behaviours (reducing energy used for heating and installing solar panels), two are related to travelling (taking holidays close to home and taking an aeroplane for long holidays only) and one behaviour is related to more sustainable product alternatives (purchasing clothes made from recycled materials). Behaviours related to consuming less generally have a large TRP as they reduce both GHG emissions and land use. Energy- and mobility-related behaviours result in a relatively high reduction in GHG emissions, whereas behaviours related to furniture and clothing generally contribute to a relatively high reduction in land use. Separate results on both GHG emissions and land use can be found in the Supplementary material (S9).

As explained in Section 2.2, the extent to which circular consumer behaviour can reduce environmental pressures depends on the combination of the TRP and the behavioural plasticity. In Fig. 3, the TRP and behavioural plasticity are depicted for the nine different types of circular behaviour separately. Fig. 3 shows that most of the behaviours with a large TRP (3 points or higher) have a behavioural plasticity smaller than 50 %, resulting in empty upper right regions of the graphs (with one exception, namely buying clothes made from recycled materials). The behavioural plasticity of these behaviours is low for one out of two reasons: Either because the level of willingness amongst respondents is low (behaviours in box A in Fig. 1), which is the case for only rarely eating dairy or not owning a car. Or because the behaviour is currently already done by the majority of respondents (behaviours in box C in Fig. 1), such as saving energy on heating or applying insulation. Moreover, Fig. 3 reveals that different behaviours with a small TRP (lower than 3 points) have a relatively high behavioural plasticity. Despite the small TRP, they could still make an important contribution to reducing environmental pressures as the majority of consumers are willing to engage in them if price and accessibility were comparable to current non-circular alternatives. This mainly applies to various behaviours related to prolonging product lifetimes and purchasing sustainable product alternatives.

Circular behaviours that have *both* a relatively large TRP (2.5 points or higher) and a relatively high behavioural plasticity (40 % or higher) are labelled in Fig. 3. These cover various types of behaviour, including prolonging product lifetimes (buying durable clothes), buying more sustainable product alternatives (furniture and clothes made from recycled materials), buying second-hand and refurbished products (refurbished furniture), mobility-related behaviours (driving an electric vehicle or taking holidays close to home), and behaviours related to lower consumption levels (buying few new clothes). Behaviours related to sharing, borrowing, and renting, giving products away for reuse, and handing broken products in for recycling tend to have both a relatively small TRP and a low level of behavioural plasticity.

5. Discussion

We aimed to assess the environmental mitigation potential of a broad range of circular consumer behaviours, in order to identify which types of behaviour are most relevant for policymakers to target in the CE transition. In Section 5.1, we discuss our main findings, and the theoretical and practical implications of our findings. Next, we discuss the limitations of our study (Section 5.2) and provide suggestions for further research (Section 5.3).

5.1. Main findings and theoretical and practical implications

In line with earlier research (Dietz et al., 2009), we proposed that a

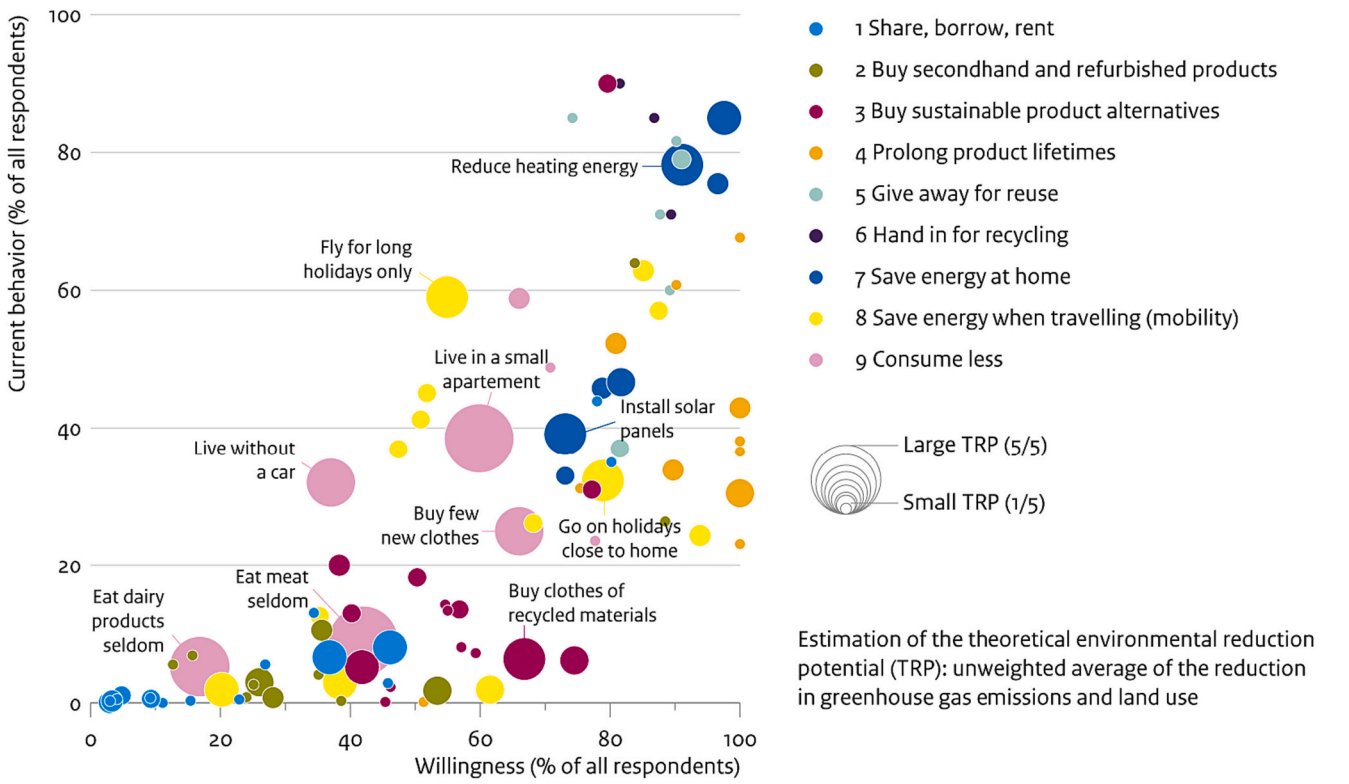

Fig. 2. Current adoption, willingness and theoretical reduction potential (TRP) related to circular consumer behaviour.

realistic assessment of the environmental mitigation potential not only depends on the environmental benefits that results from such behaviour, the TRP, but also on the behavioural plasticity (i.e. the share of people that do not yet engage in a given circular behaviour, but are willing to do so if circular products and services are easily accessible and not more expensive than currently common non-circular alternatives). By measuring behavioural plasticity of circular consumer behaviour in addition to their TRP, we address a gap in previous literature, in which behavioural plasticity was not accounted for or only roughly estimated (see Section 1). Our findings indicate that TRP alone indeed provides a limited overview of which circular behaviours would mitigate environmental pressures the most, and that it is important to also consider behavioural plasticity. Specifically, our results show that many of the behaviours with a large TRP appear to have a rather low behavioural plasticity, which means that realising the TRP in practice may be challenging. We found that circular consumer behaviour related to lower consumption levels, energy-saving behaviour related to the home and to travelling, and behaviour related to furniture and clothes have a large TRP. Behaviour related to lower consumption levels substantially contributes to the reduction in both GHG emissions and land use. Energy-saving behaviour mainly contributes to a reduction in GHG emissions, and behaviour related to furniture and clothes to a reduction in land use. These results correspond well with previous studies (Bjelle et al., 2018; Ivanova et al., 2020; Vita et al., 2019). However, the behavioural plasticity of many of these types of behaviour is rather low because we found that either many consumers already engage in them (e.g. insulating their homes or reducing energy used for heating), or few consumers would be willing to adopt the behaviour (e.g., not owning a car or eating dairy products only rarely), even if the circular options would be as easily accessible and affordable as their conventional alternatives.

Combining TRP and behavioural plasticity allowed us to distinguish four groups of circular consumer behaviour that come with different implications for policymakers.

i. *Behaviours with a large TRP and high level of behavioural plasticity*, including buying few new clothes, going on holidays close to home and buying electric vehicles. Many consumers are willing to adopt such behaviour in the future if the circular options would be easily accessible and not more expensive than the currently common non-circular alternatives. This suggests that a large group of consumers could likely be persuaded to change their behaviour in a relatively short period of time if these provisions would be met. These behaviours can be promising to target for policymakers to achieve a relatively fast reduction in environmental pressures. Making circular goods and services more easily accessible and affordable is a crucial step towards achieving this.
ii. *Behaviours with a small TRP and high behavioural plasticity*, mainly encompassing prolonging product lifetimes and buying sustainable product alternatives. A large share of consumers would be willing to engage in these behaviours if circular options were made more accessible and affordable. This suggests that, despite the small TRP, these behaviours still hold a relevant potential to reduce environmental pressures (although smaller than the first group of behaviours mentioned above).
iii. Behaviours with a large TRP and low behavioural plasticity, which can be divided into two sub-groups:
    a. *Behaviours with a large TRP which most people are not willing to adopt*, even when circular options would be more easily accessible and affordable. Examples are not owning a car, eating dairy products and meat only rarely or going on holiday by train or bus rather than by car or aeroplane. These behaviours potentially may lead to a large reduction in environmental pressures, but policy interventions that only improve accessibility and affordability are likely not enough to promote their widespread adoption. Here, policy interventions need to address other motivational factors and barriers that inhibit the circular behaviours, such as the feeling of freedom, independence and personal expression related to car ownership and social norms (Beirão and Cabral, 2007; Belgiawan

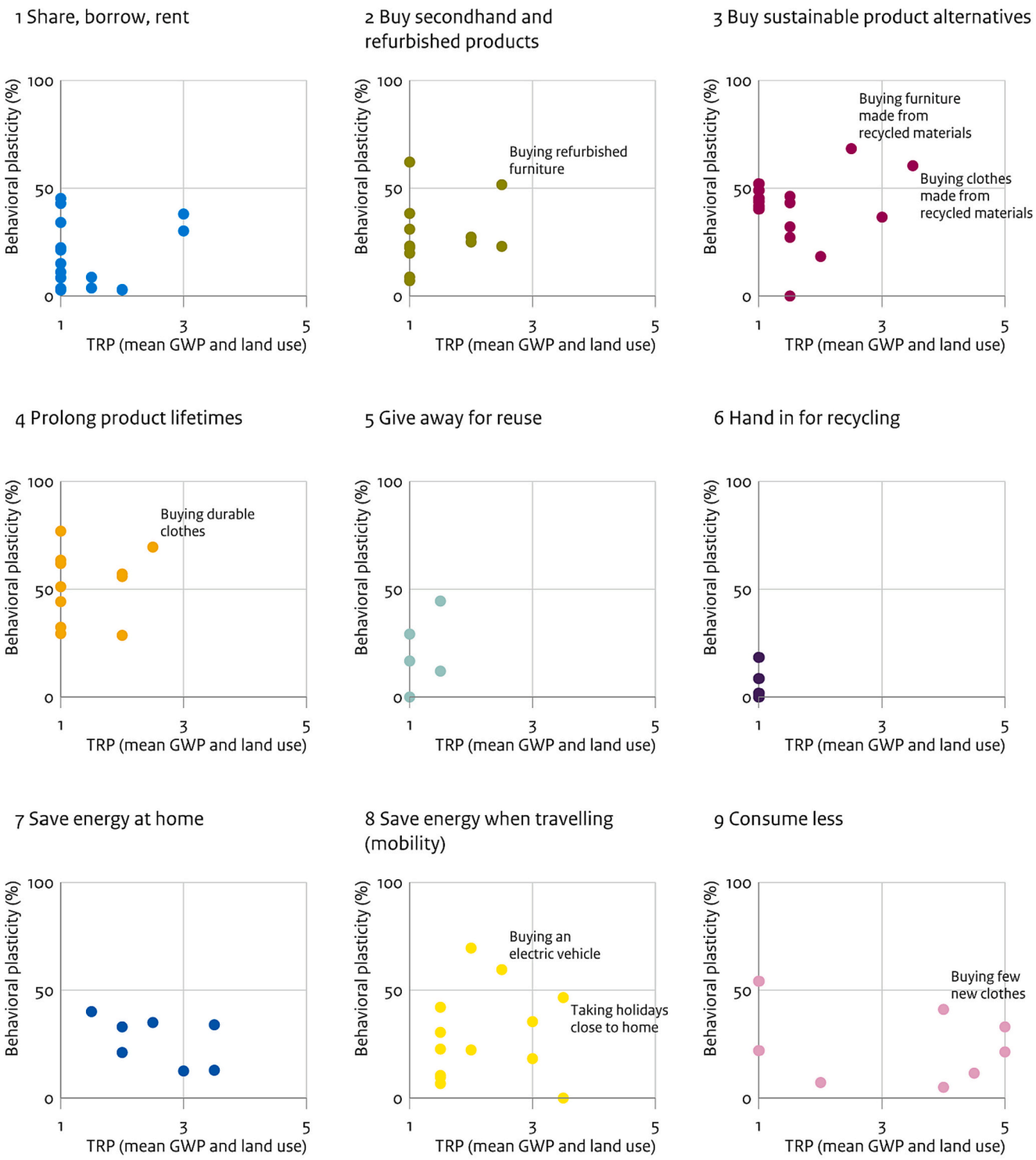

Fig. 3. Behavioural plasticity and theoretical reduction potential (TRP) of circular consumer behaviour, sorted by behaviour type.

et al., 2017, 2011), or people's idea that vegetarian or vegan meals are incomplete and unhealthy (Neff et al., 2018). Future research could provide more insights into the psychological and contextual barriers that inhibit willingness to adopt circular behaviour and the policy measures that could effectively remove these barriers.

b. *Behaviours with a large TRP which most people are already engaging in*, including reducing energy use for heating, insulating houses, and travelling by aeroplane only for longer holidays. These behaviours have a limited potential to further reduce environmental pressures, as the share of additional consumers that could take up the behaviour is only small. The

high uptake rate of these behaviours is likely a result of energy efficiency and conservation policies the EU and the Dutch government have implemented in recent years (e.g., EC, n.d.; Government of the Netherlands, n.d.). However, there may still be potential to intensify these behaviours. For example, home insulation levels could be further improved. We asked people whether they had taken any insulation measures — major (e.g. of floors, roofs and windows) or minor ones (e.g. applying seal strips or insulating pipes). Those who had implemented only minor insulation measures could do more, and policy-making could focus on stimulating them to do so.

iv. Behaviours with a small TRP and low behavioural plasticity can also be divided into two sub-groups:
   a. B*ehaviours with a small TRP that most people are not willing to engage in*, even if circular options would be easily accessible and affordable. This is the case for sharing, borrowing and renting goods instead of buying them. Here, comparable to group iii.a, policy interventions that improve accessibility and affordability are likely not enough to promote more widespread adoption, and additional policies would have to be put in place to address other barriers that people face.
   b. *Behaviours with a small TRP that many people already engaging in*, including giving away products they no longer want and handing in broken products for recycling. Here, comparable to group iii.b, the share of consumers that could still engage in the behaviour is small.

      As the TRP is small, even a wider uptake or intensification of these behaviours would result in a relatively low reduction in environmental pressure, which makes this group less promising to prioritise from an environmental perspective.

5.2. Limitations

Our study has a number of limitations. First, we measured self-reported circular behaviours, which may deviate from actual behaviour due to response biases (Gatersleben et al., 2002; Huffman et al., 2014; Kormos and Gifford, 2014). We chose this approach because we wanted to study a large number of behaviours. We tried to reduce response biases by asking respondents about the products they were currently using, their most recent purchases, and most recently discarded products instead of measuring behaviour frequency, making it easier for respondents to recall their behaviour. We also gave respondents 'don't know' options in the survey to improve data accuracy. For a few circular behaviours, the share of 'don't know' responses was relatively large. For behaviours for which the current standard is the non-circular option (e.g., clothes made of virgin fibres instead of recycled materials), we assumed that 'don't know' answers indicated that respondents most likely engaged in the non-circular behaviour because the choice for circular alternatives would have been made consciously. We therefore counted 'don't know' responses as non-circular. This approach seems warranted, as the results on current uptake of circular behaviour corresponded relatively well with available objective measures, such as sales figures about the share of organic food products or clothes from recycled materials. However, future research is needed to validate our findings.

Second, we asked people whether they would be willing to engage in circular behaviour if these options would be easily accessible and not more expensive than current alternatives. This allowed us to identify the types of behaviour consumers would consider engaging in if two major obstacles — price and inconvenience to access them — would be removed. These conditions have strong practical implications, as the behavioural plasticity measured can only be realized if these obstacles would indeed be removed. Our study design does not allow us to ensure that if price and accessibility were improved, consumers would actually adopt the assessed behaviours. There might be other obstacles, for example the lack of skills or knowledge in consumers or difficulties in changing their habits (e.g., Carrington et al., 2010; ElHaffar et al., 2020; Joshi and Rahman, 2015), that would need to be addressed as well.

Third, we made rough estimates of the TRP by assessing the environmental benefits related to people engaging in circular behaviour compared to the non-circular alternative (e.g., buying a second-hand mobile phone rather than a new one). We applied these environmental benefits (in %) to data on the annual environmental pressure of an average Dutch household to calculate the absolute reductions in GHG emissions and land use. The annual environmental pressure of households on average, however, is lower than that of households that do not engage in any circular behaviour, as this also includes the share of the population that has already adopted circular behaviours. This leads to a slight underestimation of the TRP, in particular for behaviours that are already exhibited by a large share of consumers, such as energy-saving and recycling behaviours. However, we expect that this shortcoming does not affect the overall findings of our study, because the inaccuracy is small compared to the range of the categories we used to score TRP. This means that correcting the environmental pressure of an average household to account for the share of the population that already engages in circular behaviours would not lead to a different TRP rating for most behaviours. Future research could improve our calculation of the TRP by addressing the above shortcomings and could combine the absolute TRP values with the data on behavioural plasticity to quantify the total environmental mitigation potential of circular consumer behaviour.

5.3. Future research

Our method and findings provide important directions for further research. For the purposes of this study, we developed a new survey measuring current behaviours and willingness to engage in these behaviours, in order to calculate behavioural plasticity of circular consumer behaviour. The survey could be used in future studies that aim to assess behavioural plasticity of circular consumer behaviour. We selected the behaviours on the basis of the framework presented in Table 1, which consists of the R-strategies and consumption phases. Due to this novel approach, the survey encompasses behavioural measures that have not been tested previously, and we see several aspects in which future research could improve the survey: First, 10 circular behaviours had to be excluded from our analysis as no share of the current uptake could be calculated (as described in Section 3.2.3). The measures for these behaviours should be revised. Second, it would be valuable to test the test-retest reliability of the survey to see whether it provides consistent results. Third, our measure relies on self-reported behaviour (see Section 3.2.1.1). It would be valuable to compare the responses to observed behaviour in order to test the validity of this approach. Fourth, it was beyond the scope of our research to investigate potential biases that might derive from the sequence of the questions in the survey. This is another aspect future research could assess to improve the method we have developed.

Furthermore, we see several ways in which our findings could be used as a basis for future studies. First, identifying factors that influence the uptake of circular consumer behaviour and the level of willingness and thus behavioural plasticity was beyond the scope of this paper. Future research could examine drivers and barriers of consumers to engage in the different types of behaviour we presented. It could also investigate how drivers and barriers differ between groups of consumers. This would provide a deeper understanding of how the adoption of circular consumer behaviour could be facilitated through policy. Second, further research could investigate how the uptake of circular consumer behaviour and the level of willingness and thus behavioural plasticity change over time. This would allow a reassessment to determine which circular consumer behaviours are relevant to target as the CE transition progresses. Measuring behaviour and willingness over time could also provide insights into how contextual changes affect behaviour plasticity, such as recent inflation and rising energy prices or

changes induced by policy interventions. This could indicate what policy interventions could be effective to promote willingness and the adoption of circular behaviours. Third, future studies could expand on our results about the TRP, by looking at a wider range of environmental pressures, including water consumption, acidification, eutrophication or toxic substances. Fourth, it would be interesting to investigate to what extent our results for the Netherlands hold true for other countries. The Netherlands has a high level of consumption and consumers typically have multiple options to choose from (see Section 3.2.1). The approach used in this study could serve as a model for other countries with similar characteristics to inform priority-setting for policymakers on how to reduce environmental pressures related to consumption. Previous studies have shown differences between European countries regarding the uptake of certain types of circular consumer behaviour and hindering factors (EC, 2018; Euroconsumers et al., 2022). Comparing consumers' current behaviour and their willingness to adopt circular behaviour amongst various countries could further deepen these insights and provide a basis to identify enabling cultural and contextual factors.

6. Conclusions

We aimed to make a realistic estimation of the mitigation potential of circular consumer behaviour by considering both the 'theoretical reduction potential' (TRP) that results from a given behaviour and 'behavioural plasticity', reflecting the share of people that do not engage in such behaviour yet but would be willing to do so if circular goods and services were easily accessible and affordable. Our results show that many circular consumer behaviours with a large TRP have a rather low behavioural plasticity, which means that it may be challenging to realise the TRP in practice. These findings demonstrate that the TRP is a limited indicator to identify which circular behaviour have a high mitigation potential and suggest that behavioural plasticity is indeed important to consider. We found that buying less new clothes, clothes that are more durable or made of recycled materials, refurbished furniture, furniture made from recycled materials, electric vehicles, and going on holidays close to home are circular behaviours that have both a relatively large TRP (in terms of GHG emissions and land use) and high behavioural plasticity, and are thus especially promising for policymakers to achieve a relatively fast reduction in environmental pressures. Most people are willing to adopt these behaviours if they would be more easily accessible and affordable compared to current alternatives, which means that improving accessibility and lowering prices associated with these behaviours is likely to stimulate a wider uptake. To get a deeper understanding of how the adoption of circular consumer behaviour could be encouraged and facilitated through policy interventions, future research could examine the drivers and barriers of engaging in circular consumption behaviour, changes in willingness and adoption of such behaviour over time, and comparisons between countries.

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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. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.spc.2023.12.009.

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