IASDR 2019
International Association of Societies of Design Research Conference 2019
DESIGN REVOLUTIONS

Manchester School of Art
Manchester Metropolitan University
02-05 September 2019

Embracing Change While Retaining the Existing: Sustainable Behaviour Design Insights from Astronaut Food Consumption Transitions

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Design has long been regarded as an effective tool to create and foster individual and societal changes. When design meets the opportunity to transform people's behaviour and habits, only focusing on the change aspect might be insufficient, the retention aspect also can have a crucial role to play in guiding people's sustainable lifestyles. This paper aims to fill this knowledge gap by shifting the lens from design for sustainable change to design for sustainable retention. In order to understand the role that the design of artefacts can play in retaining individuals' desired behaviour through context change transitions, first, we briefly summarize insights from the literature published in the design for sustainable behaviour (DfSB) field. Following that, astronauts' Earth-bound food consumption on the International Space Station (ISS) is taken as an explorative case study. By analysing the case study results through an activity analytical approach, we find that the effects of change do not always necessarily interfere with the effects of retention. Rather, they are compatible entities that can mutually affect the development of new behaviour and habits. We argue that design to facilitate change is not the only path that leads to users' sustainable behaviour, retaining people's existing ecologically desired behaviour can also open up windows of opportunity to embed sustainable design interventions in people's daily activities. This paper concludes with a call for further explorations of design opportunities and challenges for retaining people's existing ecologically desired behaviour.

Keywords: design for sustainable behaviour, behaviour change, behaviour retention, activity theory, activity-centred design

1 Introduction

Nowadays, individuals face both opportunities and challenges of change more than ever. These changes include individual life event transitions, such as residential relocation, new employment, having a baby (Schäfer, Jaeger-Erben, & Bamberg, 2012; Verplanken & Wood, 2006; Verplanken, Walker, Davis, & Jurasek, 2008), while they can also be triggered by longer and larger socio-economic events, such as impacts of climate change, implementations of new policies, and applications of new technologies (Thompson et al., 2011). From a design perspective, it is undeniable that all these changes can lead to

behaviour and habit disruptions which have direct impacts on the existing ways of how people use particular artefacts to carry out their daily doings (Verplanken & Wood, 2006).

In this transition process, some of people's existing doings might be changed while some might be retained as the result of the interaction with the available artefacts in the new contextual environment (Wood, Tam, & Witt, 2005). The interplay between the effects of change and retention may lead to the formation of new behaviour and habits, which in turn can influence the specific use of the particular artefact and thus reshape the design of the artefact (Kaptelinin & Nardi, 2012). When design meets the windows of opportunity for purposefully transforming people's behaviour and habits, change has been regarded as a fashionable goal that people in business, policy, and academia strive to achieve (Lockton, 2017). As a consequence, products and services are often designed to make desired changes to happen. However, in this trend of embracing behaviour change, we seem to have neglected the crucial role that a retention perspective -- to maintain people's desired ecological behaviour and incorporate them into the new behaviour patterns, can play in guiding people's sustainable behaviour transitions.

Looking at sustainable behaviour design challenges from a retention perspective, problems which need to be addressed by design can be interpreted differently. For example, facing the problem of the growing demands for personal automobiles, apart from investigating how to develop design interventions to reduce people' over overreliance on private automobiles, what we also need to consider is how to retain people's existing green transportation lifestyles when they can afford to purchase an automobile. Facing the household food waste problem, in addition to studying how to change households' food waste behaviour, what we also need to consider is how to retain people's existing environmental awareness and ecologically desired food consumption doings through design. If we shift the lens and view design not only as an agent for change but also as an agent for retaining people's existing ecologically desired behaviour, what new design opportunities and insights can be informed to facilitate people's sustainable behaviour?

We take this inquiry in the present study and explore the role that the design of artefacts (referring to products and services in this paper) can play in retaining individuals' desired behaviour through context change transitions. Astronauts' Earth-bound food consumption on the International Space Station (ISS) is applied as an explorative case study. The specific question that we aim to understand in this case study is how did the design of tools (artefacts) on ISS enable or restrict subjects (astronauts on expedition tasks) to retain the Earth-bound food consumption behaviour.

This paper makes two contributions to the field of design for sustainable behaviour (DfSB). First, it reviews the behaviour transition mechanisms with a focus on retention perspective, and argues that design to facilitate change is not the only path that leads to sustainable behaviour, retaining people's existing ecologically desired behaviour can also open up new opportunities to embed sustainable design interventions in people's daily activities. Second, with a focus on behaviour retention perspective, it proposes a set of practical design implications as the entry points for design practitioners and researchers to better cope with changes and disruptions that take place in people's daily life contexts.

2 Behaviour retention in design for sustainable behaviour (DfSB) studies

Before diving into the exploration of design for sustainable retention topic, we need to first take a step back and ask the question: Why should design practitioners and researchers working with sustainable behaviour design issues, start to consider design for retention while design for change has already become a famous term?

First of all, a successful behavioural transformation entails not only changing the undesired doings but also retaining the ecologically desired ones (de Koning et al., 2015, 2016). To avoid confusions, it is worth mentioning that the concept of retention discussed in this paper does not mean to either completely stick to old ways of doings or prevent changes from happening. Rather, it means to maintain the desired behaviour and incorporate them into the new behaviour patterns when people go through disruptions that take place in daily life contexts.

Initial insights from the previous study indicated that, compared with design for sustainable change, the topic of design for behaviour retention remains relatively untouched (Chu & Wever, 2017). In order to understand to what extent the retention aspect has been studied in design research, we conducted a non-exhaustive literature review in the present study. We began by simply identifying the number of publications within the general behaviour and design field on Scopus. The preliminary search result shows that the number of behaviour change-related publications (68 articles) is significantly higher than the behaviour retention-related publications (8 articles) (see Table 1). We then narrowed down the review scope down to the conference and journal articles published within DfSB research field in all years. In total, 57 articles were included in our review.

The result further indicates that the topic addressing how to retain people's existing ecologically desired behaviour was barely covered in DfSB studies. Among the 57 DfSB articles, only a few mentioned the sustainable design from a behaviour retention aspect. For example, in a sustainable household fridge and freezer design study, Tang & Bhaman (2012) observed that participants tend to check the contents in the fridge and then decide what food items need to be purchased, which is regarded as a desirable environmental behaviour for reducing household food waste. In order to better maintain this fridge content checking behaviour, they redesigned the layout and drawers of the fridge so that it provides a clear display of the contents inside, thus retaining people's existing behaviour at the same time reduce the unnecessary food and energy waste triggered by the use of fridge. In addition to that, in a hair care sustainable product design study conducted by Hielscher, Fisher & Cooper (2008), they identified sustainable design opportunities and insights by drawing on an in-depth review of people's past hair care practices.

Table 1 The distribution of literature search results in the change-related and retention-related category.

Search scope and terms	
Change-related	**Retention-related**
a). "Design for behaviour(al) change" b). "Sustainable behaviour(al) change" + "Design"	a). "Design for behaviour(al) retention" b). "Design to retain" c). "Retain/maintain behaviour" + "Design" d). "Behaviour(al) retention/maintenance" + "Design"
After screening	
68 articles	**8 articles**

3 Activity analytical lens

Either design for change or design with particular consideration for behaviour retention requires design researchers to develop an in-depth understanding of individuals' daily doings. Activity theory (AT) takes activity as the unit of analysis and provides a descriptive nature on understanding why and how people carried out a specific activity in a specific context to achieve a specific goal (Kaptelinin & Nardi, 2006). As illustrated in Figure 1, activity is interpreted as purposeful need-based interaction between the subject (actor) and the object (world) (Leont'ev, 1974, 1978). Six key theoretical concepts have been developed to better frame and interpret human activity system: 1). Motivations, goals, and outcome of the target activity under study; 2). Social and physical aspects of the context; 3). Mediating tools used to perform the actions and detail operations; 4). Contradictions and tensions within the target activity system; 5). Internalization and externalization; 6). History and development of the activity system (Kaptelinin, Nardi & Macaulay, 1999).

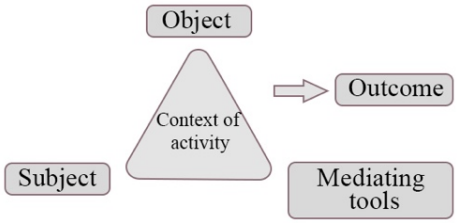

Figure 1. The activity theory model proposed by Vygotsky (1978). An activity system is viewed as a single triangle which comprises the interaction between subjects, objects, and mediating tools within a specific context to achieve a specific outcome.

Among the theoretical concepts mentioned above, two pillars make AT particularly helpful in individual behaviour related transformative design studies. First, taking an ecological perspective, it puts human activity systems in spatial (the concept of socio-cultural context) and temporal (the concept of history and development) dimensions. In other words, it views people's behaviour from a holistic and long-term perspective rather than simplified tasks and static interaction. As illustrated in Figure 2, the socio-cultural context enables design researchers to zoom in or zoom out to investigate how an activity is carried out in macro socio-cultural level, specific action level, and detail operation level. Furthermore, the temporal lens allows design researchers to analyse the disruptions and tensions within the dynamic development and transition process of the target activity system (Gay & Hembrook, 2004). Second, AT has a special emphasis on artefacts as mediators of change, it argues that a typical way to induce purposeful change in people's activity system is through changing the mediating artefacts that people use (Kaptelinin, Nardi, & Macaulay, 1999; Kuutti, 2011; Bødker & Klokmose, 2011). This concept is, to a large extent, in accordance with the goal of design for sustainable behaviour research, which focuses on improving the design of artefacts (commonly referred as products and services in DfSB literature) with a specific aim to guide users' behaviour in a more sustainable direction (Wever, Van Kuijk & Boks, 2008; Wever, 2012).

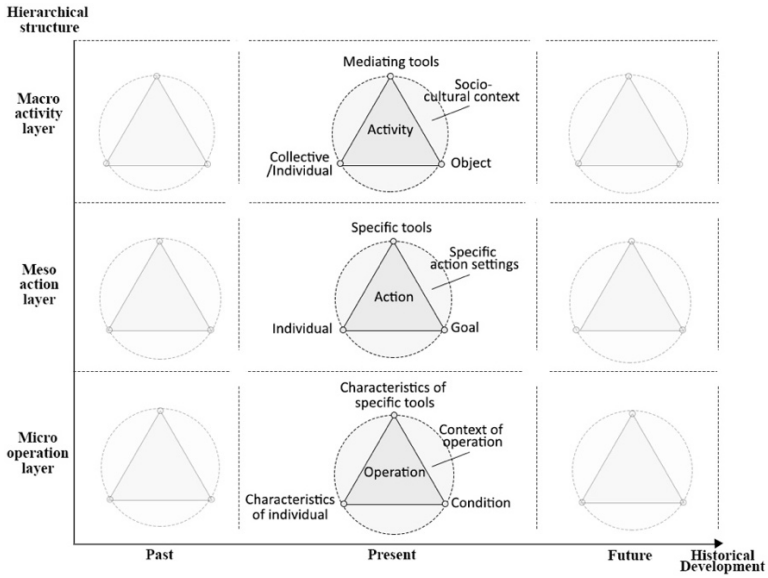

Figure 2. The activity theory analytical model adapted from Gay & Hembrook (2004).

Previously, we have applied the activity theoretical lens in analysing the food consumption activities that exchange students have transformed during their exchange studies. The results indicated that an AT-based analytical approach can systematically map and analyse not only the outcomes of individuals' behaviour transitions, but also the development process of how and why the transitions take place (Chu, Steenstra, Wever, & Glad, 2018). Based on the reflections indicated above, in the present study, we adopted AT as the analytical lens to reframe the sustainable behaviour change and retention phenomenon.

4 Astronaut food consumption case study setup

In order to understand the role that artefacts can play in retaining people's desired doings with support from real-life empirical data, we took astronauts' food consumption behavioural issues on the ISS as an explorative case study. This case study set-up was adopted by us based on two considerations: First, astronauts who on-boarded the ISS went through both physical and social changes from the Earth to a confined spacecraft environment. It is a highly representative real case scenario in which the subjects under study have undergone a significant contextual transition. This transition process thus can provide an appropriate setting for us to develop an in-depth view of why, what, and how particular behaviour can be retained through the interaction with artefacts, thus inform behavioural design implications.

Second, regarding the data availability and quality, astronauts who on-boarded the ISS have documented their daily activities such as work and experiment, food consumption, exercise, entertainment, and communication, along with their subjective experiences and psychological feelings in detail. The qualitative data provided us with a well-established background to extract the insights regarding the effects of design on behaviour transition. The data are available on NASA life sciences database archive, NASA technical report server, and crews and exhibitions page for public access. This also allows researchers with similar interests to analyse the data from their own research perspectives. As the present study focuses on food consumption behaviour, relevant descriptions regarding how astronauts carry out their food consumption activities (including meal preparation, eating, and food disposal stage), what tools they use in these activities, and the subjective

experiences behind these activities, were included in the data collection and review process. Both primary sources (expedition journals, photos, and video clips), and secondary sources (psychological and behaviour focused technical reports) were used as the empirical materials in the present study.

Through adopting the AT analytical lens, the empirical data was synthesized and analysed in an abductive approach. First, following the inductive coding method used by Stuster (2010, 2016) in astronauts behaviour studies, the descriptions of crew members' food consumption activities were extracted into segments in Excel sheets. Next, the descriptions were sorted into different categories with different themes. Identified themes that emerged from the raw material were summarized and incorporated with the themes we identified from the secondary sources published by NASA. Following that, the AT analytical lens was applied to interpret the themes. The analytical process is comprised of three steps: First, we illustrated astronauts' food consumption activity system in three contextual layers: the macro-layer represents the motives of food consumption activity within the social and physical context of the ISS. The meso-layer represents the specific actions that the astronauts need to be performed in order to attain the specific goal within their food consumption activity system. And the micro-layer represents the detail routine operations. After that, we illustrated the development of astronauts' food consumption activity within each contextual layer (see Figure 2). In the last step, each identified theme was interpreted through using the six AT theoretical concepts mentioned in the preceding section. The detail documentation of the analytical process applied in a similar food consumption case study can be found in the Chu et al. (2018).

5 Results and findings of behaviour retention in astronauts' food consumption activity system

An overview of astronauts' food consumption activity analysed through the concepts from activity theory is presented in Table 2 below.

Table 2. An overview of astronauts' food consumption activity analysed through the concepts from activity theory.

Activities	Motivations, goals, outcome	Social and physical aspects of the context	Mediating tools	History and development	Contradictions and tensions	Internalization & externalization
Cooking in space	Assemble different food resources to make a personalized meal, so that the meal tastes differently than the standard menu.	a). Food based on a 16-day standard menu; b). Limited ingredients and cooking tools; c). Cooking influenced by the individuals' daily schedule and workload; d). Cooking in the microgravity environment.	a). A water dispenser which can inject the selected amount of hot or ambient water to food pouches. b). Two food warmers to heat up food pouches or food cans.	a). Astronauts rehydrated or directly ate food in early space expedition project. b). However, as expedition duration becomes longer, astronauts start to prepare food to attain the Earth-bound food consumption experience.	a). Lack of food resources and cooking tools; b). Problems of operating in a microgravity environment.	a). Improvise with the available tools; b). Experiment with available food resources; c). Share recipes and learn from other crew members.
Eating in space	a). To enjoy company and use the occasion to chat with other crew members; b). To celebrate important events;	Usually 15-20 minutes gathering for eating and chatting around in the dining area each day.	a). A fold-down square table attached to the wall; b). A laptop computer as a TV attached to the wall; c). Both a physical space for eating and a social space for group interaction.	A transformation from food consumption as an individual activity to a group social activity. Resulting in positive psychological effects on both individual and collective level.	a). Limited space and facilities; b). Difficult to coordinate due to individuals' working schedules.	Schedule lunch or dinner time ahead and try to avoid eating alone.

5.1 Retention of cooking activity from Earth to ISS

Making personalized meal, referred by the crew members as "space cooking", is one of the activities that have been retained from Earth living environment to the ISS environment.

Social and physical aspects of the context: The design of the dining system is to make astronauts' food consumption process as convenient and harmless as possible to the safety environment of the ISS. Therefore, cooking activities is not considered in the original design of the dining system on ISS (Stuster, 2010, 2016). Food derived to ISS is based on a 16-day standard pre-packed menu and special "care packages", however, repeating the same food which have similar textures and tastes in a long-term expedition can sometimes create potential psychological problems such as lower the individual performance and well-beings (Bartone et al., 2017; Stuster, 2011). For example, one of the astronauts expressed: "*Even with a 16-day menu and personal preference food thrown in, the food can get monotonous*". Facing this particular appetite problem, the crew members retained and adapted their cooking behaviour from Earth environment to make personalized dishes on the ISS.

Motivations and goals: According to the descriptions in astronauts' journals, the motivation behind space cooking is to make meals taste differently and less boring than the standard menu. One of the crew members explicitly indicated that "*it makes a difference to spend a little extra time in preparing the meals to make them more enjoyable. Although there is only so much you can do with space food, a little effort goes a long way.*"

Tensions and contradictions: The lack of cooking resources, including cooking products and services, is one of the main challenges that the astronauts face. Facing this problem, two new activities thus emerged from adaptation to the design of the dining system in ISS: improvise with the available tools and experiment with the available food resources.

5.2 Use of tools

Tensions and contradictions: Cutting board, pans, and oven are commonly used as tools to chop, mix and heat up food in people's daily cooking activities on the group, the crew members reported that they also retained the similar doings on the ISS. However, the process can sometimes be extremely difficult compared to cooking on the ground as there is no gravity support nor plates or bowl-like containers on the station.

Mediating tools: To overcome this particular contradiction, the crew members came up with interaction with tools to improvise their cooking actions. For example, duct tape is used as *"small cooking plates*" to adhere food from floating away. One astronaut described "*I cut the onion in half, putting one on the tape for temporary stowage*". Similar to the household doings on the ground, bags on the ISS, including plastic bags and foil food pouches, are collected and properly stored for cooking and disposing food. For example, one astronaut stated "*I grab the promising ones [plastic bags] and put them in my stash so I have them handy for the next cooking day.*" Some astronauts use those bags as disposable cutting boards, so that food ingredients can be cut inside the bags to prevent things from floating away and spreading in the air — "*to cut things up I use a plastic bag, held down by the duct tape*" (see Figure 3 below). However, plastic bags have a thin layer, they can be easily sliced or damaged. Therefore, the crew members have to be especially careful when cutting foods inside the bags.

When food needs to be warmed, thermostabilized foil pouches are used as pots to collect, mix, and heat up food ingredients. One astronaut wrote: "*I can put the garlic and onion in here [the pouch] with olive oil and form the bag to the size needed to go in the Russian food warmer.*" Consumed food cans are also reused as bowls for heating ingredients in food warmers— "*recycle the cans of Russian meat we had already eaten and use them to put the beans in for heating.*" Foil pouches and food cans have to be carefully sealed to avoid the leakage of any contents, especially liquid. For example, one astronaut stated "*It [olive oil that was put in] got out of the aluminium pouch and all over the oven*." Apart from that, tortillas are often used as plates to eat ready-made food. The moisture content of the food ingredients allows it to cling to the tortilla, thus it is possible to build several layers of different ingredients and mix the ingredients on the tortilla. Unlike on the ground, where we can perform our operations without conscious awareness of how to use tools step by step, the microgravity environment requires the subject to continuously put their conscious efforts in the process. One astronaut stated "*it is a testament to how much we enjoy tortillas that we routinely go through this whole careful process*".

Figure 3. Pictures of the astronauts' cooking. The picture on the left: the astronaut uses a tortilla as a plate to put more ingredients on and mix them together by a spoon; The picture on the right, the astronaut uses duct tape and plastic bags as tools for mixing ingredients. Source: https://www.nasa.gov/centers/johnson/astronauts/journals_astronauts.html

5.3 Cooking experimentation

Motivations and goals: To the crew members, the effect of cooking does not just limited to making personalized dishes that taste differently from the standard menu, it can also remind astronauts' the particular feelings of being on the ground at home - -*"It was a great combination [referring to one dish] - reminded me of home eating frosting with my sister", "It really tasted like a cheesecake, right out of the oven with a berry topping", and "Getting in the mood for Easter… I have been experimenting with our dehydrated eggs."*

Development: As the result of cooking experiments, astronauts get more adapted to the cooking activities. For example, some crew members stated: *"I have definitely been on a learning curve. With each successive experiment I am getting less and less messy", "Tried a new recipe this week. I am getting better at combining the food."* In order to enable other crew members to reproduce the dishes that have been created before, the crew members also share their cooking knowledge and techniques with each other. For example: *"Fyodor showed us how to put the garlic paste right on the tomato with the cheese. Then we did the same thing with the horseradish", "Another trick I learned from Peggy was how to prepare roasted garlic in the Russian food warmer."*

6 Discussions and implications for sustainable behaviour design

So far, we have interpreted the empirical data through an activity analytical lens, following that, we have reported in detail regarding how the astronauts retained their Earth-bound food consumption activity on the ISS. This section briefly discusses what design implications in terms of retaining people's doings through context change disruptions can be informed through this explorative case study.

6.1 Scenarios and mechanisms of retention

Retaining the subject-goal mediation: The results of this specific case study indicated that the usage of a particular artefact and its corresponding user behaviour are, to a large extent, depending on its subjects' pre-existing motivations and goals in the context of the activity. In the case study, the astronauts usually seek, test, and adjust available tools and then incorporate these tools into their space cooking activity system to meet their particular goals. These goals were often adopted from their pre-existing Earth-bound food consumption experiences. For example, in order to make a more personalized meal, astronauts used the foil food pouches (which are brought to the ISS with the original purposes to better preserve food and make the food eating process simple and convenient), in combination with duct tapes and plastic bags as containers to hold, cut, mix and heat up food ingredients. These tools were used to replace the role that a cutting board plays on the ground. Similarly, in order to bake food, the astronauts also came up with the idea to use already consumed foil pouches and food cans to replace ovenware used in Earth-bound cooking environment. As illustrated as the scenario1 in Figure 4 below, this retention in subject-goal mediation process resulted in the adaptation of different usages of the available artefacts, which is consistent with Engstrom's argument, that the way how users interact with mediating tools depends on the specific goal that users aim to attain, there is always more possible uses than the original design intention (Engstrom, 1990). In other words, this scenario can be described as: *Although the existing ways and corresponding artefacts that subject can use in a specific activity system have been transformed, the specific goal that subjects aim to attain can still remain unchanged. As a result, the available artefacts are adapted to retain the goal.*

Retaining the subject-tool mediation: As activity can shape the particular use of mediating artefacts, the design of these artefacts can also reshape the way in which the activity is carried out (Gay & Hembrooke, 2004). For example, as mentioned in the result section, due to the constraints of the cooking tools and the microgravity environment on the ISS, the crew members had to adjust their cooking activity to simply combining and assembling different food ingredients. Although the space cooking activity was different from the Earth-bound cooking, the astronauts still retained the specific behaviour when interacting with some particular mediating tools, such as use tortilla as plates to mix and hold different food ingredients, use food warmers to heat up food, collect and re-use bags to temporarily store and wrap ingredients. This retention phenomenon which took place in subject-tool interaction process is illustrated as the scenario 2 in Figure 4, which can be described as: *Although the subjects have adapted and developed new goals within a specific activity system, the existing interaction with the corresponding mediating artefacts still remain unchanged.*

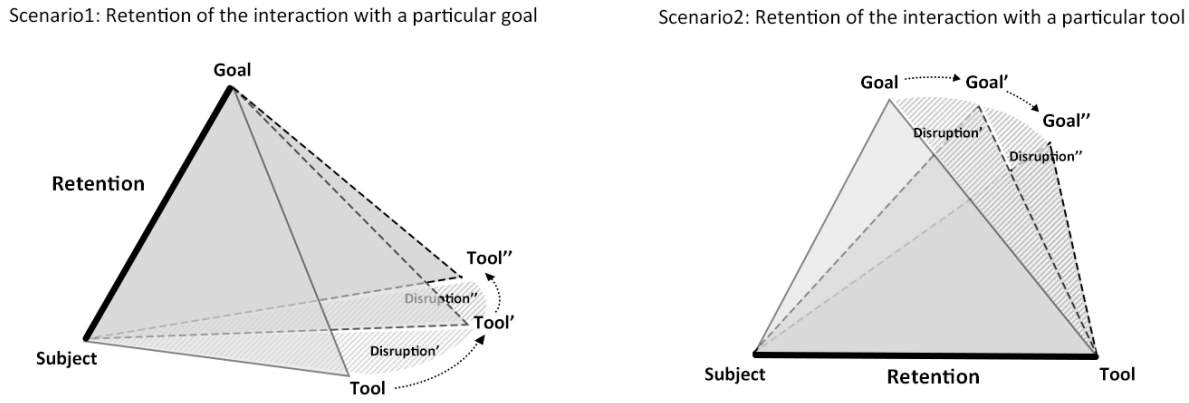

Figure 4. Two scenarios where retention can take place in user activity systems. Note that this model is constructed based on the human activity model proposed by Vygotsky (1978) illustrated in Figure1.

Both scenarios can simultaneously take place in individuals' daily activities. Taking household dishwashing as an instance, the fundamental goal of the activity can be simply described as to clean the used dishes. For households without access to dishwashers, hand wash is the only way to carry out the activity and attain the goal. However, the installation of dishwashers in such households can create a context change disruption, which might trigger a behaviour transition from hand wash to using the automatic dishwasher (as illustrated in Scenario1). At the same time, it can also transform the original goal into various new goals such as quick clean, eco-wash, and high-temperature disinfection (as illustrated in Scenario2).

6.2 Implications for sustainable behaviour design

Given the understandings of different retention scenarios and their potential influences on people's existing activity systems, the questions then come to how this insight can be applied to better frame people's behaviour transition process, and what new sustainable behaviour design opportunities can be informed by putting on the retention lens?

Gaining a holistic view of the interplay between change and retention: Today's products and services often function in complex networks which are not static but under dynamic development. The usage of a particular design is not only determined by its users, but also influenced by (a) other products and other people involved in the networks, and (b)

the context in which it operates (Wever et al., 2008). As indicated by Gay & Hembrooke (2004), if contextual disruptions become materialized in the networks, it can quickly become the driven force for the evolution and development of people's activity system. The results from the case study indicated that, for individuals who are undergoing the context changes, in order to overcome and minimise the impacts brought by the disruptions, part of the existing links in the target activity system can be broken while new links will be established and further tested (e.g., as presented in Section 5.3, learn to cook a personalized meal in microgravity environment). Simultaneously, part of the existing links can also be retained and even solidified (e.g., as presented in Section 5.2, collect plastic and foil bags and re-use them as cooking tools).

This revealed an interesting phenomenon in people's behavior transition process, the effects of change do not always necessarily interfere with or counteract the effects of retention. Rather, as presented in this astronaut food consumption case study, they can coexist with each other within the development of people's activity system. To be more specific, as illustrated in Figure 4, under the circumstance that the original tool (marked as Tool in Scenario1) that subject interact with has been changed to a set of new tools (marked as Tool' & Tool''), the original goals of the activity can still be retained as the same. Similar to that, if the original goals (marked as Goal in Scenario 2) that the subject aim to attain has been changed to a series of new goals (marked as Goal' & Goal'' in Scenario 2), the specific interaction with the particular mediating tools can still be fixed in the whole activity system. These insights, while preliminary, suggest that it is the cooperation between the effects of change and retention that constitutes the development of new behaviour patterns and habits.

Change is not the only path to sustainable behaviour: As behaviour change and retention are compatible entities which can mutually affect the formation of new behaviour and habits, design to facilitate change is not the only way to achieve sustainable behaviour transitions. Purely focusing on fostering changes may let design practitioners and researchers neglect the questions such as what ecologically desired behaviour have been performed by users in their past or existing activities, what factors can help to materialize the particular desired behavior, and what design insights can we learned from those past and existing activities. To answer the above questions, a behaviour retention perspective can offer a complementary view to examine the mainstream behaviour change design concepts, which might open up new windows of opportunity to embed sustainable behaviour design in people's existing daily doings (see Figure 5).

Taking grocery shopping activity as an example, the traditional grocery market allows customers to make tailored selections of food items and pay accordingly, which provided customers with flexible spaces to avoid potential food waste issues and at the same time save money. However, this pre-existing environmental way of grocery shopping has been influenced by the modernized supermarket service design and the excessive reliance and unnecessary usage of packaging. With the aim to help consumers re-gain the customization and at the same time minimize the use of packaging in grocery shopping, Komazec & Wilhelmsson (2017) developed a mobile wagon packaging-free food purchase system, which enables consumers to purchase selected amounts of food items from gravity silos with automatic built-in scales and barcode printers. This design concept is not only focusing on identifying consumers' current needs, but also taking the retention aspect into consideration by drawing on people's pre-existing ways of shopping.

Practical design questions to consider: As pointed out by Papanek & Fuller (1972), one of the prerequisites for tackling wicked real-world sustainability problems is to understand the underlying effects and impacts of design in a more systematic way. In terms of design for sustainable behaviour, an activity development perspective may offer a holistic perspective to help design practitioners and researchers to identify which target activity should be the focus of change and which should be retained and developed further. However, developing an in-depth view of both the change and retention aspects in each specific design setting at the same time may require enormous time and efforts from designers. One suggestion is to start from the intersection between change and retention in early-stage design ideation process, and then shift the focus to the details of change or retention aspect. For example, if a new product design concept is being developed with the goal to facilitate users' sustainable behaviour, since disruptions and behaviour transitions may perhaps take place in users' existing activity system as one of the potential outcomes of this design, design practitioners and researchers might need to consider: How can this particular design fit into users' existing activity systems? What elements of the activity need to be completely preserved as the foundation for users to carry out the target activity? What should be slightly refined and modified by this design? What should be dramatically altered? What new subject-product-goal links might be altered or established? And what aspects should be taken into consideration for the next transition stage that may happen in users' activity system? The process of seeking answers to the above questions might also facilitate design practitioners and researchers to prepare themselves for an even broader question: how can design itself better cope and cooperate with changes and disruptions that take place in people's daily life?

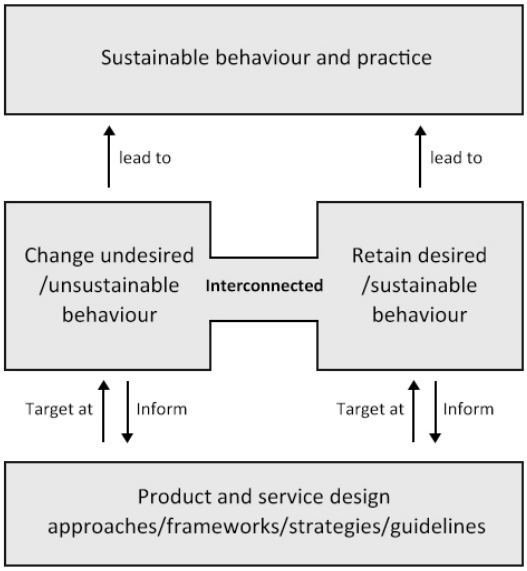

Figure 5. A proposal to incorporate the goal of retaining the existing ecologically desired behaviour with the goal of changing people's undesired behaviour into the consideration of sustainable product and service design.

7 Conclusion, limitations and future research

This study set out to explore what if we view design as not only an agent for creating behaviour change but also an agent for retaining people's existing ecologically desired behaviour? As one of the initial steps to approach this inquiry, this paper specifically focuses

on exploring the role that design of artefacts can play in retaining individuals' desired behaviour through context change transitions.

Through applying an activity theoretical lens, we found that the effects of change and the effects of retention should not be viewed as two sides of a paper, one side tends to cover the existence of the other. Rather, they are compatible entities that can mutually affect the development of new behaviour and habits. Based on this understanding, we argue that design to facilitate change is not the only path that leads to users' sustainable behaviour, design to retain people's existing ecologically desired behaviour can also open up windows of opportunity to embed sustainable behaviour in people's daily activities. In order to achieve this goal, efforts need to be made to help design practitioners and researchers to incorporate both change and retention aspects into product and service design process. The overarching design question which needs to addressed in the next stage is how design can support users in attaining the newly emerged goals while retaining their existing ecologically desired behaviour in the development of their activity system.

The lack of primary empirical data, such as one-to-one interviews with astronauts, is one of the limitations behind the set-up of the astronauts' food consumption case analysis. However, the descriptive qualitative data collected in this study can already enable us to peek into what has happened in the astronauts' food consumption transition process. And then conduct an in-depth analysis regarding what activities have been changed and what have been retained. Furthermore, the findings are subject to one particular case study. In the future, more case studies need to be conducted to provide complementary views.

Behaviour retention aspect also shares some common characteristics with the design strategies proposed for behaviour change. As indicated in Wever et al. (2008), there are two most common approaches to create behaviour change through design: functionality matching and behaviour adaption. Functionality matching means to induce the preferred behaviour by designing products and services features to match users' preferences, while behaviour adaption means to the design features which may force changes to happen. Can these two approaches be directly applied to retain people's desired behaviour or should those principles and strategies be adjusted? Discussing these questions goes beyond the scope of this paper. However, for future studies, one promising way is to review relevant sustainable behaviour design strategies and approaches with a particular focus on the retention aspect, and then interview experts regarding what design strategies have already covered behaviour retention aspect, and what design strategies should be further developed to incorporate retention aspect into the system.

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Acknowledgement: This study is supported by China Scholarship Council and Machine Design Division, Linköping University. We gratefully acknowledge the time and contributions of the reviewers.