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Developing A Behavioral Model for Designers to Encourage Sustainable Consumption

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Abstract

Industrial design has played an influential role in developing consumerist culture. Given the design's potential for the growth of sustainable thinking, altering this direction is expected from design. Despite the increasing recognition that mainstream design has unintended consequences, less attention is paid to consumer behavior as the underlying cause of unsustainability, especially the impact of purchasing new products. By considering psychology alongside design discipline, behavioral models provide a practical foundation to change behavior, and their use in sustainable design is growing. Due to the narrow focus on purchasing, maintaining, and disposing of products, this research aims to design a behavioral model in this area. In this regard, by studying literature in the field of psychology, behavioral components and ways to affect them were extracted, and known models for behavior change were reviewed. These findings were reanalyzed and utilized with sustainable design principles and evolutionary psychology to design a model with design interventions to change consumption patterns. Designers can use this model to encourage sustainable consumption. This is significant because the previous research only focused on reducing resource consumption and promoting environmentally friendly behavior in their models.

Keywords

Sustainable Behavior, Sustainable Design, Responsible Consumption, Behavior Model, Behavior Design.

Introduction

Considering the effects of consumerism cultures, including environmental and social crises, and by considering the economic benefits of sustainable development, including reduced production costs and widespread demand for sustainability, promoting a sustainable lifestyle seems necessary. In the sustainable design literature, the main emphasis is often on the reduction of environmental impacts as well as economic productivity, but relatively few efforts have been made to promote a sustainable lifestyle, meaning behavior change to improve consumption patterns (Bhamra et al., 2011). Sustainability is a human problem in the first place, and if the roots of the unsustainability of humans are not addressed, sustainability problems cannot be managed (Ehrenfeld, 2008). Extensive studies have shown that behavioral changes have a profound impact on environmental issues; therefore, to meet sustainable development goals or address sustainability issues, behavior changes must be taken into account (Nielsen et al., 2024; Zachrisson & Boks, 2012).

Researchers are becoming increasingly interested in product-induced behavioral changes (Coskun et al., 2015). Works of art, products, and technologies can change unsustainable behavior by changing users' minds or offering opportunities and limits (Cash et al., 2022; Ehrenfeld, 2008; Zachrisson & Boks, 2012). Utilizing psychology to identify design strategies to change behavior is well-recognized in this field (Cash et al., 2022; Zachrisson & Boks, 2012). Even though design research has addressed this issue, there are few explanations as to which theories or tools should be applied and there are also some gaps in the relationship between behavior change and design literature (Niedderer et al., 2016; Nielsen et al., 2024; Nielsen et al., 2021). By considering this, there is a need to utilise behavioral theories by using design as a tool (Nielsen et al., 2024).

Behavioral models provide designers with appropriate tools for identifying factors influencing behavior (Jackson, 2005). Some models suggest integrating behavioral change into the design methods but their suggestions are abstract and are not focused on sustainable design. For instance, *the behavioral design IMPACT process model* by Nielsen et al. (2024). Moreover, most of the models for promoting sustainable behavior are focused on the reduction of resource consumption and promoting environment-friendly behavior. For example, the *Design behavior intervention model*, by Bhamra et al. (2011) focuses on energy consumption, whereas the model of Hamann et al. (2016) is concerned with environment-friendly behavior. Despite a growing body of literature, purchasing products is one area in which sustainability has received little attention. For example, Coskun et al. (2015) mentioned that electricity consumption, water consumption, and fuel consumption were the popular target behaviors in previous research. This is in contrast with the recognized importance of products in the transition towards more sustainable production and consumption (Bhamra & Hernandez, 2021).

Hence, focusing on promoting sustainable behavior, regardless of the consumption of goods, will fail to bring about fundamental transformations. However, in the bigger picture, due to population growth and resource reduction, over-consumption problems will not be resolved, even with modifying consumption (Papanek, 1995; Klein, 2020). But when we consider consumption based on class difference and since affluent societies are the driving force behind consumption and the majority of the population has insignificant effects on problems such as greenhouse gas emissions (Watts, 2023), small changes in consumption patterns for certain socioeconomic groups, like reducing consumption among high-income individuals, can have a significant effect on the environment and this change can be a promising start for achieving sustainability (Leonard, 2010).

A first step in addressing this issue by research questions will be to determine which behavioral components the designer should be aware of and then how this knowledge should be implemented to influence the consumption of goods. For effective intervention, we must also consider the need to synthesize these different factors (Nielsen et al., 2021).

As a result, the aim is to first identify the key behavioral components, and understand how they influence behavior. Next, to study the relation between components, the behavioral models in the psychology literature must be reviewed. Then, by focusing on the purchase, maintenance, and disposal of products, to develop a model for designers (For the gap between design and behavioral science (Cash et al., 2022)), sustainable design literature and evolutionary psychology must be utilized so that, on the one hand, the proposed model can be placed within the framework of design and sustainability and, on the other hand, the design interventions become more effective.

Methodology

The formation of the behavioral model (A3) began with creating an understanding of behavior change. For this (Figure 1), we conducted an inductive, thematic review of the literature. The coding process was done manually; for more detailed themes data was categorized by making a table for each theme in a word processing software and for broader themes, by creating different files and categorizing each using different folders. First, before primary research, to grasp the scope of the problem, we briefly (with only six resources) explored consumerism literature. For our primary research (L1 and L1′), we focused on *sustainable behavior*, *environment-friendly behavior*, *behavior change*, and *design for behavior change* as our terms of research. Since our goal was to incorporate design directly into our behavioral model and to explore this domain more extensively, we conducted searches using *sustainable design*, *product sustainability*, *green design*, *psychological lifetime*, and *product lifetime* as our terms. Searching was first conducted using the *Web of Science* and later expanded using *Scopus* and *Google Scholar*. We further expanded our research by reviewing the aforementioned references and other background works that were used in these references. During this process, we reviewed 113 resources, encompassing 82 papers, 20 books, 2 theses, 1 online class, 2 brief video lectures, and 5 websites. The selection of the mentioned number of resources for review was guided by the principle of data saturation, with the exception being the literature on consumerism, which was done only to grasp the problem. Division of this number across papers, books, and additional resources was determined strategically to serve distinct purposes, to acquire a broader understanding, books were selected, and to delve into more detailed and precise data, papers used, all while considering the limitations of time available. The most important sources for guidance in this regard are Hamann et al. (2016), Klockner and Blobaum (2010), and Tang (2010) (and also other related works to Tang (2010) dissertation, e.g., Tang and Bahmara (2008) and Bhamra et al. (2011).

After categorizing the components of behavior, and how they are influenced by interventions (C1-2), which were initially subjected to an inductive coding process (C1-1), a series of themes began to emerge (T1 and T1′). Initially, a categorization process was implemented to establish connections among broader conceptual elements, paving the way for the subsequent generation of coherent and meaningful themes in the second round. Recognizing the necessity for a more profound comprehension of each emerging theme, an iterative approach was adopted, necessitating multiple iterations of literature review and coding to acquire additional codes and refine created themes.

Subsequently, a distinct categorization was conducted for known practical models in the field to illuminate how behavioral components interact with each other (C1′-1). After this categorization (C1 ′-2), we contrasted our themes (*rational choice*, *emotions*, and *habits*) against models to facilitate the arrangement of components according to their interrelationships, while simultaneously identifying limitations within the models (A1=Arranged behavior components and how to influence each as the main input for A2). Next, studies in the biology of human behavior and evolutionary psychology in the context of sustainability (L2) and their coding/categorizing (C2-1 and C2-2) help us draw a better connection between these two created codes (T2), and create a clear relation between abstract models and the reality of the human brain (Second input for A2) and also provided better understanding about intervention related to sustainability (input for A3). One of the most significant sources in this matter was the videotapes of Robert Sapolsky's *Human Behavioral Biology* course (at Stanford University, e.g., Stanford, 2011).

This source provided a critical perspective on applying biological studies. As a result of the process, it was determined which behavioral components should be considered to influence the purchase, maintenance, and disposal of products, how these components interact with each other, how to influence each component, and how the components should be put together according to the proposed structures in previous models and knowledge obtained from biological psychology (A2). The literature for this part was based on 63 resources (50 papers, 7 books, and 6 other resources mentioned above).

As a final step in developing the model, design interventions had to be developed. For this, first, interventions were extracted from previously mentioned coded data of behavioral change and were completed by considering evolutionary behavior studies. Then, to fill the gaps in previous models and to make the model usable for product design, studies on sustainable design were also used (L3, C3-1, C3-2 and T3), the basis of which was created in previous authors' work (Davoodian, 2019). For this part 44 resources were reviewed of which 19 were related to product sustainability and 25 were regarding the extension of the psychological lifetime of products.

Note that the proposed model was designed based on literature, and needs to be validated through further evaluations.

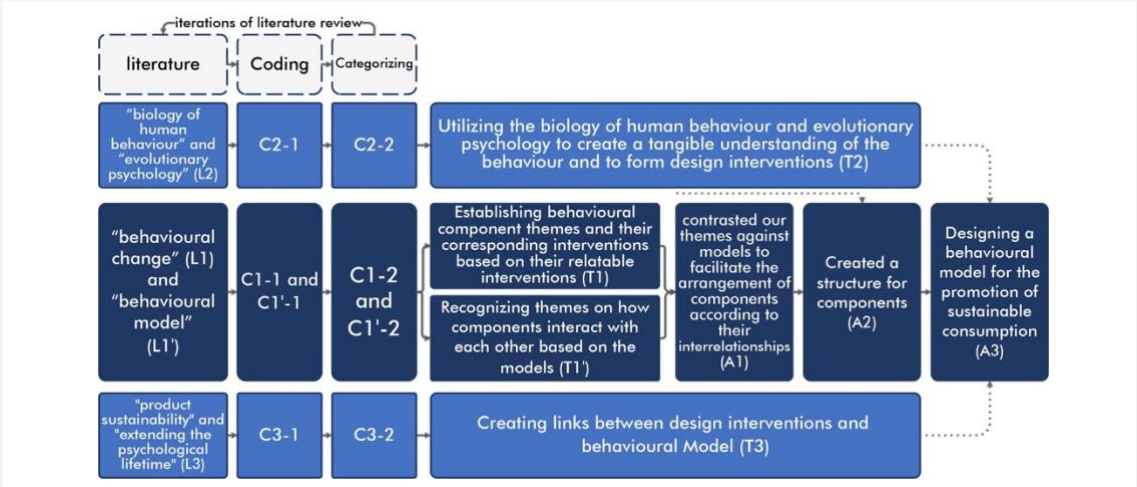

Figure 1: *Research process.*

This section deals with recognized behavioral models to create a structure for behavioral components.

Theory of Planned Behavior (TPB): According to the TPB (Figure 2), a behavioral intention in a rational choice process includes three different aspects; the individual's attitude toward a particular behavior, the individual's perception of social pressure for behavior, and PBC (Ajzen, 2005; Klockner & Blobaum, 2010). These elements were defined in the earlier section. TPB is one of the models that has been widely and successfully employed in the field of environment-friendly behavior (Carrus et al., 2008; Jackson, 2005).

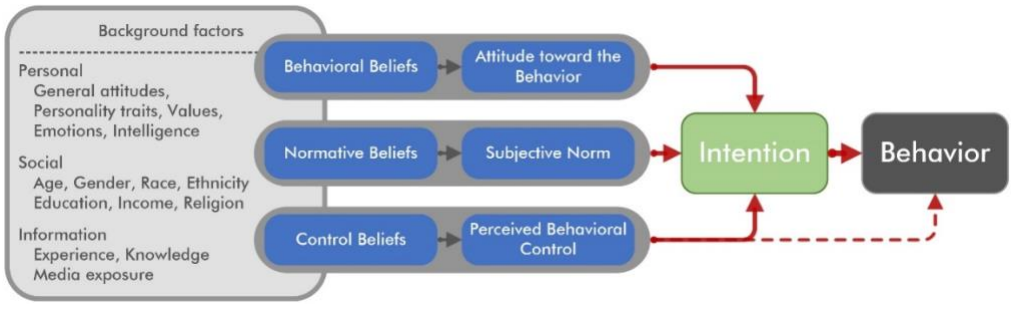

Figure 2: *TPB and the role of background factors in this theory (Ajzen, 2005).*

Model of Goal-Directed Behavior (MGB): The MGB was designed based on the TPB (Figure 3), and in comparing the two, the TPB predicts better when the behavior itself is a goal, and the MGB works more precisely when the behavior is a tool to achieve a goal (Perugini & Bagozzi, 2001). Perugini and Bagozzi (2001) have argued that attitudes, SN, and PBC explain why an action occurs but do not include the required motivations to induce the intention to act. According to them, based on previous research, it has been suggested that desires motivate goals; and attitudes, SN and PBC work through desires to induce intentions. They have also added past behaviors and anticipation of emotions to the model. In MGB, the frequency of past behavior can affect desires and intentions or even directly affect the behavior, and the recency of past behavior can directly predict behavior (Perugini & Bagozzi, 2001; Carrus et al., 2008).

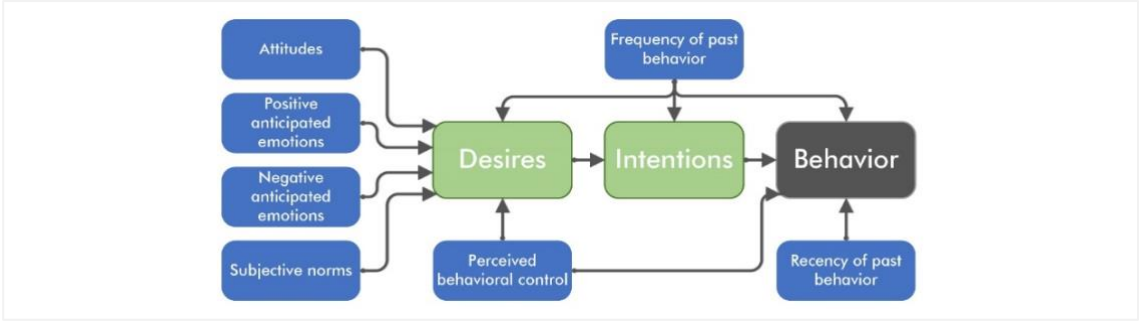

Figure 3: *Model of Goal-Directed Behavior (Perugini & Bagozzi, 2001).*

Norm-Activation Model: Onwezen et al. (2013) explain Schwartz's works and claim that the model (Figure 4) predicts behavior by focusing on personal norms, and these norms are perceived as feelings of moral obligation rather than intentions. They argue that personal norms emerge if one understands that their behavior has specific consequences or is responsible for performing the behavior. In other words, as Klockner and Blobaum (2010) wrote: *A person only acts if he/she sees a causal relationship between his/her actions and the problematic outcome. Finally, the acting person must experience some amount of perceived behavioral control to activate the personal norm*. This model has been developed for altruistic behaviors (Onwezen et al., 2013; Jackson, 2005).

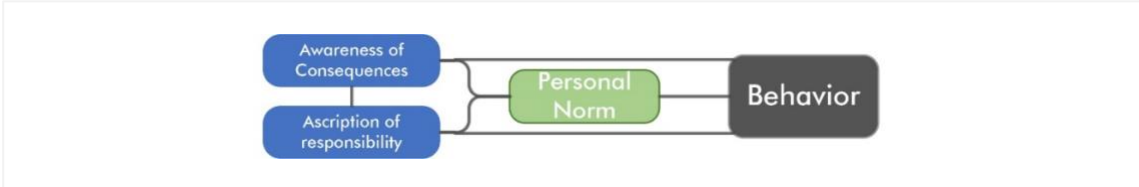

Figure 4: *Norm-Activation Model (Jackson, 2005).*

Theory of Interpersonal Behavior: In this model (Figure 5), like others, the intention is introduced as a component that explains the behavior and includes three sub-categories of *attitude*, *social factors*, and *affect* (Tang, 2010; Jackson, 2005). Jackson (2005) and Tang (2010), in describing this model (designed by Triandis in 1977), state that attitudes derive from two components: belief about outcomes and evaluation of outcomes. They explain social factors in three categories: first, *norms*, which here are like the concept of injunctive norms; second, *rules*, which include behaviors that are appropriate for a person in a particular group; and third, *Self-concept* which means the mentality that a person has about himself and the goals that are appropriate according to this mentality. They describe *Affects* as the emotional reactions to a decision; emotions are a tool for evaluating the outcome of action and can be positive or negative with different powers. Habit is another factor, in parallel with intention, that directly influences behavior in this model, and the frequency of past behaviors shapes it (Jackson, 2005; Tang, 2010). *Both of these influences* [Intention and Habits] are moderated by *facilitating conditions* (Jackson, 2005). This model addresses many drawbacks of rational choice theory and provides a holistic view of a behavioral model (Jackson, 2005).

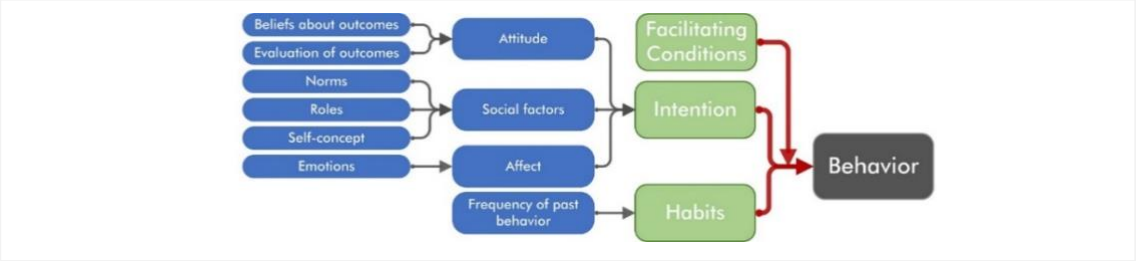

Figure 5: *Theory of interpersonal behavior (Jackson, 2005).*

Comprehensive Action Determination Model: In this model (Figure 6), the habitual processes consist of three sub-sections, first is *Schemata*, which is based on the pattern of behavior in specific situations; Second, *Heuristics*, which are simple decision-making rules; and finally, the *Associations* that relate to the concept of enhanced neural connections in the brain between parts that often work together (Zachrisson & Boks, 2012; Klockner & Blobaum, 2010). The intention processes also consist of three sub-sections: intention, attitude, and beliefs, with each affecting the previous component (Zachrisson & Boks, 2012). The *Situational Influences* here not only directly impact behavior but also influence habitual processes, intentions, and norms; in addition, *Normative Processes* indirectly affect behavior by influencing habits and intentions (Zachrisson & Boks, 2012).

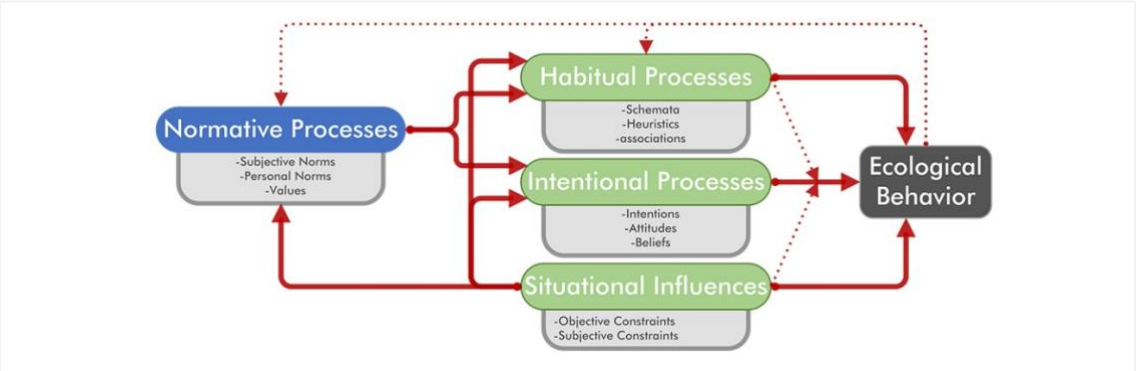

Figure 6: *Comprehensive Action Determination Model (Klockner & Blobaum, 2010).*

Extension of the Integrative Influence Model of Pro-Environmental Everyday Behavior: *The integrative influence model of pro-environmental everyday behavior* designed by *Ellen Matthies* combines the Theory of Planned Behavior and the Norm-Activation-Model (Hamann et al., 2016). Hamann et al. (2016), regarding the extension version of this model (Figure 7), explain that problem-awareness, perceived responsibility, and self-efficacy affect personal ecological norms; and various motives, such as personal ecological norms, social norms, and *behavior cost and benefit* are compared and ultimately put together as behavioral intent for sustainable or unsustainable behavior. They too mentioned that habits generally influence all stages of decision-making, and they assume emotions can also colour environmentally-friendly behaviors.

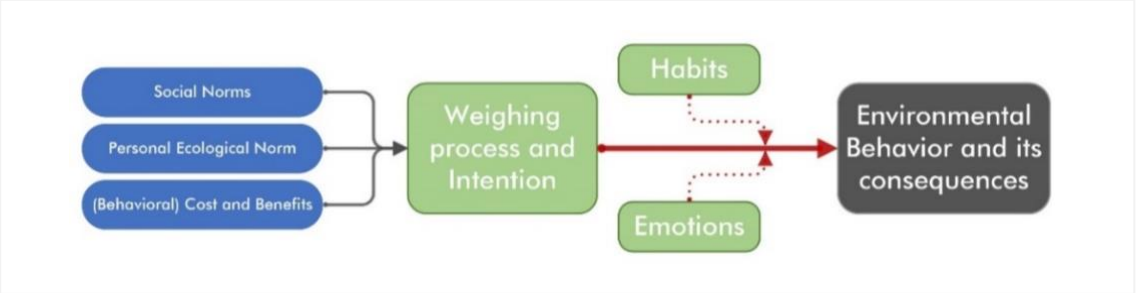

Figure 7: *Extension of The Integrative Influence Model of Pro-Environmental Everyday Behavior (Hamann et al., 2016).*

Design Behavior Intervention Model (DBIM): Intention, habit, and control are the main components of this model (Figure 8) which was developed based on the interpersonal behavior model (Bhamra et al., 2011; Zachrisson & Boks, 2012). In DBIM, a concept was introduced as *design interventions*, which is presented based on Lilley et al.'s divisions on the concept of *Script* and developed further in seven sections (Zachrisson & Boks, 2012). The subject of *Power in Decision-Making* was also added, which starts with the full power of user decision-making in the *eco-information* section, and at the end of the spectrum, decision-making power is at the minimum; This is referred to as the *Axis of Influence* in Lilley's work (Lockton, 2013).

These seven sections were designed by Tang (2010) as follows:

1. Eco-information (*design-oriented education*)
2. Eco-Choice (*design-oriented empowerment*)
3. Eco-feedback (*Design-based communication with environmentally or socially responsible actions*)
4. Eco-Spur (*design-oriented rewarding incentive and penalty*)
5. Eco-Steer (*design-oriented affordances and constraints*).
6. Eco-technical intervention (*design-oriented technical intervention*)
7. Clever design

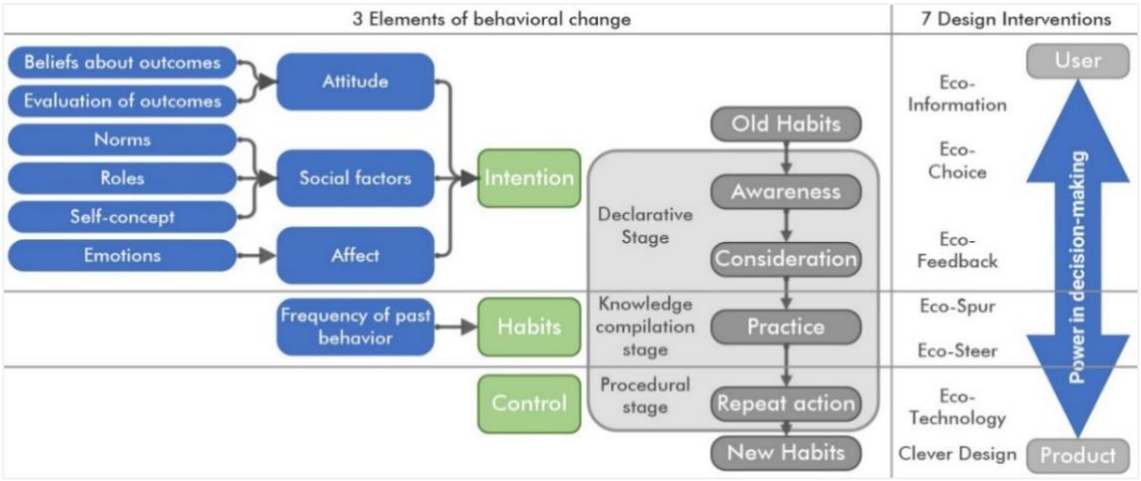

Figure 8: *Design Behavior Intervention Model (Tang, 2010).*

Behavioral Components

Relying on well-known models in the sustainable behavior literature and also the significance of such a category in terms of psychology and biological psychology, the three components of *rational choice (A)*, *emotions (B)*, and *habits (C)* were considered as a basis of behavior in this study. The reason for this categorization besides the significance of each component in the literature can be explained as such: *Theory of Planned Behavior*, as one of the known models, considers behavioral *intention* with the elements of *attitude*, *subjective norm*, and *perceived behavioral control* as the determinants of behavior (Ajzen, 2005). these elements in such models were interpreted as the *rational choice*. In the *Goal-Directed Behavior* model, other factors such as habits and emotions, in addition to those expressed in the *Ajzan* model, affect behavioral intention (Perugini & Bagozzi, 2001). Another model that forms the basis of designing sustainable behavior models (such as the *Design Behavior Intervention Model*) is the model of *Interpersonal Behavior*, in which factors such as attitude, norms, and emotions are subsets of intention and repetition of past behaviors are treated as habits (Tang, 2010; Bhamra et al., 2011). In other models specifically designed to promote sustainable behavior, such as the *Comprehensive Action Determination* model (which is designed based on the *Theory of Planned Behavior*, *Norm-Activation* model, and *ipsative* theory of behavior), two factors of intention and habits are also considered (Klockner & Blobaum, 2010).

Hamann et al. (2016) also introduce an abstract model with the main components of habits, emotions, and the *Weighing Process* to promote sustainable behavior. Other studies that have led to this classification include Zachrisson and Boks (2012), Manning (2009), and Jackson (2005). Also, according to the brain structure, parts of the brain that are related to rational choice, emotions, and automatic behaviors or habits are placed in different sections and work together based on circumstances, individual characteristics, and other factors to shape behaviors (Carrus et al., 2008; Sapolsky, 2017). This category is consistent with the simplified *triune brain* model, which divides the brain into three layers: the first layer controls automatic factors, the second layer handles emotions, and the third layer deals with complex processes like thoughts (Sapolsky, 2017). It must be noted that other attempts such as Nielsen et al. (2021) suggest categorization to make behavioral science accessible to designers, such as cognition, ability, motivation, timing, social, and physical context. This categorization has some overlaps with our suggestion, and while we understand that this can make behavioral change for designers accessible and useful, it does not create a space for designers to understand behavior more systematically since it abstracts and therefore limits the designers' ability to synthesize in different contexts.

A. Rational Choice

The rational choice or conscious evaluation that takes place in the frontal cortex does not indicate the logical decision; it simply refers to the choice that is evaluated by the person (Stanford, 2011). According to abstract models of behavior, in this study, due to direct relations with evaluation, *Intention* (Ajzen, 1985) and *Desires* (Perugini & Bagozzi, 2001) have been used to describe rational choice.

1. *Intention*

The intention is the predictor of an individual's attempt to perform a behavior (Ajzen, 1985). Based on the theory of planned behavior, intention consists of three parts: attitude, subjective norm, and perceived behavioral control (Ajzen, 2005):

- Attitude: *Most contemporary social psychologists agree that the characteristic attribute of attitude is its evaluative (pro-con, pleasant-unpleasant) nature* (Ajzen, 2005). A more favorable attitude toward behavior can increase the likelihood of that behavior (Yadav & Pathak, 2016).
- Subjective Norm (SN): Subjective norms help the person learn appropriate behavior for specific situations with less cognitive pressure and be aware of the social consequences of particular behaviors (Jackson, 2005). SN are common dos and don'ts of society, which are divided into two categories: descriptive norms (learning and repeating the behavior of others) and injunctive norms (inviolable rules) (Poškus, 2016; Hamann et al., 2016). Targeting SN as an inherent tendency can efficiently promote sustainable behaviors (Hamann et al., 2016; Poškus, 2016; Griskevicius et al., 2012).
- Perceived Behavioral Control (PBC): PBC suggests a general belief that makes one think that the behavior in question is entirely under their control or heavily influenced by external factors (Klockner & Blobaum, 2010; Ajzen, 2005). This belief is formed through direct experiences and second-hand information and increases or decreases the perception of the difficulty of performing a behavior (Ajzen, 2005). As a result, building confidence in people's minds about performing sustainable behavior can be very effective (Hamann et al., 2016).

2. *Desires*

Desire is a state of mind in which a person is motivated to act due to integrating different appraisals, including emotional, evaluative, and social ones (Perugini & Bagozzi, 2001; 2004). Attitudes, SN, and PBC produce reasons for commitment to act in volitive desires; in other words, when someone becomes aware of their desire for a purpose, it forces them to create an intention (Perugini & Bagozzi, 2001). The attitude, SN, and PBC work as catalysts for releasing the hidden desire for biological needs in appetitive desires (Perugini & Bagozzi, 2001).

B. Habits

If a routine is performed repeatedly by observing a cue, a relationship between the cue and the routine takes place in the brain, and without cognitive intervention or spending much energy on the information process, by seeing the cue, the behavior is automatically activated (Wendel, 2013; Ajzen, 2005). Well-practised behavior in a fixed environment leads to the frequency of past behaviors, indicates the power of the habit, and carries a direct impact on future behaviors, but for behaviors that are not well-learned (or when repetition of behavior takes place in an unstable environment), the frequency of past behavior only leads to formations of favorable intention (Perugini & Bagozzi, 2001). Repetition is not the only way to develop habits; if one anticipates receiving a reward, specific reactions are triggered automatically by seeing a cue (Wendel, 2013; Stanford, 2011).

C. Emotions

Emotions are formed by different variables and indirectly affect behavior (Baumeister et al., 2007). Emotions and rational choice are not opposed; on the contrary, the processes related to emotions help judgment and reason (Dolan, 2002; Sapolsky, 2017). Baumeister et al. (2007) divide emotions into two categories. The first category is *Emotion* (or Mood), which by definition is a conscious state of emotion. It is also associated with cognition and physiological changes such as arousal, which occurs and disappears slowly and originates from cognition. They introduce the second category as *Affect*, which means automatic reaction; subconscious; which is usually a short experience of something good or bad, welcomed or not, and can directly affect behavior.

Emotions indirectly affect behavior through feedback; Positive emotions indicate good performance and encourage the person to repeat the behavior in similar situations, and negative emotions send a signal which indicates the behavior needs to be reviewed (Baumeister et al., 2007). Predicting future emotions toward behavior has a more significant influence on behavior than the actual state of emotion, and this perception of emotion does not necessarily correspond to one's real emotion (Baumeister et al., 2007). Predicting future emotions is highly effective in promoting environment-friendly behavior (Wong-Parodi & Feygina, 2021; Carrus et al., 2008).

Discussion

Designing a Behavioral Model to Promote Sustainable Consumption

Studies have shown that rational choice, emotions, and habits, play a significant role in shaping behavior.

Table 1: *Comparison of behavioral models.*

Indicators / behavioral mode	Rational Choice	Emotions	Habits	Impact of the context on behavioral elements	Coercions beyond the individual's control	Designed to promote sustainable behavior	purchase, maintenance, and disposal of products
Theory of Planned Behavior	✓	✗	✗	✓	✗	✗	✗
Model of Goal-Directed Behavior	✓	✓	✓	✓	✗	✗	✗
Norm-Activation Model	✓	✗	✗	✓	✗	✗	✗
Theory of interpersonal behavior	✓	✓	✓	✓	✓	✗	✗
Comprehensive Action Determination Model	✓	✗	✓	✓	✗	✓	✗
Extension of The Integrative Influence Model of Pro-Environmental Everyday Behavior	✓	✓	✓	✓	✗	✓	✗
Design Behavior Intervention Model	✓	✓	✓	✓	✓	✓	✗

Also, consideration of the structure of these components in behavioral models showed that the context (or, in other words, design) could be influential in two ways. First, by affecting the components separately (such as background factors in the TPB) and secondly, without affecting these components by just creating coercions beyond the individual's control (for example, the control factor in the DBIM). Hence, these five criteria, along with the fact that the model should be designed to promote sustainable behavior and also consider the purchase, maintenance, and disposal of products, have formed seven indicators of the new behavioral model. According to these seven indicators, other models were compared in Table 1.

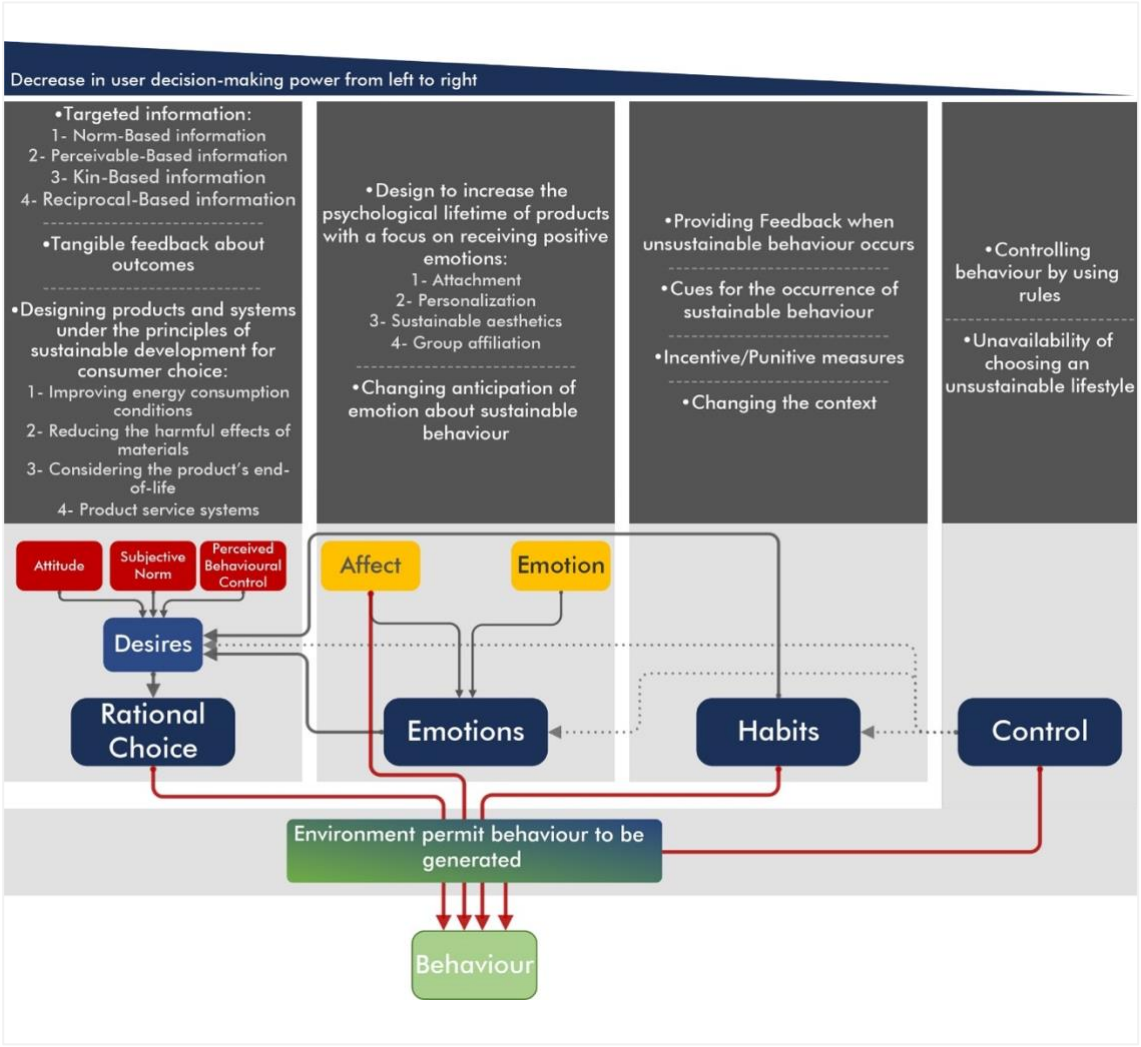

Figure 9: *Behavioral model for the promotion of sustainable consumption.*

Based on these seven indicators, we can conclude that the DBIM has the most adaptation to the design requirements of the new model. Hence, DBIM is used as a basis for development, but several factors differentiate the new model from it. The first difference is in the level of emotional consideration. Regarding the literature, influencing emotions and the user's decision-making power concerning this component differs from influencing rational choice. As a result, although most emotional responses do not directly affect behavior and influence rational choice indirectly, this component must be considered separately. Secondly, due to the indirect effect of habits on behavior alongside its direct effects, the MGB was considered to integrate components. Another difference is the placement of the control component, which is placed separately to filter all other components. Hence it can inadvertently lead to behavior on the one hand and also prevent certain behaviors. The final difference is in the design interventions that are redesigned according to the subject.

In explaining each part of the model (Figure 9), by relying on the MGB, it can be stated that attitudes, SN, and PBC all directly impact desires. Then, Emotions are defined by *Emotion*, that is, predicting good and bad feelings and *affects*, that is, instant feedback (Baumeister et al., 2007). Affects can directly affect behavior, but emotions commonly shape behaviors by providing feedback (Baumeister et al., 2007). Another part is habits that can directly create behavior and can also influence desires (Perugini & Bagozzi, 2001). In general, Desires lead to rational choice (Perugini & Bagozzi, 2001). Finally, contextual conditions can directly affect behavior (as cited in Zachrisson & Boks, 2012). Their moderating role affects other components (Jackson, 2005). These contextual conditions (*Facilitating Conditions* and *Situational Influences*) are named control in this model.

To be in the practical framework, design interventions (inspired by DBIM) were added to the model. Due to the division of the main components of behavior into three parts and considering the control factor separately, behavioral interventions were distributed in four parts. The user's *power in decision-making* in these four components is different from each other and decreases in the chart from left to right. In addition to the strategies described in the behavior literature, studies of environmental sustainability and the psychological longevity of products have been utilized to design these interventions, and evolutionary psychology also assisted in the optimization of these interventions. In the following section, design interventions are introduced as a strategy for behavior change and categorized according to their effects on the four components outlined above.

Design Interventions Affecting Rational Choice

In three subsections (A, B, C, and their subsections that are numbered accordingly) we discuss tools that fall into the rational choice space for changing behavior.

A. Targeted Information

One way to promote sustainable behavior is to raise awareness about environmental problems, which Hamann et al. (2016) divide awareness into two sections: problem-knowledge and action-knowledge. Compared to other strategies, information alone has a minor effect on behavior change (McKenzie-Mohr, 2000; Hamann et al., 2016; Jackson, 2005).

However, the evolutionary psychology literature suggests some modifications for awareness-raising strategies. Given the cultural context of the present age and the generalization of these findings only in the culture of the present days (Evolution has created a set of behavioral mechanisms for humans that can function in different ways depending on the environment and culture; Also, in interpreting a particular behavior from an evolutionary perspective, one should try not to mistakenly consider the environmental condition that affects the behavior and have created similar behavior across cultures as a genetic factor (Cohen & Bernard, 2013)), it can be said that information is more effective if it shows the effects of behavior in the present times, on the living environment and the near individuals:

1. Norm-Based information: Providing information that shows the majority of the society or a social group accepted the targeted behavior could raise the acceptability of needed change (Hamann et al., 2016; Wendel, 2013; Griskevicius et al., 2012). Therefore, information about accepted sustainable behavior by the majority of people or just inducing that a large number of people behave this way can be more effective (Griskevicius et al., 2012; e.g.: saying 100,000 people (instead of *one percent*) in this city are vegan).

2. Perceivable-Based information: People are less worried about the distant future; to be more effective, the information given to them should be about the impact of a sustainable action on the present (Griskevicius et al., 2012). People also pay less attention to places out of their reach than locations where they live; hence information about the impact of their unsustainable behavior must include the result on their surroundings (Griskevicius et al., 2012; e.g.: Climate change will affect the water supply of *your city*).

3. Kin-Based information: People pay more attention to those close to them, so for providing information, focusing on the impact of targeted behavior on this group of people can be helpful (Griskevicius et al., 2012). Understanding kinship does not necessarily require sharing genes; *Pseudo Kinship* produces similar effects if one solely perceives kinship (e.g., Using titles such as brotherhood and sisterhood for other people in the community; Stanford, 2011).

Hence, highlighting the kinship of all living organisms can be an effective strategy (e.g.: saying *Your children* (instead of *the next generation*) will face a raw material shortage).

4. Reciprocal-Based information: According to *Reciprocal Altruism*, it can be predicted that it is more likely for people to change their behavior for someone if they predict receiving benefits from them (Sapolsky, 2017). Therefore, another solution is to emphasize the mutual benefits of sustainable action (e.g.: Your contribution will improve your health).

B. Tangible Feedback about Outcomes

Tangible environmental problems which *[people] can feel, hear, smell, touch, or see* can have a more profound effect on behavior (Griskevicius et al., 2012). Due to the provision of better feedback about environmental impacts, local production is a relatable example (McDonough & Braungart, 2002).

Information and feedback were also mentioned in the DBIM. However, according to the strategies obtained from evolutionary psychology and considering the impact of culture on these findings and also considering the context of use, these interventions were modified (e.g., see the waste containers near your house).

C. Designing Products and Systems Under the Principles of Sustainable Development for Consumer Choice

Creating options for user selection was also mentioned in the DBIM (e.g. (Bhamra et al., 2011)), but DBIM's focus was on sustainable energy consumption. However, this model suggests that if people have a positive attitude toward sustainable behavior and there are options to choose from and given PBC, users can be expected to make sustainable choices in their purchases. In this regard, by reviewing the environmental design literature, the following solutions can be addressed:

1. Improving energy consumption conditions: Usage of local materials and energies (Anastas & Zimmerman, 2003; McDonough & Braungart, 2002), Reducing production stages (Ramani et al., 2010; Ljungberg, 2007), Assembling after purchase (Papanek, 1995), Simplicity (Zafarmand et al., 2003; e.g., flat-pack design for efficient transport, utilization of the user's muscle power for final assembly, reduction of assembly steps by choosing better materials or shapes).

2. Reducing the harmful effects of materials: Usage of renewable materials (Vezzoli, 2018; McDonough & Braungart, 2013; Ljungberg, 2007; Anastas & Zimmerman, 2003), Usage of non-toxic materials (Vezzoli, 2018; Anastas & Zimmerman, 2003; McDonough & Braungart, 2002), Reducing the quantity of material (Vezzoli, 2018), Reducing material variety (Vezzoli, 2018; Anastas & Zimmerman, 2003; e.g., use of ribs in plastic production to reduce thickness and weight, use of different physical forms of the same material, use of plastics without the addition of additives or other plastics).

3. Considering the product's end-of-life: Repairability and maintenance (Vezzoli, 2018; Mugge et al., 2005), upgradability (Vezzoli, 2018; Chapman, 2005), designing for reuse and remanufacturing (Ramani et al., 2010), designing for disassembly (Ramani et al., 2010; Anastas & Zimmerman, 2003; Papanek, 1995), Durability instead of immortality (Anastas & Zimmerman, 2003; e.g., consideration of modularity in phones, consideration of standards, and the right to repair).

4. Product service systems: Product rental systems (McDonough & Braungart, 2013; Manzini & Vezzoli, 2003), sharing systems (Vezzoli, 2018; Mugge et al., 2005; Papanek, 1995; e.g., car sharing services).

Design Interventions Affecting Emotions

In two subsections (A and B and their respective subsections, which are numbered accordingly), we discuss tools for changing behavior related to emotions.

A. Design to Increase the Psychological Lifetime of Products with a Focus on Receiving Positive Emotions

Many products are discarded or replaced before the end of their useful life (Zafarmand et al., 2003). Emotionally durable design *examines and articulates the unspoken emotional experiences that occur between products and consumers* and associates it with product longevity (Haines-Gadd et al., 2018).

Since positive emotions command the individual that their behavior is favourable and should be repeated in the future (Baumeister et al., 2007), it can be said that emotionally durable design (or other strategies for increasing the psychological lifetime of products), due to its contribution for generating positive emotions, can be used in the model as a behavioral strategy. There are various strategies to increase the psychological lifetime of products that are associated with positive anticipation of emotions, including:

1. Attachment: Evoking memories (Page, 2014; Van Krieken et al., 2012; Chapman, 2009; Mugge et al., 2005), Pleasurable to use (Mugge et al., 2008), creating a sense of having a soul for products (Van Krieken et al., 2012), keeping the user involved during the usage period (Chapman, 2005) and creating the honest initial expectation (Chapman, 2005; e.g., appreciation of a handcrafted aesthetic, use of smells, addition of layers of meaning in the product that are difficult to detect).

2. Personalization: Using the end-user in the design process (Mugge et al., 2009; Tseng & Ho, 2012), actual production diversity (Papanek, 1973; Chapman, 2005), mass customization (Mugge et al., 2009), local aesthetics and cultural identity (Zafarmand et al., 2003), changeability (Mugge et al., 2005; Chapman, 2005) and modular design (Vezzoli, 2018; Mugge et al., 2005; e.g., maximizing the potential of mass customization, taking real needs into account, design thinking in action).

3. Sustainable aesthetics: Ageing gracefully (Page, 2014; Chapman, 2005; Papanek, 1973), Simplicity (Zafarmand et al., 2003), Natural forms and materials (Griskevicius et al., 2012; Papanek, 1973) and changeability through time (Zafarmand et al., 2003; e.g., upgradeability of aesthetic features, repairability).

4. Group affiliation (Mugge et al., 2008; e.g., creation of space for use in groups).

B. Changing the Anticipation of Emotion about Sustainable Behavior

Enhancing emotions (Negative or Positive) can be used as a way to engage audiences in sustainable behaviors (Wong-Parodi & Feygina, 2021). Still, it must be considered that *anticipated emotion may be more important in guiding behavior than actual, felt emotion* (Baumeister et al., 2007). Sustainable behavior is expected if people anticipate that unsustainable behavior will not lead to a positive emotion or that sustainable behavior creates positive emotional states (Carrus et al., 2008). Thus, it is practical to change this anticipation by providing knowledge explicitly or implicitly (e.g., the suggestion that a change in diet can evoke positive feelings).

Design Interventions Affecting Habits

The following subsections discuss tools for changing habits in four subsections (A, B, C, D).

A. Providing Feedback When Unsustainable Behavior Occurs

It is possible to form habits that lead to behaviors that are not intentional (Young, 2010). If habits are mentioned when unsustainable behavior occurs, the user can be expected to notice their behavior and think more about doing a particular behavior (Zachrisson & Boks, 2012; e.g., send an alarm when an unused device is on).

B. Cues for the Occurrence of Sustainable Behavior

Habits can be formed if a particular process is repeated under similar circumstances; therefore, receiving relatable cues to these conditions can activate behaviors (Wendel, 2013). Hence, if a cue is given while performing a sustainable behavior, after a certain period, the person automatically performs the behavior when the cue is received (e.g., a reminder for separating wastes).

C. Incentive/Punitive Measures

If in return for behavior, a reward is received, the brain expects to receive the reward again by repeating this action; as a result, habits are formed by incentives (Wendel, 2013; Stanford, 2011). Therefore, encouraging the user with the reward (positive feedback) element can lead to sustainable habits (Bhamra et al., 2011; Manning, 2009). Also, receiving negative feedback in return for behavior can help prevent the repetition of action in the future (Bhamra et al., 2011; Manning, 2009; e.g., facing angry faces after littering).

D. Changing the Context

Habits occur in the face of cues or, in other words, environmental stimuli. Eliminating these stimuli and not facing them can lead to the elimination of unsustainable habits (Jager, 2003; Zachrisson & Boks, 2012; e.g., eradication of plastic bags at the checkout counter).

Design Interventions Related to Control

Two subsections (A and B) discuss tools for changing behavior in control space.

A. Controlling Behavior Using Rules

Rules can confront users if they intend to engage in unsustainable behavior. Acceptance of coercive norms is not due to the adaptability of behavior but to compliance or fear of punishment that forces the individual to perform a particular behavior (Hamann et al., 2016; e.g., fines for excessive consumption).

B. Unavailability of Choosing an Unsustainable Lifestyle

If a person seeks unsustainable behavior, but the unsustainable choice is unavailable, the possibility of action decreases (Klockner & Blobaum, 2010; e.g., circular economy in action).

Conclusion

To develop a tool for designers to help minimize purchases, increase product maintenance, and reduce waste, components that influence behavior were identified by research in the field of psychology. These studies introduced rational choice, emotions, and habits as three separate but intertwined components influencing behavior (Carrus et al., 2008; Sapolsky, 2017). Then, by reviewing the known behavioral models, the relationships between these components and how these components affect behavior were identified. Understanding how the three behavioral components work and how to influence each of them and examining these components in behavioral models created the theoretical basis for designing a new model to influence consumption.

To adapt the model for product design, studies in the fields of sustainable design and evolutionary psychology were conducted. The model proposed in this research can be considered as a complex model. This complexity contrasts with simpler models' testability and readily applicability (Jackson, 2005). Even though complex models are harder to test, theoretical evidence of the separate effect of specified components and the better ability of complex models to explain customers' behavior made these models valid for practical use (Jackson, 2005).

In addition to the three internal behavioral components (rational choice, emotions, and habits), a controlling factor outside of individual decisions is considered. As a result, design interventions are distributed in four sections that were mentioned above, and the user's decision-making power differs in each of these four components. In rational choice, the decision-making power is at its highest, and in control, the user's power is at the lowest level. Design interventions are divided according to their relationship to each section. They include *targeted information*, *tangible feedback about outcomes*, *designing under the principles of sustainable development*, *design to increase the psychological lifetime of products with a focus on receiving positive emotions*, *changing anticipation of emotion about sustainable behavior*, *providing feedback when unsustainable behavior occurs*, *cues for the occurrence of sustainable behavior*, *incentive/Punitive measures*, *changing the context*, *controlling behavior by using rules* and *unavailability of choosing an unsustainable lifestyle*. This means, that by incorporating a wide range of factors into the model, the model is capable of facilitating the adoption of sustainable behaviors. For instance, by being grounded in understanding human behaviors, the model can be leveraged to develop more effective strategies for promoting sustainability and fostering environmental awareness, or it can serve as a valuable tool for designing self-assessment tools, enabling individuals to measure their ecological footprints, or as a cultivating environment-friendly habits tool. In addition, it can be used as a framework for product designers during the development process, providing a basis for introducing methods for prolonging product life cycles or designing sustainable products in general.

The proposed model designed in this process is the final aim of this research and it is our understanding that no existing theory or model explicitly incorporates all mentioned variables in one single model. Previously implemented as discrete entities, the components of this model have demonstrated their effectiveness in fostering sustainable behavior. Bringing together disparate components, this model provides a holistic approach to promoting sustainability by synthesizing prior findings. Since it was arranged in a format to improve consumption patterns of products as an approach that has not been followed before to encounter consumerism and design guidelines used as tools in this model, it can be seen that, after validation, designers will be able to use it as a tool to try to influence behavior, influence the purchase, promote maintenance, and reduce the disposal of products. The pursuit of this research's path can be consideration of the iterative nature of design methods in the model and the fact that changing behavior for the better does not necessarily guarantee responsible intervention, as mentioned in Nielsen et al. (2024), both of the issues can be addressed better by integration of design thinking into the model after validation of this model's accuracy.

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