Promoting Healthy Eating Through Packaging Design

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The candidate confirms that the work submitted is her own, except where work which has formed part of jointly-authored publications has been included. The contribution of the candidate and the other authors to this work has been explicitly indicated below. The candidate confirms that appropriate credit has been given within the thesis where reference has been made to the work of others.

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Abstract

The imbalance of excess intake of high energy density foods and inadequate intake of nutrient dense foods contributes to the prevalence of obesity and other nutrition related non-communicable diseases worldwide. The ongoing challenges in maintaining a healthy diet demonstrate the need to foster a supportive environment for healthy eating. Beyond a marketing vehicle, food packaging has gradually evolved into a communication tool. The impact of food packaging on consumer intake is evidence-based. Designers can provide a supportive food environment for consumers through packaging design. Despite the known impact of packaging features on consumption there remains a notable gap in addressing the support for designers grappling with this emerging design domain. Thus, the aim of this research was to explore the role that packaging could play in promoting healthy eating and provide necessary support to designers.

Through a systematic review of related experimental research, a comprehensive understanding of packaging attributes and their impacts on food intake has been established. A photo-elicitation approach combined with semi-structured interview was applied to gain insights from consumers themselves, to understand what they notice, the ways in which packaging affects portion choices and their values when making purchasing decisions. The needs of designers in practice were identified through one-to-one interviews with designers using a packaging design task.

The findings from these studies have been integrated into the initial support materials (design tool version 1) for designers consisting of information and inspirations. Concentrated background knowledge, like food energy density and portion size, was included to build understanding. Experiential data and findings of the intake effect of packaging attributes were visualised in digital cards. Consumer insights and experiences on interaction with packaging were summarised. Five main aspects of design strategies integrating the Theory of Reasoned Action, Persuasive Technology and Health Belief Model were proposed. Some design examples from other designers have also been provided. The design tool has then been developed and improved through a series of studies with student designers. Feedback from designers was analysed and applied to the improvement of the tool into design version 2. The design tool version 3 was developed into a web-based prototype and evaluated with professional designers to demonstrate its value in providing support to designers.

This research concludes with a reflection on the application of packaging design for behaviour change as well as the integration of social psychology theories and design, supportive design tool development and evaluation of the potential benefits and scenarios of the design tool application. Further research implications have been highlighted including: the improvements in the presentation and expected functions of the web-type design tool, the impact of more packaging design elements, the evaluation of packaging design concept with consumers. Overall, this thesis contributes to the evidence-base of how packaging design can inform consumer choice and support healthy eating.

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Abbreviations

HED (LED): High (Low) Energy Density

ND: Nutrient Dense

WHO: World Health Organization

NCDs: Non-Communicable Diseases

F&V: Fruits and vegetables

DfBC: Designing for Behaviour Change

mHealth: mobile health

HBM: Health Belief Model

PT: Persuasive Technology

TRA/TPB: Theory of Reasoned Action/Theory of Planned Behaviour

DT: Design Thinking model

DD: Double Diamond model

RQ: Research Question

DSR: Design Science Research

DRM: Design Research Methodology

RC: Research Clarification

DS: Descriptive Study

PS: Prescriptive Study

SR: Systematic Review

PE: Photo-Elicitation

PDPE: Participant-Driven Photo-Elicitation

TA: thematic analysis

BMI: Body Mass Index

SD: standard deviation

SSR: Serving Size Recommendation

NT: Nudge Theory

Chapter 1
INTRODUCTION

This chapter provides an overview of this research topic, by discussing the issue of low diet quality patterns, increased consumption of high-energy, nutrient-poor foods and its risks on individual. The underexplored role of food packaging design in shaping consumer eating behaviour and the contribution of design to behaviour change are introduced, highlighting the potential of using packaging as a tool to guide consumers towards healthier eating behaviours. Also, in this chapter the research aims, research questions and objectives are described. Finally, the chapter concludes with an outline of the thesis structure.

1.1 The overview background of the research topic

1.1.1 Why healthy eating is important and hard to achieve?

Over the past few decades, there has been a notable shift in human dietary patterns, that "double burden of malnutrition" is a rising issue worldwide (Kearney, 2010, Popkin et al., 2020, Popkin and Reardon, 2018). For example, concurrent challenges of undernutrition and obesity are faced by many countries, especially in many low-and middle-income countries (WHO, 2016). At the population level, there has been a rise in the consumption of foods rich in energy, fats, sugars, or salt, along with an increase in the intake of energy-dense beverages (Malik et al., 2010, Moubarac et al., 2017). This phenomenon is often linked to changes in the global food system, driven by factors such as globalization of the food industry, urbanization, and rising income levels, which have made high-energy, high-fat, and high-sugar foods more accessible for consumers (Monteiro et al., 2013). However, in contrast, the consumption of traditional healthy foods like fruits, vegetables, and whole grains has significantly declined and remained below recommended levels (Popkin, 2006).

Eating is fundamental to survival and the influence of eating behaviours on health is well-known. It is confirmed that maintaining a well-balanced diet is essential for

overall well-being (Khaw et al., 2008, Muscaritoli, 2021). However, the imbalance of excess intake of high energy density (HED) foods and inadequate intake of nutrient dense (ND) foods contributes to the prevalence of obesity and other nutrition related non-communicable diseases (NCDs), like hypertension, diabetes, cardiovascular disease and even some type of cancer (Chooi et al., 2019, Monteiro et al., 2018, Stanhope, 2016). The overconsumption of HED foods not only elevates individual health risks but also places immense pressure on national healthcare systems (Guldan, 2020), land degradation, water scarcity, and increased carbon emissions (Reynolds et al., 2015, Joshua and Joshua, 2017) and hinders economic development (Dijkstra et al., 2018, Horton and Steckel, 2013). Despite the well-documented risks of excessive energy intake (Prentice, 2001), altering eating behaviour remains a complex challenge across populations. Furthermore, the consumption of nutrient-dense foods, particularly fruits and vegetables, is important in maintaining health and preventing chronic diseases (Wang et al., 2014, Wallace et al., 2020). These food groups are rich in essential vitamins, minerals, and dietary fibre, while most being relatively low in energy content. However, many populations fail to meet the recommended daily intake levels. Many factors lead to the overconsumption of energy-dense but nutrient-poor foods, displacing the consumption of healthier options like fruits and vegetables (F&V) (Troesch et al., 2015).

This balance diet difficulty stems from a combination of biological, psychological, and environmental factors. One significant contributor is food palatability that the highly palatable foods, often high in fat, sugar, and salt, can trigger reward pathways in the brain (Münzberg et al., 2023), similar to addictive substances, leading to overconsumption despite negative health consequence. The pleasure derived from such foods can override physiological signals of satiety (Petit et al., 2016), making it harder for individuals to regulate their intake. Other than that, food variety, availability, and other environmental elements significantly contribute to this challenge. Food variety, while often seen as a marker of a balanced diet, can paradoxically lead to overeating (Martin, 2016). The concept of sensory-specific satiety suggests that the more variety people are exposed to in terms of flavours, textures, and appearances, the more likely they are to continue eating, even when

they are no longer physiologically hungry (Havermans and Brondel, 2013). In environments with abundant choices, such as buffets or supermarkets stocked with an overwhelming selection of processed and HED foods, people tend to overconsume by continuously seeking new tastes. In addition, some other environmental elements, like portion sizes (Young and Nestle, 2007), marketing and advertising (Harris et al., 2010) also significantly contribute to the ongoing HED foods overconsumption and low ND foods intake.

1.1.2 Why packaging design is potential to promote healthy eating?

In most cases, food and beverages are contained within packaging, which acts as a crucial interface between the consumer and the product. Consumers are typically exposed to the design, labelling, and visual cues on the packaging before and during consumption, making packaging a powerful environmental factor in influencing eating behaviours. Consumers are accustomed to judging the product by its cover (Magnier et al., 2016). The packaging not only provides information about the product but also shapes consumer perceptions of the food's healthfulness (Yarar et al., 2019), taste (Machiels and Karnal, 2016), and quality (Wang, 2013). Besides, the packaging also influence decisions on the purchase choices (Rebollar et al., 2012), serving and consumption quantity (Antonuk and Block, 2006) across age groups. While poor design or misleading health claims may contribute to the overconsumption of unhealthy, highly processed foods (Chandon, 2013). As a result, packaging acts as a continual point of interaction that extends beyond product protection, shaping consumer perception and behaviour in profound ways.

Despite the significant influence of food packaging design on consumer perceptions and choices, its role in influencing consumer diet behaviour is often overlooked. For example, many food manufacturers prioritize aesthetic appeal and marketing over health-promoting features, using packaging to highlight indulgence, convenience, or novelty. As a result, packaging is frequently used to enhance the attractiveness of highly processed, energy-dense foods, while healthier options like F&V are often sold with minimal or unattractive packaging (Elliott, 2009, Linn and

Novosat, 2008). This disparity can mislead consumer perceptions, making unhealthy options appear more desirable and easier to consume on-the-go, while nutrient-dense foods may be perceived as less appealing. Moreover, sustainability efforts in packaging design, such as reducing packaging waste, are sometimes prioritised at the expense of promoting health-conscious choices. While environmentally friendly packaging is essential, focusing solely on this aspect may inadvertently lead to missed opportunities to encourage healthier eating patterns through design and labelling that emphasize the nutritional benefits of the food itself (Svanes et al., 2010). Therefore, while food packaging has immense potential to influence consumers and reach broader populations, its role is often underutilised or neglected in favour of promoting healthy diet.

Design for behaviour change is a multidisciplinary approach that seeks to influence user behaviour through thoughtful design (Christmas et al., 2015). This approach is applied across various fields, including health, sustainability, and safety, to encourage individuals to adopt more beneficial habits or reduce harmful behaviours. Research indicated that well-designed environmental cues can significantly enhance human behaviour. Take health promotion as example, design interventions have been used to subtly nudge individuals toward healthier lifestyle choices, such as promoting increased physical activity or improving dietary habits through visual cues and user-cantered interfaces (Michie et al., 2011). Similarly, some design strategies were also explored and applied to foster eco-friendly practices, such as waste reduction, energy conservation, and recycling (Lockton, 2013, Fogg, 2009). Although the value of design is identified in encouraging desirable human behaviours, there is less attention on the role of design in guiding eating behaviour (Marteau et al., 2015, Roberto and Khandpur, 2014, Cinovics, 2020, Tang et al., 2022).

The ongoing challenges and barriers mentioned above in maintaining a healthy diet suggest the need for action aimed at promoting healthy eating. The packaging interactive nature and the identified impacts on consumers reveal the potentials of packaging design on encouragement of healthier eating behaviour. Which also indicate designers are not just responsible for making the packaging visually appealing, but also for providing a supportive environment for consumers to adopt

healthy habits. Although the value of design in behaviour changes in areas such as sustainability and health promotion and the value of packaging design are both recognised, limited attention was paid to consider how packaging design can nudge less intake of HED foods or encourage the ND food intake, or even help foster healthy habits, from a design perspective. Moreover, the new role of food packaging provides designers with new insights into the purpose of packaging design, while also bringing some challenges. This is due to the role of packaging design in food intake has not been systematically examined and no existing strategies or design tool directly support packaging design aimed at promoting health. Therefore, the focus of this research was to synthesise useful materials and translate them into packaging design tool to facilitate the packaging design for healthy eating.

1.2 Scope of this research: aims, questions and objectives

1.2.1 Research aim

The overall aim of current research was to develop an effective packaging design tool to assist designers in creating new solutions of food packaging concepts that provide a more supportive environment for healthy eating. To be specific, this research focuses on promoting healthy eating by supporting portion control of HED foods and encouraging the consumption of ND foods.

1.2.2 Research questions

Primary research question:

PQ: How can designers be effectively supported in creating packaging designs that promote healthy eating?

Secondary questions:

RQ1: What are the characteristics of packaging design in influencing consumer food intake?

RQ2: What strategies and tools can be developed to support designers in designing food packaging that promotes healthy eating?

1.2.3 Research objectives

1) To demonstrate a detailed understanding of the healthy eating, approaches to influence eating behaviour, design for behaviour change, the role of packaging design and design tool for designers.

2) To investigate the impacts of packaging attributes on food intake and their characteristics, identifying the attributes that facilitate portion control.

3) To explore the consumer insights from their real life on the packaging impacts on their food consumption.

4) To investigate the challenges and needs of designers in creating packaging designs that promote healthy eating.

5) To develop packaging design tool to support designers in shaping packaging that encourages healthy eating.

6) To test, refine, and enhance the design tool through iterative development and feedback from designers.

7) To evaluate the design tool prototype in terms of its usefulness, values and applications for supporting the packaging design aimed at healthy eating.

1.3 The outline of this thesis

This thesis is structured around four main research phases: 1) research clarification and methodology, 2) exploratory phase, 3) development, improvement and evaluation phases and 4) discussion and conclusion phase. The structure of the thesis is illustrated in Figure 1.1, and each chapter in this thesis is described more in detail below.

1.3.1 Research clarification and methodology

Chapter 2 – Literature review (LR)

This chapter includes a review of existing literature around four main topics of healthy eating, design for behaviour change, food packaging design and its impacts, as well as the design tool. It provides an overview background of the research

topic, presenting the significance of the promoting healthy eating and the corresponding barriers in current contexts, the role of design in healthy behaviour change, the values of packaging design in promoting healthy eating and the design support applications for designers in design idea generation. The chapter concludes by highlighting existing research gaps and summarising the areas where further research is needed.

Chapter 3 – Research methodology

This chapter provides a methodological framework for this research. It starts with reviewing research methodologies and explaining the rationale behind the choices. To address the research aim, an integrated approach (inductive and deductive) was adopted with explanatory purpose. The research type was identified as mixed approaches that primarily a qualitative exploration, but quantitative investigation was conducted in design tool testing phase. The research strategies in social science and design science research are introduced, followed by a description of the Design Research Methodology (DRM), which served as the primary framework for the current research. This is accompanied by a more detailed introduction of the specific methods for data collection. Subsequently, a comprehensive review of the research design is provided, illustrating research phases and the main outcomes of the whole research.

1.3.2 Exploratory phase

Chapter 4- Systematic review (SR)

The aim of the review was to produce a comprehensive account of the impact of the packaging features on food intake. This chapter outlines the process of conducting the systematic review and details of how the included studies were characterised and analysed. The tested food packaging features were categorised into visual cues, structural features and other attributes, and the study results were synthesised to presents the impacts of the packaging manipulations. The experimental data were then extracted to capture the characteristics of the studies. Followed by the summary and the discussion of the main findings to demonstrate how packaging features influence food intake from an experimental

perspective, alongside the consideration of other contributing factors such as food features and consumer characteristics.

Chapter 5 – Consumer study

This chapter explored the consumer interaction with food packaging by gathering insights of eye-catching features of food packaging, the noticed useful packaging features for facilitating the portion control and how consumers decide their portions in real life. It describes the photo-elicitation study carried out with consumers, followed by an interpretation of the collected packaging images, integrated with the consumers' explanations. This is followed by a summary of the key themes related to salient packaging features and those that influence intake, from the consumers' perspective. Then it reveals key values that consumers consider when making portion decisions and presents several packaging design implications based on consumer suggestions.

1.3.3 Development, improvement and evaluation phases

Chapter 6 – Designers needs and design tool development

This chapter contains an investigative study with designers which aimed at understanding the challenges and the needs of the target users for the packaging deign to promote healthy eating and the development of the design tool to support the design. In this chapter, the study conducted with designers is introduced, followed by an exploration of how designers perceive the evolving role of packaging and this specific design topic, along with the corresponding challenges they encounter and the support they may need. Then, a design tool framework is proposed accordingly, and the detailed content is presented, building upon the review of the literature and data and findings in the exploratory studies. The tool was designed to support designers on the idea generation and concept development of the food packaging design to achieve the healthy eating promotion. The chapter illustrates how the tool was developed, with the initial design tool material (design tool version 1.0) illustrated for an overview at the end of this chapter.

Chapter 7 – Design tool testing and improvement

This chapter describes how the tool was tested and refined through the testing studies with designers. In the first study, the design tool content was introduced to designers and the feedback on the content clarity and the usefulness as the design tool was collected. In addition to validating the usefulness of the tool's content, an improved framework was proposed based on feedback from designers. Afterward, how the design tool was improved, and the new version of the design tool (version 2.0) is presented. Then, the testing of the design tool 2.0 with designers is then described, which is evaluated the design tool via various methods, including the creativity, relevant knowledge gaining, tool using experience. Additionally, the application of the design tool was connected to the design processes and design states, offering a comprehensive overview of its application. The further feedback on the clarity and the usefulness of the design tool 2.0 indicated the well-developed of the design tool.

Chapter 8 – Design tool final evaluation

This chapter presents the web-based design tool prototype (design tool version 3.0) to make it convenient and unrestricted available for designers (which were reflected as tool expectation in the designer needs exploration). Them, how the new version of design tool was evaluated with professional designers is described. This chapter discusses the feedback of the design tool implication on the support in topic understanding, design inspiration and potential benefits for the relevant shareholders. At the end of this chapter, it summarises the areas for further optimization reflected in the feedback and the further works.

1.3.4 Discussion and conclusion phase

Chapter 9 – Discussion

This chapter synthesises the findings of all studies together and their significance . Building upon the results obtained in the exploration studies, the impact of packaging design on consumers' food intake, consumers' perceptions and expectations of packaging and the conflicts and benefits’ of using packaging design to influence eating behaviour are discussed. In addition to design concepts by designers, the important role of food companies and policies in further achieving

health-oriented packaging design was emphasised. Furthermore, based on the design tool development, the results of the design tool usefulness and the other feedback on the design tool from the evaluation studies, this chapter making some consideration on its contribution to DfBC, its role in the design process, along with a deeper discussion of the tool's multiple values and its potential applications. The limitations of the tool and how to optimise it were also addressed.

Chapter 10 – Conclusions

The purpose of this chapter was to summarise and synthesise the entire research process and findings. First, it provides a summary of the research findings and contributions from each chapter, followed by an analysis of how these findings addressed the research objectives. Next, it highlights the value of healthy food packaging design, and the emerging needs of the design support, summarising the tool's performance in promoting healthy eating designs, the core assistance it offers to designers, and how it addresses the challenges faced by designers. Furthermore, it describes the tool's application value and innovative contributions in the fields of food packaging and design. Lastly, it reviews the limitations of the study and outlines future works.

Chapter summary

This chapter provides an overview of the implications of the research on how to promote healthy eating through packaging design and highlights the research aims, questions and research objectives. The problem of unbalanced diet was highlighted, presenting the difficulty to keep a healthy diet. In this context, designers need to embrace the new role of packaging, providing a supportive packaging deign for healthy eating. While for this new design challenge, there is a lack of comprehensive understanding regarding the impact of packaging design on food intake. Additionally, there is no existing guidance or design tool to enable designers to effectively leverage packaging in ways that actively promote dietary behaviour change, particularly in relation to food intake. Thus, this research carried out several investigative studies to gain deeper insights into the research problem, providing a detailed description of the design tool's development, improvement,

and evaluation. In summary, this chapter outlines the structure of the thesis in Figure 1.1.

Chapter	Aim	Outcomes
Chapter 1 Introduction	To provide the research background, describe the research topic and present overview of the thesis structure.	Research aim, questions, objectives and the thesis structure
Chapter 2 Literature review	To demonstrate a detailed understanding of the research and theories surrounding the research topic.	A cohesive summary of established knowledge in the field.
Chapter 3 Research methodology	To explain the approach of the research, introduce selected methods and the rationale of the choices and the overview of the study design.	Research approach, framework and the study design
Chapter 4 Systematic review	To summarise the impact of the packaging features on food intake from a experimental perspective	14 packaging features 3 packaging clusters 2 aspects of other factors
Chapter 5 Consumer study	To gain insights from consumers about the influence of packaging on their intake and portion decision.	2 Salient feature themes 3 effective feature themes 4 design implications
Chapter 6 Designer needs and design tool development	To capture the designer challenges and needs for this design problem, and describe the development of the design tool to support designers accordingly.	2 identified needs themes 2 tool preference themes Initial design tool materials (design tool 1.0)
Chapter 7 Design tool improvement	To get feedback from designers on the design tool to improve it accordingly.	Improvement framework Design tool 2.0
Chapter 8 Design tool evaluation	To improve the design tool, evaluate the improved design tool and reveal the design tool values.	Design tool 3.0 (Web-based prototype) Design tool values
Chapter 9 Discussion	To discuss the main findings of all study and their significance from a comprehensive perspective	Each chapter findings Conflicts of healthy eating Design tool usefulness, values and applications
Chapter 10 Conclusion	To summarise and synthesis the entire research process and findings	Answer research questions Theoretical and practical contributions Limitation and further work

Figure 1.1 Illustration of the overall structure of current thesis.

Chapter 2
LITERATURE REVIEW

This chapter reviews the existing literature related to healthy eating, design for behaviour change, food packaging design and its impact on consumers, and the design tools. It establishes a contextual background and the theoretical foundation for the research by addressing the importance of promoting healthy eating and its challenges, exploring how design can influence behaviour change and the role of packaging in facilitating healthier behaviours, as well as the design tool to support designers. The chapter concludes by identifying current research gaps and outlining the areas where further exploration is necessary to enhance the effectiveness of design interventions (packaging) in promoting healthy eating.

2.1 Healthy eating and its challenges

2.1.1 Healthy eating and its importance

Healthy eating is a fundamental component of maintaining health and preventing chronic diseases (Shams-White et al., 2023, Willett et al., 2019). European Food and Nutrition Action Plan calls for priority actions on contributing to the overall quality of the European population's diet and nutritional status in 2015 (WHO, 2015). In the UK, Eatwell guide, a food-based dietary guide has been proposed by Public Health England since 2016, recommending a reduction in intake of foods high in sugar, fat and salt/sodium and an increase in fruits, vegetables and whole grains (Buttriss, 2016). Research indicates that adherence to the Eatwell Guide can lead to reduction in health risk, but with only about 0.1% of the UK population meeting all recommendations (Scheelbeek et al., 2020), suggesting that guide is effective in theory, but limited in practical application.

Over decades, many studies have highlighted the importance of a balanced diet in fostering overall well-being, both physical and mental well-being (Cena and Calder, 2020, Colatruglio and Slater, 2014, López-Gil and Tárraga-López, 2022, Shams-White et al., 2023). Studies showed that poor dietary habits significantly contribute

to the development of NCDs like obesity, hypertension, and diabetes. The overconsumption of the processed foods, particularly those high in added sugars, salt, and unhealthy fats has been linked to increased risks of cardiovascular diseases, metabolic disorders, and obesity (Hu, 2003). Conversely, a review of large population studies indicated that individuals who adhere to healthy eating patterns experience lower incidences of cardiovascular diseases and longer life expectancy (Schwingshackl et al., 2017). In addition, nutrient-rich diets are associated with improved mood and cognitive function, while poor dietary patterns are linked to an increased risk of mental health disorders, including depression and anxiety (German et al., 2011, Jacka et al., 2011, Mayer et al., 2014). The imbalance in dietary intake, characterised by the overconsumption of HED foods and insufficient intake of ND foods, resulting in inadequate nutrient intake and potential long-term health consequences (Yeh et al., 2021). As the global burden of NCDs continues to rise (Habib and Saha, 2010), promoting healthy eating should remain a top public health priority.

2.1.2 The imbalance diet and its consequences

Overconsumption of HED food

From a health perspective, most HED foods are energy dense, but lack essential nutrients (Nicklas et al., 2014), however, they are highly liked by consumers. Specifically, some HED food is usually overconsumed by consumers, such as sweet snacks (e.g. sweets, cookies, cakes), salty snacks (e.g. potato crisps, pretzels), sugar-sweetened beverage (e.g. soda, fruit drinks) (Liang et al., 2016, Roberto et al., 2016, Rolls et al., 2007). Excessive intake of HED foods is not only harmful to human's well-being (Gasbarrini and Piscaglia, 2005, Teo et al., 2021), but also contributes to food waste (Sheen et al., 2020). HED food is defined as foods and beverages that contain more than 2.5 kcal/g (10.4 kJ/g) (Albar et al., 2014). Consumer may not familiar with the its definition, but research indicated that consumers are aware of the negative impacts of HED foods on healthy and defined them as unhealthy foods (Younginer et al., 2016). However, despite this awareness, the consumption of HED foods remains increasing, suggesting that other factors influence food choice and food intake beyond health considerations.

Insufficient intake of the ND food

Fruits and vegetables (F&V) are widely recognised for their high nutrient density and essential components of a nutrient-dense diet, providing essential nutrients while being relatively low in calories (Zaccari et al., 2021). Recommendations for increased fruit and vegetable' intakes are similar across many countries, where consumers are advised to aim for at least 5 portions of F&V (2 servings of fruits and 3 servings of vegetables per day) (Herforth et al., 2019). However, despite the benefit of eating F&V in health (Boeing et al., 2012), the daily intake of F&V remains below the recommended healthy dietary levels worldwide (Wallace et al., 2020, Vandevijvere and Knai, 2015).

It has been revealed that Individuals consuming a diet high in HED foods may experience increased appetite and cravings, leading to further overconsumption and neglecting the healthier food options (Choi, 2023), resulting in lack of dietary variety (Qasrawi et al., 2024). Therefore, reducing the intake of HED and encouraging the consumption of F&V are identified two key approaches to adverse effects of dietary imbalances and promote healthy eating across populations.

2.1.3 The internal and environmental challenges

2.1.3.1 The environmental factors

- *Food palatability, variety and accessibility*

Food palatability plays a significant role in influencing eating behaviours and preferences, driving excessive energy intake. (Sutton et al., 2024, Yeomans et al., 2005). The palatability of HED foods is often linked to their sensory properties, such as sweetness and fat content, which activate the brain's reward systems more robustly than less palatable options (Drewnowski, 1998, Kenny, 2011). In addition, food variety plays a significant role in promoting overeating that greater food variety encourages increased food consumption within an eating occasion, known as "sensory-specific satiety" (Hetherington and Rolls, 1996). This is due to a natural tendency of humans to explore different tastes and textures, leading to a delay in the feeling of fullness (Brondel et al., 2009). In current market, the energy-dense but nutrient-poor foods are easily accessible for consumers (Crino et al., 2015),

making it difficult to maintain healthy eating habits (Swinburn et al., 2022). The availability of energy-dense foods in the home environment has also been associated with increased consumption among children (Chavez et al., 2020). In addition, the rise of vending machines, food delivery services and convenience foods further exacerbate this issue, making it easier to consume large quantities of unhealthy foods without much effort (Urban et al., 2016).

- *The attribution of the marketing environment*

Beyond the factors mentioned above, other marketing environmental factors such as lower price, advertising promotion, larger portion size and attractive packaging exacerbate the problem of overconsumption. HED foods, often processed foods, are typically cheaper than low energy density foods, like F&V (Monsivais and Drewnowski, 2007, Whybrow et al., 2011). Consumers may perceive energy-dense foods as a cost-effective way to meet their daily energy need (Wellard et al., 2015), leading to the consumption of more HED foods. This issue is particularly problematic among lower-income populations, where financial constraints may limit access to healthier alternatives, resulting in a greater reliance on processed, energy-dense foods (Jetter and Cassady, 2006). In addition, advertising through various platforms (e.g., television, website, social media) has shown the impacts on food choices, promoting higher intake of HED foods, especially for the HED snacks (Folkvord et al., 2013, Kearney et al., 2021). These advertisements often emphasize the taste, convenience, and fun aspects of food, overshadowing its nutritional content and long-term health impacts (Harris et al., 2010). Additionally, the portion sizes in restaurants and packaged foods have significantly increased over the past few decades, leading to greater energy intake (Young and Nestle, 2021). This changes people's normal serving size norm, making it easier to consume more than necessary without realising it (James, 2008), since the combination of large portion sizes and high energy density can overwhelm satiety signals, leading to excessive energy intake (Rolls et al., 2004a, Williams et al., 2014). Besides, studies have demonstrated that the visually appealing packaging of HED foods is effective in capturing consumers' attention, significantly boosting their purchase intentions (Su and Wang, 2024, Vilnai-Yavetz and Koren, 2013). Similarly, food packaging with market claims may lead “health halo” effect, which suggesting that the contents

are healthier than they actual are, also encourage overconsumption (Chandon, 2013).

In sum, the HED foods are easy to access, inexpensive, heavily marketed with promoting advertisements and packaged in large or attractive packaging, with misleading market claims on it, creating an obesogenic environment that promotes excessive energy intake.

2.1.3.2 Difficulties of self-control

The internal factors that make it difficult for individuals to achieve a healthy diet include genetics and biological variables, psychological influences and social context pressures.

Specifically, food intake depends on basic biological signals, such as hunger, appetite and satiety (Beaulieu and Blundell, 2021). Genetic regulated eating behaviour (Grimm and Steinle, 2011), is responsible for the preference for higher fat or carbohydrate intake and large meal size, as well as avoiding certain F&V (Branch et al., 2017). Additionally, eating with other people could extend the food consumption in that people tend to adjust food choice and food intake when other people are present (Salvy et al., 2007), especially among adolescents, so called “peer pressure” (Al-Sheyab et al., 2018). In some cultures, it is considered impolite to refuse food when offered, leading to social pressure to eat more than one might normally consume (Rozin, 1996). This phenomenon is exacerbated in social settings where individuals may feel pressure to conform to group eating behaviours, further driving the consumption of HED foods (Robinson and Higgs, 2013).

Moreover, psychosocial determinants such as stress and negative mood can further compound the challenge, as individuals may turn to food for comfort (Adam and Epel, 2007). Research indicated that individuals with higher anxiety levels were more susceptible to increased intake of HED foods (Buckland et al., 2021). Similarly, emotional eating was revealed positively correlated with the consumption of energy-dense snacks, particularly among individuals experiencing depressive symptoms (Camilleri et al., 2014). Besides, both adults and children tend to eat more in response to negative mood (Frayn and Knäuper, 2018, Steinsbekk et al.,

2018). Therefore, it is harder for people without healthy goals or concerns to reject the temptations of HED foods and the overconsumption habits (Papies, 2016).

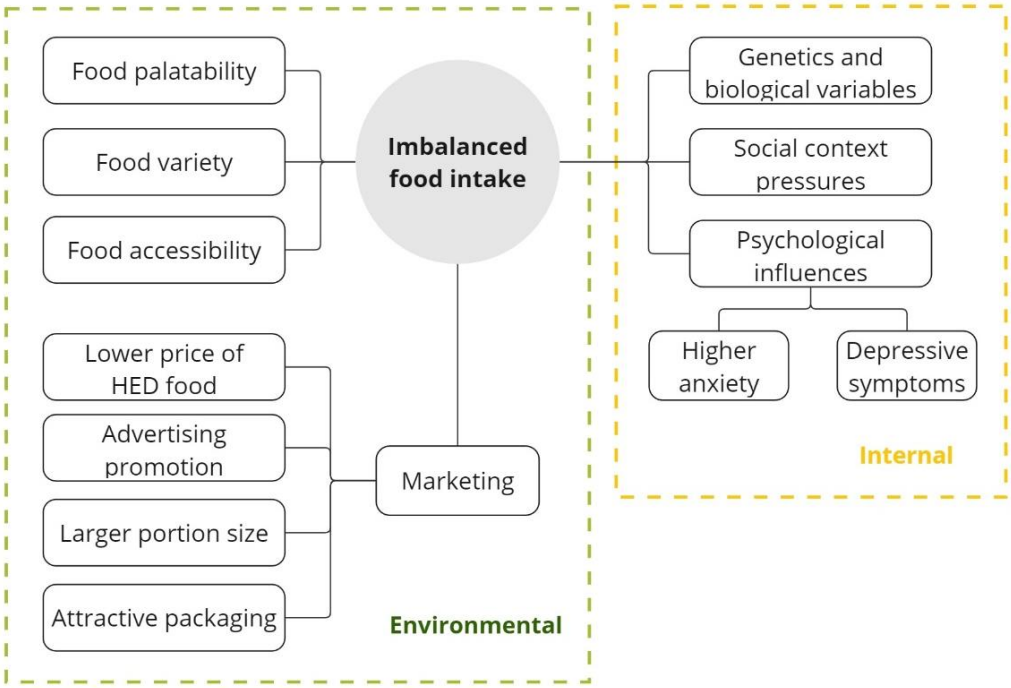


Figure 2.1 The overview of the main factors driving overconsumption.

In conclusion, although the risks of excessive energy intake are recognised, the current food environment exposes consumers to tempting HED foods, encouraging their overconsumption. Additionally, internal barriers like negative emotions further complicate efforts to regulate eating behaviour. Figure 2.1 presents the barriers for achieving the healthy eating. Addressing these issues requires a more supportive environment for healthy eating, improving nutritional education, and considering the emotional aspects of eating.

2.1.4 Efforts to promote healthy eating

It is challenging to achieve health goals and simultaneously resist the temptation of HED foods (Fishbach and Zhang, 2008). Thus, there are increasing efforts to promote a shift towards more healthy diets, including the conduction of some media campaigns to educate the consumers, taxation on HED food to reduce the purchasing, healthy eating programs in varied settings and some “nudges” targeting at behavioural change.

Media campaigns to educate consumers

Media campaigns can significantly enhance public awareness regarding the health risks of sugary drinks intake. For example, a campaign in South Africa reported that 78% of respondents recognised the message that "drinking sugary drinks can make you sick," leading to increased knowledge about the risks of obesity associated with sugary drink consumption (Murukutla et al., 2020). Similarly, campaigns in New York successfully educated the public about added sugars in beverages, resulting in a 35% decrease in sugary drink purchases (Kansagra et al., 2015). Additionally, limiting the advertising of unhealthy foods to children is a progress in reshaping the food environment (Story et al., 2008). The accessibility of campaigns across different populations is important since traditional media often faces limitations in terms of audience engagement and interactivity. A review by Durkin and Wakefield (2014) found that while mass media campaigns effectively raise awareness, their long-term impact on actual behaviour change is less clear.

Taxation strategies on HED food

Taxation strategies have been suggested to reduce the intake of energy-dense, nutrient-poor foods (Comans et al., 2013), governments worldwide are increasingly adopting such policies to tax on sugary drinks and junk food, and provide subsidies for healthier food, like fresh F&V (Wright et al., 2017). For example, subsidizing F&V and the discounts on healthy food can create a synergistic effect, making healthy choices more appealing and accessible (Hoenink et al., 2020). Taxation on sugary drinks is another strategy that has garnered support as a means to reduce consumption. The sugary drink tax in Ecuador resulted in a notable decrease in consumption across various income groups (Segovia et al., 2020), highlighting the potential for policy measures. However, such taxes may unfairly burden lower-income populations potentially exacerbating existing inequalities in health outcomes (Goiana-da-Silva et al., 2020), raising ethical concerns about the fairness of such policies. In addition, research indicated that taxation alone may not sufficiently alter dietary patterns without accompanying the access to healthy foods (Thow et al., 2014).

Healthy eating programs to increase the access to healthy foods

Community-based programs that increase access to fresh and nutritious foods, such as farmers' markets, food cooperatives, and community gardens, have been successful in improving dietary habits in low-income areas (Freedman et al., 2013), solving the limited access to healthy options. Nutrition North Canada program, which also showed success in increasing access to nutritious foods in eligible communities (Pagaduan et al., 2024). While there is ethical consideration regarding the equitable distribution of food across different communities. Furthermore, workplace and school-based programs represent another avenue for promoting healthy eating. The school meal programs that incorporate fruits, vegetables, and whole grains have been shown to significantly improve children's dietary intake on healthy food options (Glanz et al., 2007). Similarly, the workplace wellness programs offered employees with healthier options in cafeteria were proved can positively influence employees' eating habits (Cawley and Price, 2013). These community-based programs that increase access to nutritious foods have shown promise in improving health outcomes. However, challenges persist in reaching broader populations and ensuring the long-term impact of these efforts on behaviour change.

"Nudges" for behavioural change

Nudge refers to subtle interventions that influence people's choice behaviours (Thaler, 2008). Some nudges were conducted and showed effectively increasing the consumption of healthier food options across various settings. For instance, placing healthier foods at eye level in supermarkets (Hoenink et al., 2020) and relocating less healthy food choices to less accessible areas, successfully encouraging the choice for healthier alternatives (Kokkorou et al., 2024). Besides, the interventions that using the colourful meal trays and the strategic placement of food items were found effective in increasing children's consumption of fruits and vegetables (Park and Kim, 2022). It has also been proposed that the promotional efforts of hedonic foods on marketing practices that can be adapted for healthy alternatives (Bublitz and Peracchio, 2015). Study showed that the placement of healthier snacks at checkouts did not decrease the purchase of the unhealthy foods and 75% consumers did not even notice the nudges (Huitink et al., 2020), indicating the

importance of the visibility and salience of nudges. These nudges are based on modifying food demonstration in environment to alter the food choice architecture to encourage the choice for healthier foods. These modifications are low-cost and feasible to implement, which could contribute to broader public health. However, the effect may be not sustainable once the nudge is removed or when they are in different environments (Anderson et al., 2021). The frequency of nudge can impact its effectiveness, as repeated exposure to nudging cues can reinforce healthier choices over time (van Rookhuijzen and de Vet, 2021). Above emphasises the effectiveness of food environmental nudges, but also highlights the importance of the nudges being notice and consistently being present in the environment.

In sum, these efforts illustrate the multidimensional nature of promoting healthy eating. Whether through education, policy, community initiatives, behavioural nudges, all of them trying to shape a supportive food environment and encouraging healthier dietary patterns.

2.2 Design for behaviour change

Designing for Behaviour Change (DfBC) is to encourage individuals' specific choices and actions through strategic design elements by involving purposeful adjustments to environments, products, or communication (Aunger and Curtis, 2016). It emerged as an important interdisciplinary approach, leveraging design to influence behaviour positively among individuals and communities. Designers have increasingly recognised the potential of design for driving meaningful change, which stems from a growing body of research that highlight the interplay between design, behaviour, and social influence. Thus, designers use design to create positive behavioural changes (Ploos van Amstel et al., 2017, Niedderer et al., 2014).

It demonstrates the versatility of DfBC across various context of addressing complex social issues, with sustainability being the most studied subject, followed by human health, and fewer studies addressing safety (Niedderer et al., 2016). In the context of environmental sustainability, DfBC has been used in promoting sustainable practices. Research has shown that design strategies can effectively influence user behaviour towards more sustainable choices, such as reducing

energy consumption (Bhamra et al., 2011) or encouraging recycling behaviour (Lockton et al., 2013). For example, Bhamra et al. highlighted the role of product design in changing user behaviour, advocating for a holistic approach that considers ethical implications and user contexts. This aligns with the growing recognition of the need for sustainable design practices that not only meet consumer needs but also contribute to the environment. The application of DfBC in environmental sustainability has been more extensively studied, driven by policy priorities and greater public concern for environmental issues, particularly climate change and pollution, over health risks. (Kecinski et al., 2020).

Another significant application area of DfBC is in health promotion that using design to achieve healthy behaviours, with a notable emphasis on creating supportive environments that encourage individuals to adopt healthier lifestyles (Oliveira et al., 2021). For example, it has been used to modify dietary behaviours (Watson et al., 2023) and increase physical activity (Coldrey, 2018) among different population. Moreover, the integration of behavioural science theories into design has showed values on improving the effectiveness of health promotion (Orji et al., 2012).The potential of DfBC to address pressing public health challenges has been revealed. However, there is limited focus of DfBC on human health potentially, which due to the complexity of health issues, involving theoretical, psychological, technological, and contextual dimensions (Rusoja et al., 2018). This highlights the need for further research on health behaviour design to achieve broader societal benefits and promote interdisciplinary integration.

Moreover, DfBC has found applications in safety and crime prevention. For example, improved street lighting has been linked to significant reductions in crime (Welsh and Farrington, 2008). By understanding the psychological factors that influence behaviour, designers can create interventions that motivate individuals to adopt safer practices (Cooper, 2009), which can be used in high-risk environments where behaviour change can significantly reduce accidents and injuries.

2.2.1 Design for health behaviours

The following design applications focus on encourage healthier behaviours, presenting how designers facilitate healthier behaviours by strategically designing environments or interventions. It can be categorised into digital design applications, environmental design implications and the product designs.

2.2.1.1 Digital design applications

Digital health interventions have emerged as a promising avenue to promote and maintain health and wellbeing, a significant focus on nutrition, physical activity and mental health. For example, the mobile health (mHealth) applications and platforms have increasingly been used to encourage more physical activity (Schoeppe et al., 2017, Munson and Consolvo, 2012), through goal setting and tracking, tailored feedback and reminders. Besides, TreC-LifeStyle was designed as a nutrition education app for dietary improvement (Gabrielli et al., 2017), and Calm, Smiling Mind and Headspace were designed for supporting mental health management (Howells et al., 2016, Flett et al., 2019). Furthermore, using supermarket loyalty card data to guide healthier purchasing decisions through providing personalised recommendations (Lee et al., 2021), exemplifies how tailored approaches can lead to significant healthier behaviour changes. In addition, digital apps QuitNow and Smoke Free were designed to help users quit smoking by providing (Bricker et al., 2014). Although users reported high satisfaction the app, the actual impact on smoking abstinence rates remains inconclusive (Bindoff et al., 2020). While many mHealth applications failed to maintain user engagement over time (Taki et al., 2017) and the complexity of applications can deter users, particularly among older adults or those with lower digital literacy (Garnett et al., 2022). Besides, there is privacy concerns on sharing personal health information from users (Zakerabasali et al., 2021).

2.2.1.2 Environmental design implications

Designing staircases more visible, attractive, and easy to access, encourages people to use the stairs instead of elevators, especially when adding motivational signage

(e.g., "Burn calories, not electricity") near the elevators and stairwells in office buildings, which significantly increased the use of stairs (Boutelle et al., 2001), promoting regular physical activity. Similarly, the design of walking meeting rooms, or communal areas that encourage movement, can help reduce sedentary behaviour and promote physical energy expenditure (Commissaris et al., 2016, Hall, 2017). However, staircase-focused designs and walking meeting rooms may exclude individuals with mobility impairments, like older adults or people with disabilities and may cause psychology resistance. The importance of the built environment in promoting healthy behaviours has been highlighted (Funderburk et al., 2020). For example, incorporating biophilic design principles into workspaces and homes, such as natural light, plants, and views of nature, has been used to reduce stress and improve mental health (Hung and Chang, 2021, Veitch, 2011). It is also revealed that the design of sensory rooms in school environments can help children with emotional or behavioural difficulties manage their stress and improve their focus (Ashburner et al., 2008). While these design strategies may be effective in specific contexts, their impact might be reduced in other settings.

2.2.1.3 Product design applications

Adding graphic health warnings on the packaging, making packaging into plain style, and removing the branding of the cigarette packaging design, have been shown to discourage smoking (Hammond, 2011), which are easy to implement and integrated into users' daily life. H2Opal, HidrateSpark Steel, HidrateSpark 3 and Thermos Smart Lid are smart water bottles designed to encourage users to drink more water by tracking hydration levels and providing reminders (Lee et al., 2015, Borofsky et al., 2018, Stout et al., 2022). Products like standing desks (e.g., VARIDESK) (Bodker et al., 2021) and active sitting chairs (e.g., Herman Miller Aeron Chair) (Levin et al., 2009) were designed to reduce the health risks associated with prolonged sitting. These designs are easy to use and serve as continuous reminders. However, over time, users may start to ignore the reminders, diminishing the product's effectiveness, which is highly dependent on user motivation. Additionally, the high cost may limit access to these designs, preventing broader populations from benefiting.

2.2.2 Design model or theory for health behaviours

Design interventions can be particularly effective when it is tailored to the specific context and the underlying psychological mechanisms of the target behaviour. For example, a systematic review by Hardeman et al. (2000), highlighting that interventions grounded in psychological models yield better outcomes in preventing weight gain.

The Behaviour Change Wheel (BCW) framework has been utilised to design interventions for type 2 diabetes management (Cradock et al., 2022), the effectiveness of it lies in its structured approach to identifying and addressing the multifaceted nature of behaviour change. Capability, Opportunity, and Motivation (COM-B) are the central to the BCW, emphasising that behaviour occurs as a result of the interaction between these components. Behaviour Centred Design (BCD) was used to improve hand hygiene (Sands and Aunger, 2021) and sanitation quality (Tidwell et al., 2019). Information-Motivation-Behavioural Skills (IMB) model was applied in hospital contexts (Yang et al., 2020, Dai et al., 2023).

Another dominant model is the transtheoretical model of behaviour change (TTM) by Prochaska and di Clemente (1997), revealing that behaviour change follows a series of stages, including precontemplation, contemplation, preparation, action, and maintenance. (Hashemzadeh et al., 2019). It showed effectiveness on smoking cessation, but its effectiveness in promoting dietary changes has been less consistent (Spencer et al., 2007). The model primarily focuses on individual cognition and motivation, potentially overlooking social and environmental factors that can significantly impact behaviour (Weybright et al., 2024). Thus, for TTM to be more effectively applied in real-world settings, it may need to be integrated with other behavioural theories that account for external influences.

In addition, the health belief model (HBM) developed by Becker and Rosenstock in 1974 aims to explain and predict individual health behaviour (Rosenstock, 1974), is one of the oldest and the most widely used models of health behaviour promotion (Deshpande et al., 2009). It contains six determinants, perceived susceptibility, perceived severity, perceived benefit, perceived barrier, cue to action and self-efficacy (Anuar et al., 2020). Diddana et al. (2018) demonstrated that educational

interventions based on the HBM significantly improved the nutritional knowledge and dietary practices. However, the model is relying on individual beliefs, which may overlook broader social determinants, suggesting a more holistic approach to health promotion that incorporates multiple theoretical perspectives.

Persuasive Technology (PT) aims to bring target change in attitude and behaviour (Orji and Moffatt, 2018) and it is effectiveness to bring behavioural changes was revealed. PT is increasingly being used in the health and wellness domain to motivate and assist users towards a healthier lifestyle (Aldenaini et al., 2020). A prominent example of persuasive technology is mobile health applications, utilising persuasive strategies, such as reminders, rewards, and social comparisons to motivate users towards healthier behaviours (Akmal Muhamat et al., 2021). However, it is predominantly applied in the digital field, and its long-term effectiveness remains a concern, as users may revert to their previous habits once the novelty of the technology diminishes (Adams et al., 2015).

Furthermore, the theory of reasoned action/theory of planned behaviour (TRA/TPB) are two important psychological frameworks to explain and predict human behaviour (Ajzen, 1991), particularly in the context of health behaviours, decision-making, and attitude change. The main aspect of TRA/TPB is the behavioural intention is formed by attitude and subjective norm, and the intention is the most immediate predictor of behaviour (Conner and Sparks, 2015). Furthermore, the flexibility of the TPB allows for the integration of additional variables (Orr et al., 2013), making it adaptable to develop targeted interventions that address specific health issues. They are limited in their reliance on rational decision-making processes and the neglect of emotional and environmental factors that may influence behaviour (Hale et al., 2002).

By understanding the psychological mechanisms of human behaviour and applying this knowledge in design, designers can enhance health outcomes. This multidisciplinary approach underscores the importance of integrating behavioural insights (model/strategy) into the design process, ultimately leading to more effective and impactful design solutions.

2.2.3 Design for promoting healthy eating

Since the 1960s, behavioural interventions to change eating behaviour have primarily focused on cognitive changes, food choices and consumption quantity (Summerbell et al., 2003, Stuart, 1967). Currently, three types of interventions have been identified to help people make healthier eating choices and behaviours, including cognitively oriented, affectively oriented, and behaviourally oriented interventions (Cadario and Chandon, 2020).

- *Affectively oriented – announcements or messaging delivery*

Affectively oriented designs for promoting healthy eating leverage emotional and sensory appeals to encourage healthier dietary choices, which focus on the enjoyment of eating. It can be more effective than traditional health-oriented messages in promoting healthy eating behaviours among adults (Vaillancourt et al., 2019), suggesting that emphasizing the enjoyment of healthy foods can positively influence food choices. It also revealed that portraying healthy foods in social settings can enhance their appeal and encourage healthier choices, such as sharing meals with family or friends (Maldoy et al., 2021). However, the impact of pleasure-oriented messaging may diminish if not coupled with practical strategies for making healthy foods accessible (Stok et al., 2015).

- *Cognitively oriented – informative and educational digital tools*

Some app designed to promote healthy dietary behaviours have shown promise by increasing users' knowledge about nutrition and food options, thereby facilitating healthier choices and motivating the healthy eating behaviours. Some informative apps like MyFitnessPal, Yazio, FatSecret and Lifesum were designed to promote healthy eating by tracking food intake, counting calories, and offering personalised nutrition advice (Shyuan and Wahid, 2021). These apps often include databases and provide reminders, and gamification to encourage healthier eating habits (Carter et al., 2013). SyberShop (Dunn et al., 2004) and Teen Choice: Food & Fitness (Cullen et al., 2013), are online platforms, designed to educate users to improve fruit and vegetable intake.

Similarly, Creature-101, a digital game was designed to teach adolescents about energy balance, using goal setting and rewards to motivate users. As a result, a

reduction in the intake of processed snacks and sweetened beverages was observed (Majumdar et al., 2013). Gnam's Planet is a gamified digital platform aimed at engaging young users in learning about healthy eating and physical activity in a fun and interactive way (Fraticelli et al., 2016). Nutri-Advice, an software designed to educate middle school students about healthy eating and guide them toward better food choices, the user of which were more likely to choose healthier options (Turnin et al., 2016). OrderUP!, was designed to help players learn strategies for healthy eating choices by having them play the role of a server in an restaurant, showing the potential of mobile health games to promote healthy behaviours in adults (Grimes et al., 2010). The key advantage of gamification is its ability to enhance motivation through interactive and enjoyable experiences. A review by Suleiman-Martos et al. (2021) indicated that gamification can significantly enhance knowledge about healthy eating and promote positive dietary changes among children and adolescents. It showed potential to sustain changes over time (Mazeas et al., 2022), but Nour et al. (2019) argued it may not address deeper psychological barriers to behaviour change, leading to short-lived engagement. Besides, the effectiveness of gamification can be varied across populations (Li et al., 2024).

Cognitively oriented designs combined interactive digital tools and educational resources to enhance knowledge and awareness of food choice, many of which involved gamification to improve the engagement. However, whether improved knowledge can translate into sustained behaviour change remains inconclusive. Achieving long-term change is challenging without additional support or motivation (Naicker et al., 2021).

- *Behaviourally oriented - nudging product design*

Portion control plates, such as those with divided sections for different food groups: vegetables, proteins, and carbohydrates, were designed to encourage balanced meals (Jia et al., 2022). This type of tool helps users visually understand correct portion sizes to prevent overeating. In addition, some portion control tableware mostly reduced-sized were found impacts on reduce the intake, typically smaller bowl (Ahn et al., 2010), spoon (Venema et al., 2020), or glass (Pilling et al.,

2020). The design of food labels aimed to make it easier for consumers to understand the healthiness of a product at a glance. These labels are often colour-coded or include visual elements (e.g., icons) that represent key nutritional facts. It showed that traffic light labelling significantly improved consumers' ability to identify healthier foods compared to traditional packaging (Koenigstorfer et al., 2014). Some portion control packaging concepts were designed for children to help reduce the intake of HED foods (Tang et al., 2022), the results of which showed the well acceptance from consumers and the potential on portion control.

In sum, the affectively oriented designs evoke feelings of pride, happiness, or even guilt to affect consumer attitudes towards healthy eating. The cognitive oriented designs help improve the knowledge and awareness of the healthy eating, and the pleasure and fun experience also facilitate the healthier food choice and behaviour. These two focus on encouraging healthier choices by changing attitude or enhancing awareness, but not on actual intake. Behaviourally oriented designs tend to yield the most consistent and sustainable results. This is likely due to their practical focus on modifying specific behaviours and environments, which can lead to immediate changes in dietary practices. However, integrating three approaches to specific dietary behaviours may provide a more comprehensive strategy to achieve long-term dietary change.

2.3 Packaging design and its impacts on consumer

2.3.1 Packaging design and packaging roles

Packaging design focus

Packaging design involves many categories and its focus is constantly changing and expanding, as shown in Figure 2.2 by Azzi et al. (2012), including (1) functionality and protection; (2) sustainability and environmental impact; (3) cost efficiency; (4) consumer experience and usability; (5) branding and marketing; (6) logistics and supply chain efficiency. From the 1960s to 2010s, the focus of food packaging design has gradually evolved from simple preservation methods to include such aspects as convenience, point of purchase (POP) marketing, source reduction (e.g. material, energy), food safety and security, packaging authenticity, environmental

concerns (e.g., solid waste, carbon footprint) as well as food waste (Grönman et al., 2013, Brody and Lord, 2007). These evolving focus areas in food packaging design together shape consumer perceptions and behaviours by promoting brand loyalty, influencing purchasing decisions, and addressing growing concerns about environmental sustainability, enhancing the overall consumer experience.

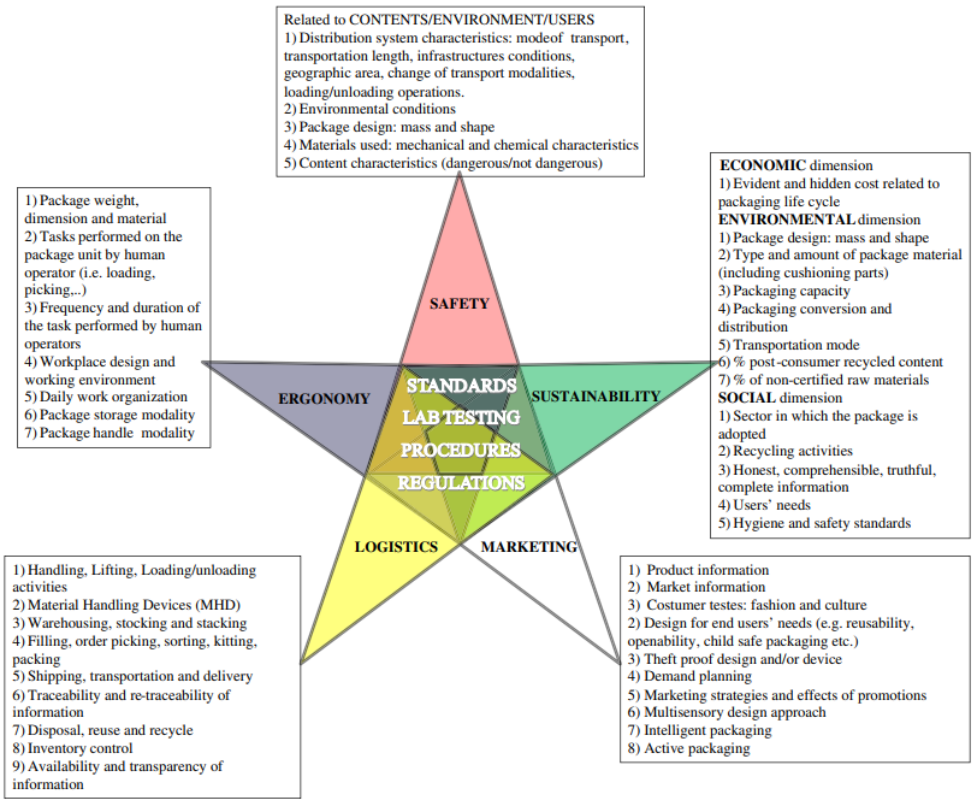


Figure 2.2 Framework: content categories of packaging design.

Packaging design elements

Yokoyama (1985) listed five essential characteristics of a qualified packaging design, including mass production possibility, reasonable and efficient packaging material, suitable structure and form, convenience, and consideration of disposal. From the design perspective, basic elements of packaging include size, colour, shape, text, graphics and material (Baidoun and Salem, 2024). Food is frequently accessed and consumed by people, thus, its packaging must fulfil more functions than other packaging. The food packaging elements can be categorised into visual and verbal packaging elements (Al-Samarraie et al., 2019). Visual elements include shape, size, colour and graphics. The verbal category consists of elements that offer

further details about the product, including nutritional information, label information, country of origin, and brand name. In addition, food packaging also includes functional elements, such as material and structural features.

Visual elements - Size and shape

Packaging features offer visual heuristics for consumers to make judgements about the contents and volume. Packaging size is directly linked to convenience and practicality. Smaller packages are typically designed for single serving or on-the-go consumption, on the contrary, the larger packages are designed for family, which usually have greater shelf presence and visibility, making it more likely to attract consumer attention in retail environments (Underwood et al., 2001). Packaging shape influences how products are stored and displayed, with innovative shapes creating a strong visual impression (Berkowitz, 1987, Becker et al., 2011). For example, packaging shapes that are angular in shape are associated with energy and strength, while rounded shapes are associated with friendly and harmony (Heide and Olsen, 2017). Moreover, elongated packages are perceived as more appealing and containing a greater amount (Silayoi and Speece, 2007).

Visual elements - Colour and graphics

Colour is a fundamental visual cue, grabbing consumers' attention to distinguish one product from others and suggesting luxury, exclusivity, nature, hygiene, quality, and security (Labrecque and Milne, 2012). For instance, black is widely related to luxury, and green is most often related to organic and ecological products (Burke, 2000). About 62% to 90% of consumers make purchase decisions based on colour alone (Singh, 2006). In addition, colour also the core the brand's identity, contributes to brand recognition (Jin et al., 2019). Graphics includes image layout, colour combinations, typography, and product photography, and the total presentation communicates an image, working together to appeal consumers and arouse their interest in a product. Image serving as a central cue on packaging, and it is found to have stronger effects on product evaluations than other elements (Chrysochou and Grunert, 2014). Study by Kovač et al. (2019) showed that consumers preferred photography over illustration, concrete pattern over abstract and vivid colours over dull colours. In addition, the brand characters are usually

used to enhance brand loyalty (McNeal and Ji, 2003). Typeface is an essential element as a potential moderator in generating positive impressions about food and to convey/reinforce specific brand associations (Velasco and Spence, 2019). It is found that natural script fonts are more reassuring and pleasant than simple, non-ornate fonts (Henderson et al., 2004). The placement of visual elements as layout also matters. For example, as Otterbring et al. (2013) revealed pictorial elements should be on the right-hand side to receive more consumer attention. Besides, the positioning of the image, logo, and flavour elements affects the consumer attention (Barbosa et al., 2021).

In packaging design, the visual and verbal elements work together to create brand message, communicate food information, capture attention and influence choice.

Verbal elements -Nutrition information

The verbal information on the packaging cognitively help consumers to make purchase decisions (Silayoi and Speece, 2004). Among these verbal elements, consumers tend to pay more attention to nutritional information and ingredients than the other informational elements (Ares et al., 2013), since consumers have more health conscious and are now gravitating toward the nutritional values displayed on the packaging (Festila and Chrysochou, 2018). The nutrition information on the packaging is presented in different forms, such as multiple traffic light systems and letter grades (Downs et al., 2015), and in different locations, front-of-pack or back-of-pack (Kiesel et al., 2011).

Verbal elements - Brand and the country of origin

Generally, branding information is presented with both verbal and nonverbal forms, including brand name, special slogans and brand logo, creating brand awareness and reputation among consumers (McNeal and Ji, 2003). A brand name generates various associations in the minds of consumers and offers additional advantages, helping to ensure the product's uniqueness and maintain consumer loyalty (Calvo Porral and Levy-Mangin, 2016). Displaying the country of origin on product packaging can enhance the level of consumers' attention, thereby influencing their purchasing decisions (Ribeiro et al., 2018), since some consumers were found particular care about the origin of products (Adam and Ali, 2014).

Verbal elements - Label information

Label information helps to convey all essential details of the food to consumers (Ribeiro et al., 2018), which can be grouped into semantic and nonsemantic. Semantic information includes the presence of legible information about the product name, flavour, ingredients, shelf life, weight, serving and storage information, the instructions of preparing food and usage warnings etc. The, nonsemantic information consists of a suitable colour combination for easy reading with an appropriate font style (Wyrwa and Barska, 2017). While, label information can contain inaccurate information or omit some information, which may cause misleading among consumers (Nilsson, 2012).

Functional elements

In addition, packaging material and packaging structure both contribute to the basic function of food packaging. The type, physical and chemical properties of the material influence the functional characteristics of the packaging (Emblem, 2012). The general belief of consumers is packaging material is important for protecting the product from damage (Poturak, 2014). More than that, material type can also suggest perceived value, for example, glass is perceived to have a higher value than plastic (Steenis et al., 2017). It influenced consumer choices by its association with health concerns, environmental sustainability, and aesthetic appeal. For example, studies have shown that consumers prefer to choose products with sustainable packaging, such as biodegradable or recyclable materials (paper or glass) for environmental concern (Norton et al., 2022). Structural features of packaging involve single package, multi-packs, and resealability, transparent panels and other special structures. They are seen as the keys of preserving food quality and enhancing consumer convenience (Verghese et al., 2015). It has been noted that consumers typically favour packaging technology that ensures using convenience and long-lasting durability (Biji et al., 2015). More than that, new technology also contributes to novel functions (Cheng and Chou, 2013).

Packaging developing roles

The discipline of packaging was introduced to Europe by American corporations in the 1960s, and by 1995, packaging design had evolved into a powerful tool for

promoting brands (Alervall and Saied, 2013). Packaging is initially designed to contain products and protect them from other destructive forces. Besides, preservation is a key function of packaging to reduce the environmental influence on food, for example, as a barrier to oxygen, moisture and odours (Sonneveld, 2000). Both of these functions ensure the quality and safety of food. Packaging conveys required information about product, instructions on food storage, food eating and sometimes the uses of packaging (Langley et al., 2021, Orth et al., 2010). Packaging used for raising the product's value, was also described as a marketing vehicle, involving in the four P's of marketing: product, price, place and promotion (Olsson and Györei, 2002). Specifically, packaging is designed to capture attention, offer an appealing way to communicate the product's benefits, persuade consumers to make a purchase, and serve as a prominent advertisement for both the food and the brand. Packaging also eases the food production, storage, transport, display, distribution, usage (proving container, accessibility) and dispensing (Coles et al., 2003). When combining all these aspects, packaging can be seen as an integral part to the product (Ahmed et al., 2005). The functions of food packaging were summarised in Table 2.1.

Table 2.1 The summary of food packaging roles.

Function	Description
Containment	Hold the food and keep them secure until they are consumed
Protection	Protect the food from mechanical and environmental hazards
Preservation	Minimize chemical, biological and microbiological spoilage for extending shelf-life
Communication	Convey required information of products Provide handling instructions of food and/or packaging
Marketing	Attract attention to the product to assist in selling Reinforce brand recognition and reputation
Facilitation	Provide convenience in various stages, including food production, storage, transport, display, distribution, using and final disposal

Understanding of package using pattern

Despite daily exposure to packaging, consumers tend not to pay active attention to the functions of packaging. The first interaction consumers have with packaging is often visual since the packaging serves as the face of the product on the shelf.

Then, consumers make choices and decisions based on the product values conveyed by packaging. After that are post purchasing stages. When the food is consumed, packaging turns into a useless thing which needs to be disposed (Ryynänen and Rusko, 2015). Actually, from purchasing through disposal, human-package interactions are comprised of several steps involving a set of user actions, depending on the user, package and the context of use. Several general tasks are identified, including purchasing (starting point), carrying, storing, opening, dispensing, closing and disposing. The actions not always follow the steps strictly, sometimes there are other possible paths of action, which have been summarised by de la Fuente et al. (2015) (see Figure 2.4).

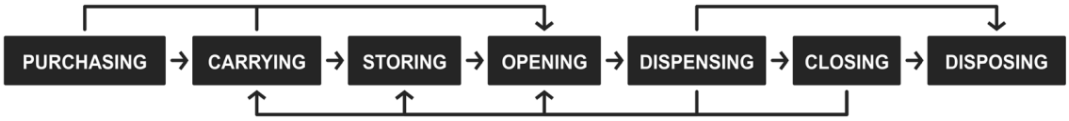


Figure 2.2 Generic package use life cycle.

2.3.2 The influence of packaging on consumers

Research has shown that consumer decisions about healthy eating are heavily influenced by external cues such as packaging design (Vermeir and Roose, 2020). Increasing research has shown that the influence of food packaging on consumers is a complex, multifaceted phenomenon that shapes their overall perception and plays a significant role in the decision-making process, to be specific, significantly influence consumers' perceptions and behaviours.

2.3.2.1 Perception influence

The packaging design features can activate heuristic inferences which in turn shape consumer perception and judgments of the product inside, which is also relevant to the purchase decision of consumers (Wells et al., 2007). The perception influenced by packaging includes the following aspects: quality, taste, healthiness and portion.

Quality perception

Packaging influences the perception of inside product quality. Take colour as example, the packaging with red, blue, black, and purple background are perceived

as high-quality (Grimes and Doole, 1998). Similarly, Malešević and Stančić (2021) found that bright and appealing colours can create positive associations, leading consumers to perceive the product as higher quality. Furthermore, packaging material choice also impacts quality perception. For example, compared to glass, plastic materials may leach chemicals into food, potentially leading to negative perceptions regarding quality and safety (Martin, 2024). Besides, environmentally friendly options are increasingly associated with higher quality and healthiness (Donato et al., 2021). In addition, research revealed that box packaging (either designed with cardboard or plastic material) are perceived with higher quality than the plastic bag packaging (Nørgaard Olesen and Giacalone, 2018).

Taste perception

Packaging cues can also guide taste and flavour perceptions. Packaging shape and colour influence taste expectations and anticipated liking. For example, food is perceived as more intense when associated with angular than with rounded packages (Becker et al., 2011). Veflen et al. (2023) also found round shapes, high brightness, and low saturation suggest a mild taste, while triangular shapes, low brightness, and high saturation indicate a sharper taste. Additionally, round shapes are associated with the highest levels of expected liking. Also, taste ratings were high when cartoon characters and popular brand images were on packaging (Enax et al., 2015). Under certain circumstances, the image shape on the packaging can even modify taste experiences (Liang et al., 2013).

Healthiness perception

In addition, perceived healthiness differs by packaging cues. Research indicates that colours associated with naturalness can enhance consumers' willingness to pay for healthy food options, as these colours evoke perceptions of freshness and healthiness (Marozzo et al., 2020). For example, colours (especially green) and pictures front-of pack also affected food healthfulness beliefs (Elliott, 2008). Furthermore, the slim shape packaging acts as a symbolic cue for product healthiness compared to wide shape packaging (Van Ooijen et al., 2017). For individuals with high health concerns, the less heavy typeface leads to a stronger link between sugary foods and unhealthiness (Karnal et al., 2016). Cute packaging

designs increase perceived tastiness but decrease perceived healthiness (Schnurr, 2019).

Portion perception

Food packaging features also affect the perception of portion size. For example, beer in cans is perceived as containing less volume than in bottles, particularly for those who drink beer less frequently (Yang and Raghubir, 2005). It is also confirmed that the underestimation of the portion size increase was particularly severe when the modification is only in one dimension (height, width, and length) (Chandon and Ordabayeva, 2009).

2.3.2.1 Behaviour influence

Purchasing and recycling behaviour

Since packaging is an important marketing tool, there is no doubt that it influences consumers' food choices from initial attraction to final purchase. Apart from shaping consumer perception of the product, packaging aids decisions at point of purchase (Wells et al., 2007). It has been revealed that colour, shape, image, lines, and typography are main design elements influencing consumer purchase behaviour, with image being the most significant factor of purchase decisions (Wang et al., 2023). In addition, the packaging that communicates ecological benefits can enhance consumer trust and willingness to buy (Magnier and Schoormans, 2015). The review by Nemat et al. (2019) underscores the single material packaging, clearly recycle label or symbol, transparent or light and natural colour, standardised shape and providing specific guidance as effective communication channel for encouraging consumers to recycle behaviour.

Eating behaviour – specific on food intake

Furthermore, multiple packaging features, including visual, informational, and functional are known to alter intake. Specifically, there is a strong link between packaging cues and food consumption quantity, independent of the food quality and even the food taste on some occasions (Keller et al., 2012). For example, fitness verbal cues relating to energy expenditure on packaging increased both serving size and actual food consumption (Koenigstorfer et al., 2013). Health claims

and nutrition information on packaging alters consumption quantity; with label users reporting healthier nutrient consumption (Ollberding et al., 2011). Another study found an effect between labelling of smaller serving sizes and downsizing food consumption (pizza) (Spanos et al., 2015). One study showed that a smaller image size of the products on the packaging lowered consumption (Neyens et al., 2015). Stroebele et al. (2009) revealed that people tend to eat less with small packaging. Other studies also showed similar findings (Aerts and Smits, 2017, Marchiori et al., 2012). Packaging shape influenced food intended intake when people are exposed to healthfulness knowledge (Koo and Suk, 2016). Transparent packaging appears to increase food consumption for certain type pf food (Deng and Srinivasan, 2013), whereas resealability reduced consumption volume (De Bondt et al., 2017). Partitioning state is another determinant for consumption quantity. Compared with the non-partitioned packages, the partitioned packages (single serving) reduce the food intake (Raynor et al., 2009).

2.4 Ideation design tool for designers

2.4.1 Ideation and design processes of designers

Ideation definition and facilitating methods

Ideation is the formation of ideas or concepts which is seen as the creative process of generating, developing, and communicating new ideas (Jonson, 2005). It is an essential part of the design process which can be conducted by individuals or teams (Graham and Bachmann, 2004).

Various methods have been explored to facilitate this process, the effectiveness depending on the context of application. For example, brainstorming is one of the most widely recognised techniques, not only increases the number of idea generation, but also stimulates cognitive processes (Kim et al., 2019), particularly when participants build on each other's contributions in a group. Idea diversity may be improved, the practical utility of these ideas may not always meet expectations (Chulvi et al., 2013). Besides, it is rely heavily on verbal communication and abstract thinking, thus social apprehension and group dynamics, which may inhibit individual creativity (Wieland et al., 2022). Bodystorming a variant of the

brainstorming, engages designers by putting them in the context of the user's environment, allowing for a deeper understanding of the user's need to develop user-centred solutions, so called as embodied design (Schleicher et al., 2010). It helps bridge the gap between conceptual ideas and practical applications, allowing designers to visualise and test interactions in a more tangible way. Besides, mind mapping helps ideas organisation, assisting to see connections that may not be immediately apparent to enhance cognitive processing and creativity (Jones and Morrison, 2021). Visual nature of it helps in breaking down complex problems into manageable parts, fostering more comprehensive understanding of the design problem. Furthermore, design thinking workshops is used for design solution by bringing together interdisciplinary teams to explore multiple perspectives, thus generating solutions for specific design problems (Razzouk and Shute, 2012). However, if it is lack of participants diversity, the design outcome quality may be limited. Persona is another tool to help personalise and humanise the otherwise abstract concept of a group of users (Bornet and Brangier, 2016). It brings the target consumers to life and helps to connect designers and users by integrating their needs and goals as a central driver of design processes, but the effectiveness of it relies on the accuracy and depth of the user research conducted.

Design processes

There are many ways of describing design processes, Dorst and Dijkhuis (1995) viewed the design process as a rational problem-solving process. One typical model is design thinking (DT) process, which focuses on understanding users' needs and solving problems in an iterative approach. It is structured into five key stages: (1) Empathise, (2) Define, (3) Ideate, (4) Prototype, and (5) Test, the description of which is presented in Table 2.2. The iterative nature of DT allows for continuous refinement of the solution to ensure it effectively meets user needs (Shafiee et al., 2021), especially suited for complex, user-driven problems. Another general process is Double Diamond Process (DDP), which was introduced by the UK Design Council in 2005 and has been applied in various fields (Gustafsson, 2019). The model is divided into four stages: (1) Discover, (2) Define, (3) Develop, and (4) Deliver, with two "diamonds" representing phases of problem identification and design solutions (Saad et al., 2020). It is widely recognised for its clear structure

that separates problem definition from solution generation, allowing for more focused exploration through both divergent and convergent thinking. It also encourages feedback and iteration, ensuring that designs are well-informed by research and validated through testing.

Table 2.2 The design process models.

Model	Stages	Description
Design Thinking Model	Empathize	Understand the users' needs and challenges.
	Define	Clearly articulate the problem to be solved.
	Ideate	Generate a wide range of creative ideas and solutions.
	Prototype	Develop tangible representations of solutions for testing.
	Test	Gather feedback on prototypes to refine the solutions.
Double Diamond Process	Discover	Understand the problem through research, user insights exploration.
	Define	Narrow down the insights to clearly define the problem to solve.
	Develop	Explore potential solutions, brainstorming, and prototyping.
	Deliver	Test, refine, and finalize the solution for implementation.

In summary, both DT and the DD offer valuable frameworks that DT's flexibility and user-centric focus make it suitable for exploring complex design issues, while the DD is beneficial for ensuring thorough problem analysis and strategic development in packaging design. The clear delineation between problem and solution of DD allows designers to focus on understanding the problem before jumping to solutions, which can be particularly useful in packaging design for healthy eating, where understanding the impact of packaging design on consumer behaviour is important.

2.4.2 Design tool for designers

A wide range of tools are available to assist designers throughout the various phases of the design process. These tools can be categorised into several types: (1) Design tools for design practice (Lauff et al., 2019), usually are the software for

concept generation; (2) Design tools for rapid 3D prototyping (Ho, 2019, Saakes and Stappers, 2009), to refine design ideas dynamically; (3) Design tools for remote collaboration, usually are web platforms (Dorta et al., 2008); (4) Design tools for design ideation or creativity support (Han et al., 2018). In current research, the focus is not on how to assist designers in presenting the design ideas or facilitate collaboration, but on how to foster the generation of creative design solutions to address specific design problems. Thus, the design tool that aids designers in generating creative ideas are reviewed and discussed in this section. The primary purpose of the ideation design tool is to facilitate innovative thinking, enhance problem-solving capabilities and enabling designers to explore a wide of possibilities.

2.4.2.1 Random divergent inspiration

Some design tools offer divergent creative inspiration based on certain established database. For example, Idea-Inspire 4.0 provides analogical inspiration aimed at enhancing creativity across various design domains (Siddharth and Chakrabarti, 2018). The biological systems (web-based application) serve as a rich source of inspiration, helping designers access biological knowledge more easily and apply it systematically. Designers can input keywords related to their design problems and the tool would retrieves biological systems to present relevant content. Similarly, PAnDA tool, a software can retrieve the relevant analogies from a patent database which contains 155,000 patents (Verhaegen et al., 2011). These two types of tools are more helpful in design fields that draw inspiration from biology or patents, offering limited inspiration for packaging design. The Character Space Construction (CSC) tool is to assist concept designers in exploring, generating, and explaining design concepts, particularly with respect to product aesthetics and semantics (Sano and Yamada, 2022). Which has been tested in professional design environments and was reported better support for exploring ideas compared with available web search tools. However, it is relied on verbal inspiration, does not include any visual component. It is effective for describing aesthetics and semantics but may not capture other critical dimensions of product design, such as functionality or engineering concerns, wound not be useful for the designs required

to be beyond aesthetics.These web-based interactive systems provides structured access to information (lists of candidate words and phrase suggestions) based on the input brief to support designers' cognitive processes, helping them better articulate design concepts and communicate them effectively to stakeholders.

2.4.2.2 Providing summarised inspirational prompts

Some design tools provide inspiring content from specific fields, summarising it and presenting it in a more intuitive format for designers. The aim was to inspire design ideas through integrating the content into the design process. The toolkit by Wang and Ajovalasit (2020) was created to increase designers' awareness of traditional Chinese cultural aesthetics and enhance cultural sensitivity to incorporate Chinese cultural elements into their design. The card desk help designers incorporate cultural references on design effectively by illustrating the culture feature, emotion connection and design application examples to inspire culturally sensitive design decisions. The PLEX Cards were created to help designers incorporate playfulness into products and services by providing 22 playful experience categories on each card, with a definition and images to help understand the concept (Lucero and Arrasvuori, 2013). The cards stimulate creativity and offer a structured way (creating scenario based on card) to explore how playfulness can be integrated into various design context where playfulness could enhance user experience. However, the images on the cards might come preloaded with specific meanings, which can limit open interpretation. The playfulness design can be strongly linked to consumer engagement. As some digital platforms involving gamification to keep the user engagement (see section 2.2.3) are the good examples that this tool can be applied. Besides, it is also useful to keep consumer engagement by integrating playful elements in packaging design. The MiX Cards were designed to help designers generate creative and practical product ideas by incorporating magical effects (such as levitation, telekinesis, and transformation) into their ideation process (Haritaipan et al., 2019). Each card representing one of 15 magical effects aimed to use magical thinking and analogical reasoning to overcome design fixation and inspire innovative solutions. Novice designers tended to benefit more from the

cards, as they helped in overcoming creative blocks and prompted fresh thinking. Professional designers, on the other hand, used the cards selectively. Incorporating digital or interactive formats were suggested by designers since they felt the cards constrained their creative freedom. In addition, as reviewed by Roy and Warren (2019), the card format design tool strength in providing convenient summaries of useful information and/or methods and communication in a team, but limited in over-simplifying information, hard to understand and difficult to change or update.

2.4.2.3 Proposed framework or methods

Some specific frameworks or methods were proposed as design tool to structurally inspire the design. For example, Qin and Ng (2020) proposed metaphorical design framework, to assist designers in blending Traditional Cultural Properties (TCPs) with modern product functionalities. The design tool is presented as a diagrammatic framework to evoke designers' reflection on cultural heritage while improving the functionality of products within contemporary design. The Product-Personification Method is designed to assist designers in generating new interaction concepts by endowing products with human-like personalities (Park and Nam, 2015). The method is supported by four tools: Product-Personality Cards, Relation Cards, Tool Cards and a Product's Talk Board, guiding designers to follow a step-by-step approach. These structured approach makes it easier for design teams to collaborate and ensure consistency, by following the same process, as well as allows for more thoughtful consideration of each phase. However, they can also limit creativity and constraint flexibility. For the emerging design challenge of using packaging design to influence eating behaviours, a step-by-step guided approach may not be the most effective in maximising creativity. However, providing directional strategies to inspire rational design ideas can be more beneficial.

2.4.2.4 Conveying specific knowledge, design principles or theories

The software by Kim and Lee (2017) aids designers to overcome challenges of limited biological knowledge, by providing a framework and recommendation system that simplifies the selection of biological analogies and the extraction of

design principles (Aeni Zuhana Saidin, 2015). Cards for Circularity tool is designed to facilitate circular design in practice by helping designers understand and implement circular design principles (Dokter et al., 2020). The tool was presented as a card deck, providing a structured approach to guide designers in considering circular strategies, material choices, product lifecycles, and business models throughout the design process, helping them move beyond theoretical frameworks into practical application. Similarly, Use2Use Design Toolkit (cards) assist designers in creating products and services that support circular consumption (Rexfelt and Selvefors, 2021). In addition, Design Principle Cards by Perez et al. (2019) is intended to assist designers, especially in the domain of additive manufacturing (AM), by offering a set of principles that guide the creative exploration of new design spaces. Each card contains text description, visual representation and real design case for inspiration. These design tools were designed to assist the design in a specific design area by either providing core information of the field and/or principles to guide the design. This suggests that a design tool tailored to a specific area could support designers by simplifying the process of acquiring and digesting relevant information and applicable principles. This is particularly important for cross-domain design challenges, such as utilising packaging design to promote healthy eating. In addition, Won (2021) developed a colour tool prototype (initially presented in PDF format, targeting to an interactive website) to convey colour research to assist design practice. It demonstrated the design tool could provide convenience and inspiration for design practice by summarising the results of relevant research.

2.4.2.5 Facilitating the behavioural effect

Lockton et al. presented the Design with Intent Method, which provides a structured approach for designers to create products and systems that intentionally influence user behaviour (Lockton et al., 2010), which typically aim at influencing user interactions with systems that guiding users following a particular process. Furthermore, some design tools incorporate behavioural science, aiming at effectively influencing user behaviour. The PToolkit was created to support designers by providing them with structured persuasive design knowledge for

achieving target user behaviour. Similarly, the Behaviour Change Design Cards serve as a practical tool for designers to integrate behavioural theories into their design processes, ensuring that design decisions are grounded in psychological principles (Konstanti et al., 2022). The cards translated the knowledge of two behavioural models, Transtheoretical Model of Behaviour Change (TTM) and Behaviour Change Technique (BCT), mapping BCT to the five stages of TTM. This not only highlights the importance of providing and translating behaviour change theoretical models for designers but also demonstrates the combinability of different models based on the specific design purpose.

2.4.2.6 Summary of the ideation design tool

Based on the design tools mentioned above, the two key aspects of ideation design tools are summarised: content and format (see Figure 2.3). These two aspects highlight how current ideation design tools are provided and presented.

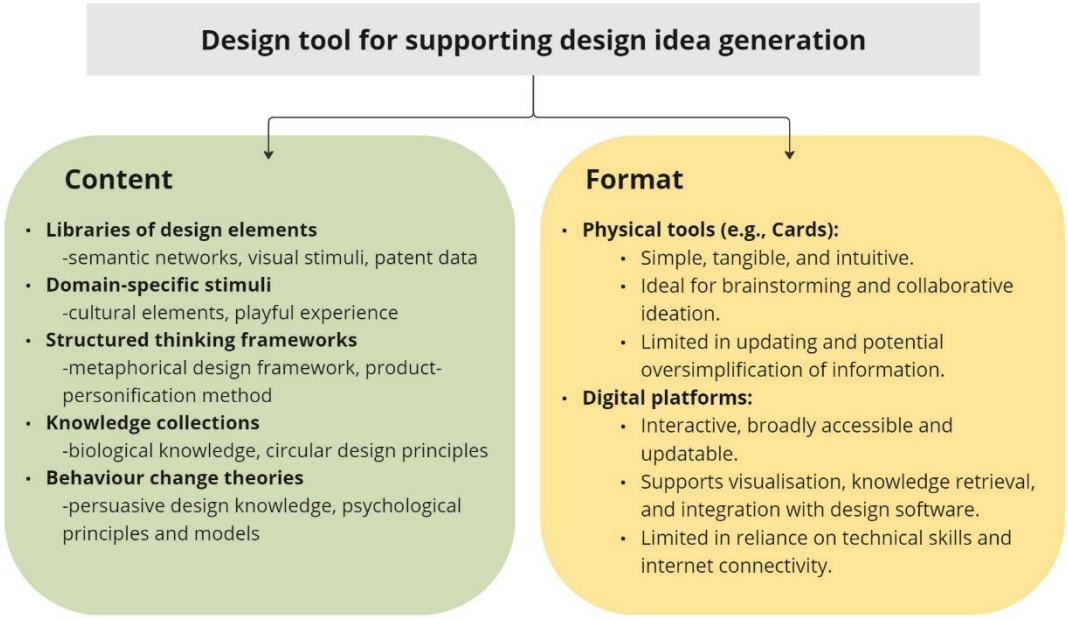


Figure 2.3 Summary of the design tool for design idea generation from tool content and format perspectives.

Design tool content

In terms of content, relevant and stimulating material are provided to inspire design idea generation, emphasising the role of external knowledge sources in

helping designers generate design solutions. The content includes: (1) Libraries of design elements (e.g., semantic networks, visual elements, patent data) to randomly inspire designs; (2) Summarised stimuli in specific domain (e.g., cultural elements, playful experience) to ignite creativity; (3) Structured thinking processes (e.g., design frameworks or methods) to structurally guide the design concept development; (4) Collection of knowledge in a particular field (e.g., specific design strategies or theories), with the tool serving as a medium for convening this information; (5) Behaviour change theoretical models to assist the behavioural change effect of the design outcomes. These tools provide domain-specific knowledge, enabling designers to overcome gaps in expertise or behavioural insights by integrating information into easily digestible formats. Besides, these approaches suggested that diverse content can be incorporated into design tool to encourage the exploration beyond designers' immediate context.

Design tool format

Regarding format, design tools for ideation are typically presented in two main formats, including digital platform/material and physical kits/material. Physical material, like card decks, are designed to be simple, easy to handle, and intuitive, often combining textual and visual elements to clearly convey the tool's content to the users. To be specific, cards are typically used to present summarised principles or inspirational content key points to stimuli creativity. This format has been shown to foster collaborative ideation (e.g., communication and idea sharing), enhance engagement and creativity among designers. Card-based tools offer easy-to-use, and structured approaches that are ideal for quick idea generation and team-based brainstorming. However, they can be hard to update, and sometimes oversimplify complex information, limiting flexibility and adaptability for more dynamic or iterative design tasks. Digital platforms, on the other hand, are generally used for functions such as visualisation or knowledge retrieval. These digital tools are designed to perform specific functions (e.g., step-by-step guidance or information retrieval) or to make the tool more accessible for designers. This format is increasingly prevalent, offering advantages such as ease of sharing and integration with other software (Ekströmer and Wever, 2019). Digital tools provide interactive, scalable, and updatable features that enhance collaboration, adaptability, and

accessibility, making them suitable for evolving design challenges. However, they may require technical skills and rely on internet connectivity, which can pose barriers in certain contexts.

In summary, under current research context, it is essential for designers to receive support from cross-domain knowledge in a summarised and simple way within an accessible format in order to foster packaging innovation. Due to the complicity nature of the health challenge, the integration of diverse knowledge allows for a more holistic understanding of healthy eating issues and being informed by various perspectives (Ding et al., 2022), which is essential for developing effective designs. Moreover, in addressing design problems related to user behaviour change, it is necessary to consider the psychological aspects of ideation, as these significantly influence the effectiveness of design ideas in shaping target eating behaviours. The choice between physical and digital formats depends on the context of use and the specific needs of the designers.

Chapter summary

In sum, the literature on healthy eating identifies the global issue of imbalance diet, with overconsumption of HED foods and inadequate intake of F&V being the primary dietary problems. The permissive food environment and the internal factors make it hard for individuals to achieve healthy diet. Then, the varied efforts made for improving the healthy eating were summarised in their approach, effectiveness and limitations. These approaches showed positive results, but the limitations raised more considerations on the accessibility of broader population, consumer engagement, as well as the potential for long-term sustainability of the intervention. Additionally, design is increasingly being applied to positively influence human behaviour, with emphasis on the potential of design to encourage healthier behaviours. The design applications to encourage health eating and the design models and theories relevant to health behaviour change were discussed, highlighting the value of psychology-based strategies for encouraging healthy behaviours.

Packaging, as a medium between food and consumers, has its design elements and evolving responsibilities outlined in this chapter. Research continues to demonstrate the significant impact of packaging on consumer perceptions and behaviours, further emphasizing the critical role packaging plays as an environmental factor influencing dietary behaviours. The methods of helping design idea generation and design tool applications as well as the design tool features were subsequently reviewed. The purpose, content and format of the design tools were summarised, indicating the design tool could support designer by providing summarised knowledge for a cross-domain design challenge and providing appliable strategies/principles to address behavioural change design.

In light of the literature review findings, two main gaps were revealed:

- Packaging design, while potential in shaping consumer behaviour, existing literature has not fully explored the intersection of packaging design and behaviour change in the context of healthy eating promotion.
- Design tools, while valuable in assisting designers in different ways, lack of tailored functionality for addressing specific challenges such as promoting healthier eating. Thus, here remains a gap in the development of specialised design tools that directly support designers in creating packaging aimed at promoting healthy eating.

Therefore, this research aimed to address these gaps by investigating the impact of packaging attributes on food intake, drawing from both experimental data and real-life consumer experiences. Additionally, it developed a design tool specifically tailored to assist designers in creating packaging that promotes healthier food choices. This tool integrated insights on the influence of packaging features on intake, behaviour change theories, and the practical support required from the designers' perspective. The next chapter details the methodology used, outlining the approaches and specific methods employed to achieve the research objectives.

Chapter 3
RESEARCH METHODOLOGY

This chapter presents an overview of the methodological approach of the research and describes the rationale of the selected methods.

3.1 Introduction: elements of a research design

Research in the context of design, particularly within packaging design for healthy eating, is a systematic process of inquiry aims to discover, interpret, and develop knowledge that informs design solutions (Abusaleh and Anwar, 2022). Adopting appropriate research methodology for the inquiry is the key to explore how packaging design can promote healthy eating (Patel and Patel, 2019). A model of research process was characterised by Crotty (1998), including epistemology, theoretical perspective, methodology and methods. A guiding hierarchy between these elements is presented in Table 3.1. In current research, epistemology informs the theoretical perspectives (Denzin and Lincoln, 2004), guiding how knowledge is perceived and structured in the context of healthy eating. These perspectives determine the methodology (Alam, 2019), ensuring appropriate approaches are used to capture the packaging impacts on dietary behaviour and develop the design tool to support designers. The methodology governs are embedded within the choices of specific methods for a particular research task (Casper et al., 2007).

Table 3.1 The basic elements of research process.

Elements	Description
Epistemology	The theory of knowledge embedded in the theoretical perspective and thereby in the methodology.
Theoretical perspective	The philosophical stance informing the methodology and thus providing a context for the process and grounding its logic and criteria.
Methodology	The strategy, plan of action, process or design lying behind the choice and use of particular methods and linking the choice and use of methods to the desired outcomes.
Methods for research	The techniques or procedures used to gather and analyse data related to some research question or hypothesis

The chapter then discusses the research paradigm as a guide for current research. The research approach, purposes, strategies and research type are then discussed as the theoretical foundation. Followed by a research framework of current research. Selected methods at each research stage are presented next. The following Figure 3.1 illustrates the structure of the methodology for this research. The adopted methodology in this research is rationale in the following content of this chapter. Furthermore, an overview map of the research design, including the main contents of the following chapters is provided at the end of this chapter.

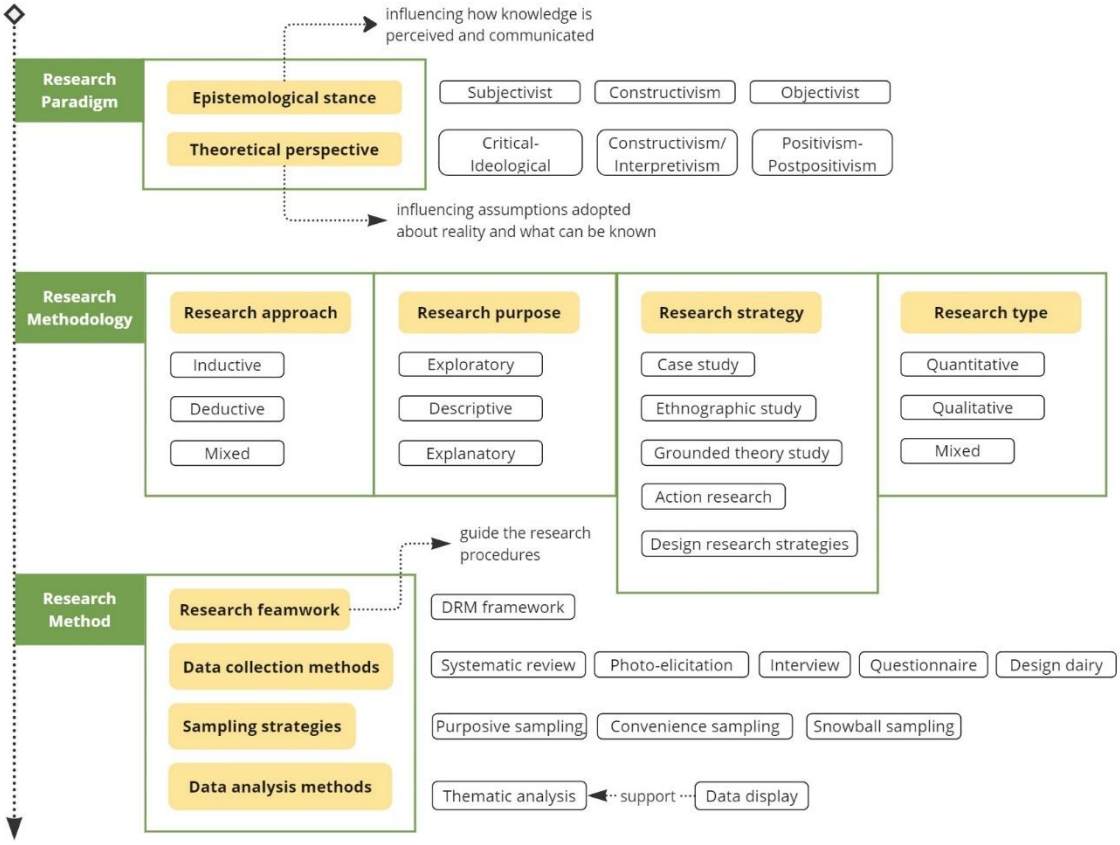


Figure 3.1 The overview of the methodology building and selection of this research.

3.2 Research paradigm

Paradigm is defined as the philosophical orientation that influences what should be studied, how it should be studied, and how the results of the study should be interpreted (Okesina, 2020). There are three major epistemological stances: subjectivist, constructivist and objectivist, the theoretical perspectives adapted to

these epistemological stances. They are described in Table 3.2, which are summarised from (Crotty, 1998, Feast and Melles, 2010, Ponterotto, 2005).

Table 3.2 Paradigms from epistemological and theoretical perspective.

Epistemology	Epistemological stances	Theoretical perspective
Subjectivist	It is imposed by people's minds without the contribution of the object. This implies that what is perceived is what is real, and that there is no underlying true reality that exists independently of perception	**Critical–Ideological** It emphasises a dialectic stance on the researcher–participant interaction that aims to empower participants to work toward egalitarian and democratic change and transformation.
Constructivism	It rejects the view that there is an objective truth waiting to be discovered. Rather truth and meaning are constructed out of the engagement of minds with the world. The constructionist stance maintains that different people may construct meaning in different ways, even in relation to the same phenomenon.	**Constructivism-Interpretivism** It espouses a hermeneutical approach, which maintains that meaning is hidden and must be brought to the surface through deep reflection. The researcher and participants jointly create findings from their interactive dialogue and interpretation.
Objectivist	It holds that a meaningful reality exists independently of consciousness and experience, that entities carry intrinsic meaning within them as objects and that this 'objective truth' can be discovered by carefully going about it in right way.	**Positivism- Postpositivism** It acknowledges the socially constructed nature of reality; The primary goal is an explanation that (ultimately) leads to prediction and control of phenomena.

This research involved two different groups of people, consumers and designers. They may have different perspectives within the role of food packaging design on healthy eating. Thus, constructivism is the appropriate epistemological stance for this research since it is used for understanding of the social world from the participants' perspective (Khazanchi and Munkvold, 2003). The constructivism-interpretivism paradigm underscores the significance of participants' definitions and perspectives in shaping reality (William, 2024) and acknowledges that

knowledge is collaboratively created by researchers and participants (Gilbert and Driscoll, 2002). Thus, the interactive researcher-consumer and researcher-designer dialogue can stimulate the deep reflection on the understanding of insights from consumers and designers, the complex reality of which could be uncovered by constructivism-interpretivism paradigm (Schwandt, 1994). Besides, this research not just involved building knowledge, but also involved communicating knowledge to the target audience, specifically, including the translation of the acquired knowledge from consumer perspective, experimental perspective and designer perspective to support designers. Constructivism-interpretivism is the most appropriate paradigm for this research as it allows for the complementary interpretation and translation of knowledge from different perspectives.

3.3 Research approach

Research approach is classified into inductive approach and deductive approach by Soiferman (2010). The inductive approach is a bottom-up approach, moving from specific observations to broader generalizations (Belozerov, 2002). It uses the participants' views to build broader themes and generate a theory interconnecting the themes to uncovers new knowledge or concepts. The deductive is a top-down approach, starting with a theory or hypothesis and testing it against with the empirical evidence (Reyes, 2004). In addition, Abdalmajid et al. (2023) and Proudfoot (2023) revealed the potential benefits of a mixed-method approach to gain a comprehensive understanding of certain research context.

The insights from various perspectives of related stakeholders (consumer and designer) are needed to be explored. Thus, to answer RQ1 (What are the characteristics of packaging design in influencing consumer food intake?), the inductive approach was used to discover new knowledge in this research (Sibeoni et al., 2020). The knowledge gained was then used for the development of the design tool to answer the RQ 2 (What strategies and tools can be developed to support designers in designing food packaging that promotes healthy eating?). A set of hypothesis on how design tool could be used was built and followed with a deductive approach to test the validity of those hypothesises (Mesly and Mesly,

2015). In sum, in current research, an integrated approach was adopted to address the research aim and answer these two main research questions. Figure 3.2 illustrates the approach structure in current research.

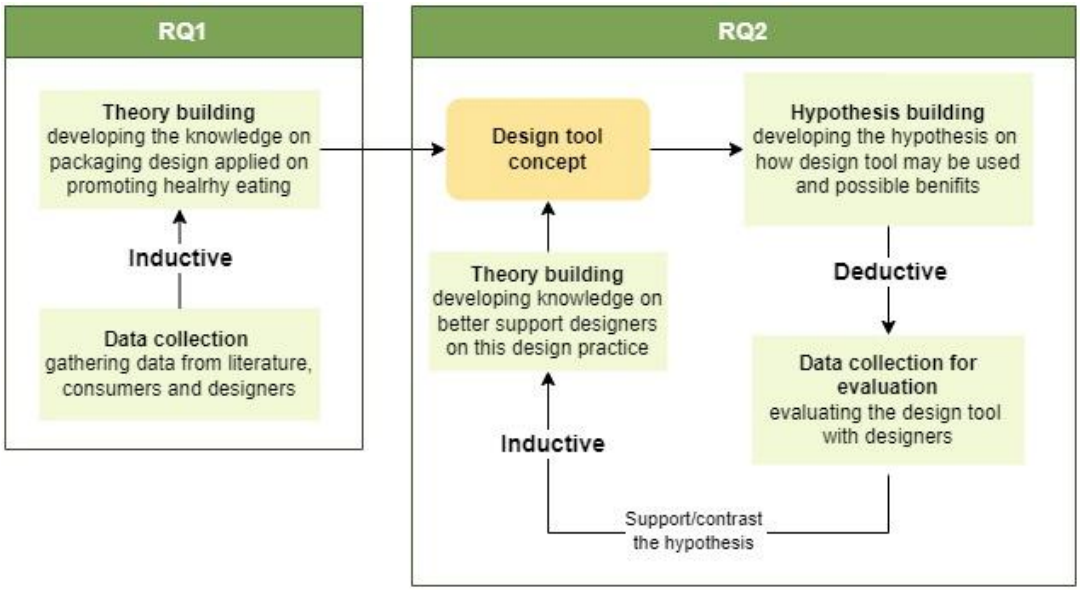


Figure 3.2 Combination of inductive and deductive approaches in this research.

3.4 Research purpose

Research purposes can be classified into three main categories based on the intention of the research (Robson, 2002), including exploratory, descriptive and explanatory. The different types of research purpose and its related objectives are shown in Table 3.3 adapted from (Robson, 2002, Strydom, 2013, Swaraj, 2019). Marlow (2023) defined the exploratory research as a form of research that generates initial insights into the nature of an issue and develops questions to be investigated by more extensive studies. The purpose of descriptive research is to describe individuals, events, or conditions by studying them as they are in nature (Siedlecki, 2020). It is about describing how reality is. The goal of the explanatory research was identified as to explain why things are the way they are (Adler and Clark, 2011). Explanatory research normally builds on exploratory and descriptive purposes and goes beyond focusing on a description of a topic or providing a picture of it (Strydom, 2013).

Table 3.3 Classification of the purposes of enquiry and related objectives.

Purpose type	Objective description
Exploratory	-To seek new insights -To generate new ideas -To find out what is happening, particularly in little-understood situations -To assess phenomena in a new light -To increase the researcher's familiarity with the problem -To make a precise formulation of the problem -To gather information for clarifying concepts -To determine whether it is feasible to attempt the study
Descriptive	-To look at the characteristics of individuals, events, conditions or a population -To identify problems that exist within a unit, an organization, or a population -To look at variations in characteristics or practices between institutions or countries -To record and report phenomena (not primarily concerned with causes) -To gain a denser description of phenomena by describing the setting
Explanatory	-To identify causes -To ascertain causality between factors -To determine effects on behaviour of a social phenomenon -To predict how one phenomenon will change or vary in relation to another variable

Design for healthy eating is an emerging area that has garnered attention in recent years. As for using packaging design to promote healthy eating has not yet been addressed in detail by design research practically or theoretically. This research aimed to build understanding of what packaging features affect food consumption and what are the supportive needs of designer for utilising packaging design for healthy eating. Exploratory research is characterised by its flexibility (Swaraj, 2019), thus, it is valuable on seeking new insights that to understand the eating behaviour from a new insight: packaging design. Thus, it is appropriate to adopt current study with exploratory purpose.

3.5 Research strategy

Research strategy serves guiding the selection of appropriate methods and tools to collect and interpret data effectively (Opoku et al., 2016).

3.5.1 Research strategies in social science

Case study aims at helping understand the problem in its natural setting, thus, it is used when the research aim is to find answers to “why” and “how” questions (Teegavarapu et al., 2008). Ethnographic study aims to provide a deep understanding of people's behaviours, beliefs, and practices within their natural social settings (Rasku et al., 2021). The general goal of grounded theory is to generate theories derived from data in order to understand the social context (Halaweh et al., 2008). Action research is a form of collective, self-reflective inquiry undertaken by participants in social situations to enhance the rationality and justice of their practices (Altrichter et al., 2002). Table 3.4 summarises these research strategies.

Table 3.4 General research strategies and their characteristics.

Case study	Ethnographic study	Grounded theory study	Action research
Focuses on the study of a single case or small number of related cases within its real-life context (individual, a group, a setting or others)	Aims to capture, interpret, describe and explain the live, experience, culture, structure of a group, organization, community or society.	Focuses on generating theory of certain phenomena to form the basis of the study. Particularly suitable for new areas which lacks research or theory.	Aims at investing complex, real-life problems and it is characterised by iterative and reflective process and by a close collaboration between researcher and practitioners.
Involves multiple sources of evidence and data collection techniques, mainly including observation, interview and documentation.	Requires extended periods of participant observation through immersion of the researcher in that setting.	Provides a conceptual overview with grounded interpretation, explanations, impacts, and underlying causes.	Allows quantitative and qualitative data to be used. It is usually carried out through participatory processes.

Grounded theory aims to develop theory based on data systematically gathered and analysed (Urquhart et al., 2010). It focus on theory building rather than theory testing, making it ideal for areas with limited existing research (Engward, 2013, Heppes and du Toit, 2009). Given healthy-centred packaging design is a developing area that limited in related research and lack of theory support. Grounded theory allows to build new theory based on experiment data and the insights from consumers to uncover how packaging attributes affect food intake and capture how consumers perceive food packaging and its influence on their portion decision. It is also effective in identifying needs and challenges from the designers' perspectives, which can then be used to inform the development of tailored design tool. The iterative nature of grounded theory (Niasse, 2023) allows for constant refinement of the design tool, ensuring that the final product is tailored to the specific needs of designers. Therefore, it can fill the gap in lack of specificity in addressing challenges unique to packaging design for dietary behaviour change.

3.5.2 Design research strategies

Design science research (DSR) has gained prominence (Peffers et al., 2018) for emphasising the importance of generating solutions that are theoretically sound and applicable in real-world contexts (Venable et al., 2017). Cross (1999) discussed the design research from three main categories, based on people, process and products. In addition, a interaction design research triangle was proposed by Fallman (2008), including design practice, design studies and design exploration. Furthermore, Frankel and Racine (2010) distinguished the design research into three fields: research for design, research through design and research about design. These categories on design research are summarised in Table 3.5.

Considering Frankel and Racine's classification, this research falls into research for design in that it concerns what support materials should be provided to designers to assist their packaging design towards healthy eating. At the same time, current research aims to develop a design tool and to investigate how designers may use the design tool and what may be the potential values of the design tool that makes

this research also involves research through design. In sum, current research is the combination of research for design and research through design.

Table 3.5 Three types of classification of design research strategies.

Reference	Category	Description
Cross (1999)	Design epistemology	-study of designedly ways of knowing (people)
	Design praxeology	-study of the practices and processes of design (process)
	Design phenomenology	-study of the form and configuration of artifact (products)
Fallman (2008)	Design practice	-The activity area of design practice denotes the kinds of activities that interaction design researchers are involved.
	Design studies	- The overall goal is to build an intellectual tradition within the discipline, and to contribute to an accumulated body of knowledge about design theory, design methodology, design history, and design philosophy.
	Design exploration	-It seeks to test ideas and to ask, "What if?", but also to provoke, criticize, and experiment to reveal alternatives to the expected and traditional, to bring matters to a head.
Frankel and Racine (2010)	Research for design	-It provides the information, implications, and data that designers can apply to achieve an end-result in their design projects.
	Research through Design	-It seeks to provide an explanation or theory within a broader context and emphasis on the research objective of creating design knowledge, not the project solution.
	Research about design	-The work that is carried out under the heading of other disciplines (sociology, psychology, semiotics, economics, history, etc.... of design); searches for an explanation in the experience of designers and those who use products.

3.6 Research type

There are two broad approaches of conducting data collection and interpretations are qualitative and quantitative research (Anas and Ishaq, 2022). The next consideration is about the data collection, either quantitative or qualitative, or a

combination of the two. Figure 3.3 sets out the main differences between the quantitative and qualitative research (Eyisi, 2016, Choy, 2014). Qualitative research was described the as the systematic collection, organization, and interpretation of textual material derived from talk or conversation by Malterud (2001). It is used to understand people's beliefs, experiences, attitudes, behaviour, and interactions (Clifton and Handy, 2003). Quantitative research produces the findings that have been recorded numerically by statistical procedures (Mohajan, 2020). It deals in numbers, logic, and an objective stance and seek to obtain accurate and reliable measurements (Rahman, 2020).

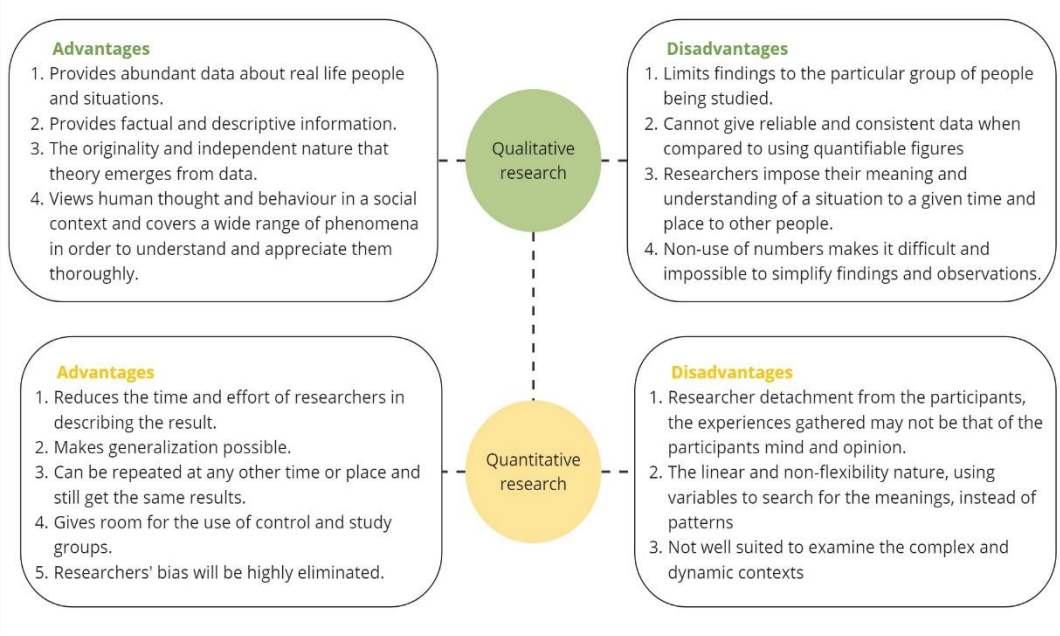


Figure 3.3 Summary of the advantages and disadvantages of qualitative and quantitative research.

There is a growing trend towards mixed methods approaches that combine qualitative and quantitative methodologies (Plano Clark et al., 2008). Mixed-methods research can help researchers triangulate findings, validate results, and gain a deeper insight into the research topic (Roer-Strier and Kurman, 2009). The concrete rationales for performing mixed research are presented in Table 3.6 (Bryman, 2006, Schoonenboom and Johnson, 2017).

Table 3.6 The benefits of performing mixed methods research.

Aspects	Description
Credibility	– refers to suggestions that employing both approaches enhances the integrity of findings.
Context	– refers to cases in which the combination is justified in terms of qualitative research providing contextual understanding coupled with either generalizable, externally valid findings or broad relationships among variables uncovered through a survey.
Illustration	– refers to the use of qualitative data to illustrate quantitative findings, often referred to as putting "meat on the bones" of "dry" quantitative findings.
Utility	– refers to a suggestion, which is more likely to be prominent among articles with an applied focus, that combining the two approaches will be more useful to practitioners and others.
Confirm and discover	– this entails using qualitative data to generate hypotheses and using quantitative research to test them within a single project.
Diversity of views	– this includes two slightly different rationales – namely, combining researchers' and participants' perspectives through quantitative and qualitative research respectively, and uncovering relationships between variables through quantitative research while also revealing meanings among research participants through qualitative research.

This research aims to have a more comprehensive understanding of the topic and identify packaging attributes that could facilitate portion control, requiring insights from various perspectives, which makes the collection of both types of data essential. This research can be defined as a mixed type of research, primarily a qualitative investigation, but quantitative investigation was conducted in some phases of the research.

3.7 Research framework and methods

Several methodologies from the fields of social sciences and design were reviewed to determine the appropriate processes and methods for this research. Multiple methods were adopted in this research to answer the research questions and achieve the research objectives. Table 3.7 illustrates what approaches and strategies were selected and how they combined in this research and corresponding methods applied in this research.

Table 3.7 Presentation of research questions, objectives, approach, strategies, research type and related methods adopted in this research.

Research question and Research objectives	Research approach	Research strategy	Research type	Research methods
RQ1: What are the characteristics of packaging design in influencing consumer food intake? **Objectives:** 1) To demonstrate a detailed understanding of the healthy eating, approaches to influence eating behaviour, design for behaviour change, the role of packaging design and design tool for designers. 2) To investigate the impacts of packaging attributes on food intake and its characteristics, identifying the attributes that facilitate portion control. 3) To explore the consumer insights on the packaging impacts on their consumption	Inductive approach	**Social science strategy:** -Grounded theory study **Design strategy:** -Research for design	Mixed methods (qualitative & quantitative)	● Literature review ● Systematic review ● Photo-elicitation ● Semi-structured interview
RQ2: How designers might be supported in designing food packaging to promote healthy eating? **Objectives:** 4) To explore the challenges designers face and the support they need when developing packaging designs aimed at promoting healthy eating. 5) To develop packaging design strategies and a design tool for shaping healthy eating, which could be useful and inspirational for designers. 6) To test and refine the design strategies and the design tool. 7) To evaluate the design tool prototype. 8) To discuss the usefulness, values and applications of the design tool developed for the health-oriented packaging design	Deductive and Inductive approach	**Social science strategy:** -Grounded theory study **Design strategy:** -Research for design -Research through design	Mixed methods (qualitative & quantitative)	● Literature review ● Semi-structured interview ● Survey ● Design diary (log)

3.7.1 Research framework

3.7.1.1 The main stages of the design research methodology

Blessing and Chakrabarti (2009) proposed a design research methodology (DRM) to support a more rigorous approach in order for design research to become more effective and efficient. It is defined as an approach and a set of supporting methods and guidelines to be used as a framework for doing design research. Design, design research, and design research methodology are related but different in a hierarchy level, the relationship of them is presented in Figure 3.4. DRM aims to bridge the gap between theoretical research and practical application, facilitating a more systematic and informed design process (Chakrabarti, 2010).

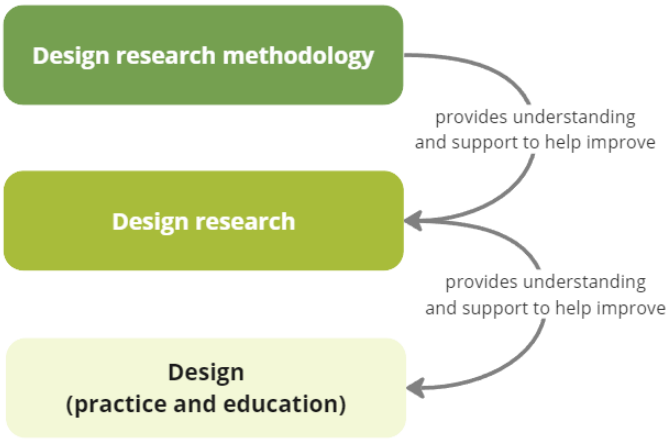


Figure 3.4 Relationships between design research methodology, design research and design.

DRM has been widely accepted and adopted by many researchers in design field (Nickpour, 2012, Ali et al., 2022, Hiekata, 2019, Ebneyamini, 2022). It well adapts to current research since this research addresses on the development of a design tool to support designers in packaging design. DRM provides a systematic research design framework to clarify each stage to build up current research. This DRM consists of four stages: Research Clarification (RC), Descriptive Study I (DS-I), Prescriptive Study (PS) and Descriptive Study II (DS-II). These main stages are illustrated in Figure 3.5, adapted from Blessing and Chakrabarti (2009). DRM is not a set of stages and supporting methods to be executed rigidly and linearly. Multiple

iterations within each stage and between stages are possible, as well as parallel execution of stages (Blessing and Chakrabarti, 2009).

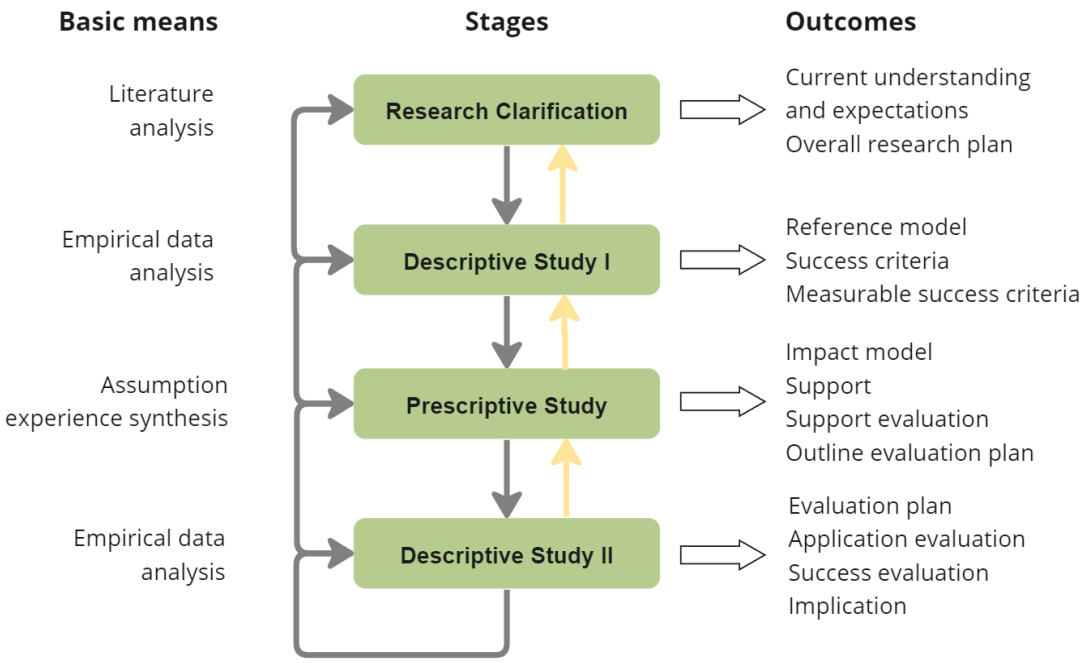


Figure 3.5 DRM main stages, basic means of each stage and the main outcomes.

Research Clarification (RC)

It helps clarify the current understanding and the overall research aim, develop a research plan and provide a focus for the subsequent stages.

Descriptive Study I (DS-I)

It aims at increasing the understanding of design and the factors that influence its success by investigating the phenomenon of design target, to inform the development of support.

Prescriptive Study (PS)

It aims at developing support in a systematic way, taking the results of DS-I into account, developing an Impact Model, developing support and undertaking continuous support evaluation.

Descriptive Study II (DS-II)

This aims to understand the impact of a support by evaluating the support, including the usability and applicability.

3.7.1.2 Research organisation

Based on the DRM structure, the specific organisation of the stages in this research is described as following and illustrated in Figure 3.6. Meanwhile, how these stages and studies are presented in the following chapters is summarised.

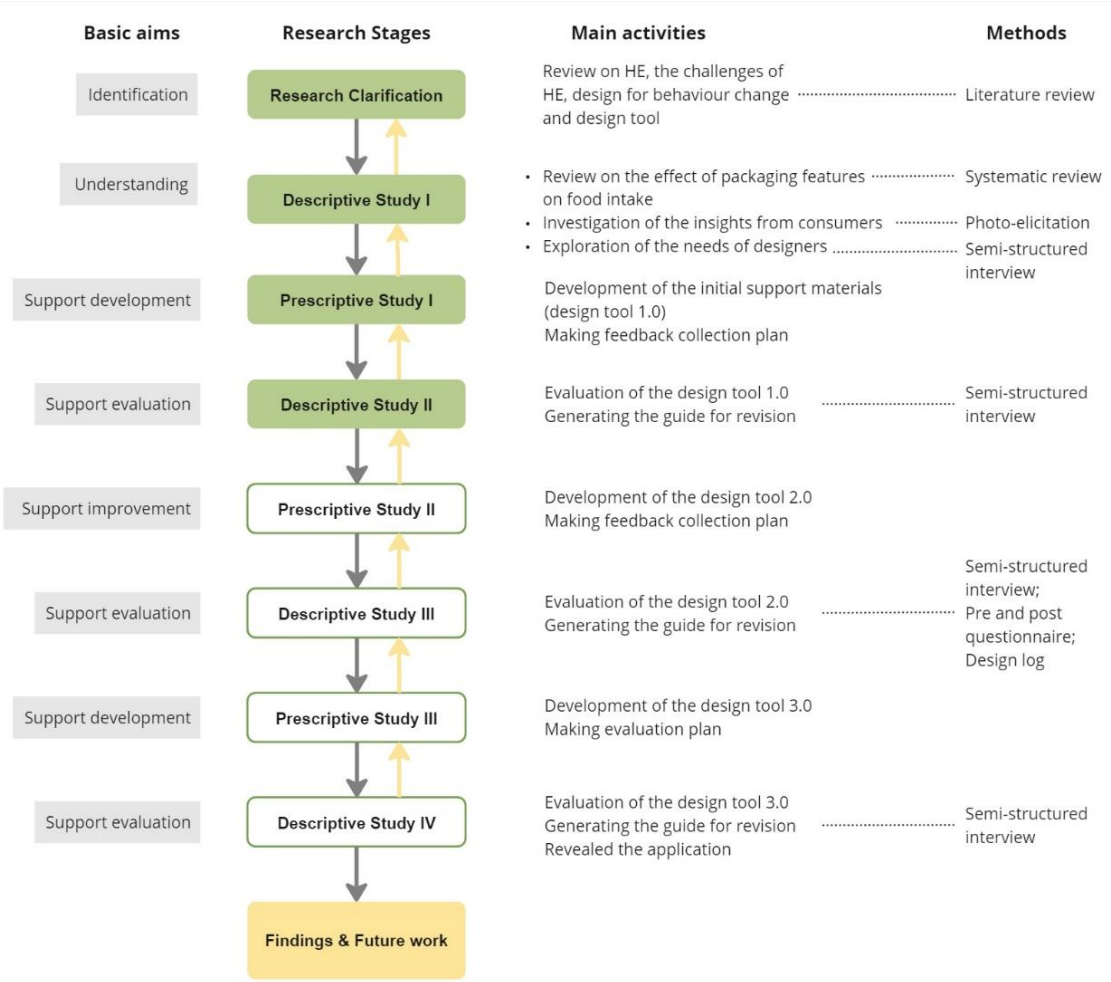


Figure 3.6 Different stages of the research under a DRM structure.

DS-I: It includes three main studies to understand the insights and needs from different perspectives to inform the development the support (design tool). To be specific, study 1 applied a systematic searching and analysing to identify the experimental validated packaging features that affect the food intake (this study is described in Chapter 4). Study 2 investigated the consumer insights into the food packaging and its influence on their portion intake through photo-elicitation (this study is described in Chapter 5). Study 3 explored the designer challenges and needs in packaging design for promoting healthy eating (this study is described in

Chapter 6). **PS-I:** It focuses on the development of the initial support materials (design tool 1.0) based on the results and findings from DS-I and clarified the continuous evaluation plan with student designers (this is described in Chapter 6). **DS-II:** It focuses on gathering feedback from designers on the design tool 1.0, testing whether they understand it and whether the support provided has the expected impact (this is described in Chapter 7). **PS-II:** It involves revision of design tool 1.0 into design tool 2.0 based on the feedback and findings from DS-II, with plans to gather further feedback from student designers for additional improvements (it is described in Chapter 7). **DS-III:** it focuses on getting feedback on design tool 2.0 from student designers and generating guides for further improvement (it is described in Chapter 7). **PS-III:** It includes the development of design tool 3.0 based on the findings from the DS-III and making following evaluation plan with professional designers (it is described in Chapter 8). **DS-IV:** It includes the evaluation of the design tool 3.0 (web-based prototype) with professional designers to gain insights into the usefulness of the design tool and the support application values as well as the improvement expectation (it is described in Chapter 8). In sum, the thesis is structed as follows:

- Chapter 4 reviewed the validated effects of food packaging features on consumer food intake.
- Chapter 5 investigated the insights from consumers on packaging impacts on their portion decision in their real life.
- Chapter 6 explored the designer needs in leveraging the evolving role of food packaging deign for healthy eating and developed a design tool to support designers.
- Chapter 7 tested and improved design tool into design tool 2.0 (iterative testing and revision with student designers).
- Chapter 8 evaluated the web-based prototype (design tool 3.0) with professional designers.

3.7.2 Data collection methods

Data can be collected from various methods (Bhattacherjee, 2012). As descripted in section 3.6, this research is characterised into a mixed type of research, combining the inductive and deductive processes, using both qualitative and quantitative methods to collect and analyse data. Thus, varied research methods were adopted in different research stages to address the corresponding research objectives. The following section provides a brief introduction of the selected method and explanation of its application in this research. The dedicated chapter provides a full description of each study's data collection, study procedure and findings.

Systematic review

Systematic review (SR) is a rigorous and transparent form of literature review. It involves identifying, synthesising and assessing all available evidence (either quantitative or qualitative) (Jones, 2004), in order to generate a robust, empirically derived answer to a specific research question (Booth, 2016). The key advantage of SR is its ability to comprehensively capture and analyse the available evidence to have an overview of the research question and identify gaps in existing literature (Rabii et al., 2020). However, despite its benefits, SR has limitations, such as potential biases (Shea et al., 2017), challenges in incorporating all relevant research and translating their conclusions (Yuan and Hunt, 2009) and varying levels of evidence quality (Rytwinski et al., 2021).

In the context of an emerging field that cuts across different disciplines, both designers and researchers have limited understanding of what packaging feature has been tested and showed impacts on food intake. Therefore, it is necessary to have a comprehensive understanding of this question. Compared to the general literature review, the SR appeared as an appropriate method to build the knowledge on the effect of packaging features on food intake. Thus, this research conducted SR to scientifically gather existing research which experimentally investigated the impacts of packaging features on food intake (Cooke and Iwashyna, 2013) to map the data evidence to answer the question about which packaging attributes could alter the intake.

Photo-elicitation

Photo-elicitation (PE) is a method usually used when researchers want to elicit information from participants by using photographs (Gomez, 2020, Matteucci, 2013). Using photographs during an interview provides a way to collect additional information, offering a visual dimension to capture the unobserved thoughts, feelings, experiences, understanding or behaviours of participants (Richard and Lahman, 2015). There are two types of PE methods: researcher-driven (where preselected photographs by researcher are used to initiate discussion) and participant-driven photo-elicitation (PDPE) (where photographs are provided by participants) (Van Auken et al., 2010). This method brings abstract questions down to a very hands-on and approachable level (Van Auken et al., 2010). PDPE can get participants deeply involved in the data generation. However, in practical, asking questions about the images provided by participants and also about the aspects that mattered to researchers is difficult. Besides, it is more time-consuming than traditional interview that demands more time preparing the photograph task guidance, linking the responses to the specific images and analysing both textual and visual materials (Meo, 2010).

Current research is focus on the impact of packaging design, text is not sufficient to convey specific packaging features, a combination of text and visual information is essential to better understanding the packaging features. PDPE method provides the opportunity to collect packaging images from consumers' real life and let them discuss their thoughts on the packaging features in detail as well as their experience. The image not just helps consumer describe the packaging features, it also assists researcher in understanding packaging design details and other reflections from consumers' perspective. Thus, the PDPE method was adopted to investigate consumer insights on the food packaging, exploring the features that they focus on and the packaging attributes that could affect their intake. In addition, consumers' portion problems, values of portion decisions were also addressed through the interpretation of the textual and visual data.

Interview

Interview is a natural way of interaction that can take place in various situations, providing valuable insights of participants (Blaxter et al., 2010). Interviewers can help ensure mutual understanding by rephrasing or simplifying questions that interviewees may not grasp. As a result, more appropriate responses and, ultimately, more accurate data will be collected (Dornyei, 2007). Semi-structured interview has the ability to dig deeply into participants' perspectives in a relatively flexible way (Motubatse et al., 2015), allowing for a comfortable dialogue and the exploration of ideas that may not have been previously considered by researchers (Isaksson et al., 2023). Moreover, semi-structured interviews are particularly beneficial in design research as they allow for the exploration of the design process (Chen et al., 2021). However, interviewees will only give what they are prepared to reveal about their perceptions of events and opinions, making these perceptions subjective and therefore may change over time according to circumstance (Rivard et al., 2024). The data might also been influenced by the incomplete knowledge or even faulty memory (Cicourel, 1974).

In this research, to deeply understand consumers' thoughts on food packaging, the semi-structural interview was used as part of the PDPE approach due to its allowing for extend the questions to further explore more insights. In addition, to thoroughly investigate the challenges faced by designers and the support should be provided, semi-structured interview was also applied with designers due to there may be some unexpected aspects of challenges, needs or design experiences from designers' perspective. To test the design tool, the semi-structured interview was adopted to gain feedback from student designers for the design tool improvement. Furthermore, The final design tool evaluation with professional designers aimed not only to explore its usefulness but also to investigate its practical value and other potential applications. Thus, a semi-structured interview was conducted.

Questionnaire

Questionnaire is a structured method containing a series of questions or prompts designed for eliciting the desired information from participants (Baker, 2003). The self-administered questionnaire is a type of questionnaire that allows the

respondent answering questions without the aid of the researcher. It can be used to collect qualitative and quantitative data (Marsland et al., 2001). It benefits in not affecting the answers that people may give without an interviewer present it and it is more convenient for the participants. However, questionnaire result is affected by social desirability bias, recall difficulties, and reliance on the researcher's predetermined questions (Widyanti, 2018, Ferrari et al., 2020).

The questionnaire was used as part of the evaluation method with designers in many research to evaluate the usefulness and user experience of the design tool (Agogino et al., 2015, Han et al., 2018). Thus, this research also used questionnaire as part of the design tool 2.0 evaluation in DS-III to evaluate the effectiveness of the tool from multiple perspectives. Besides, to collect data on both pre-and-post for revealing the impact of the design tool and to capture the changes throughout the design process, the questionnaire is evidently the most suitable method in the evaluation of the design tool 2.0. In addition, the tool using experience was also investigated via questionnaire at the end of this tool testing study.

Design diary method

The diary method has been utilised to document students' activities accurately (Wilson et al., 2008). The flexibility of the diary method is evident in its compatibility with other research methods like questionnaires and interviews (Karadzhov, 2021). This adaptability makes diaries a valuable tool for researchers seeking to gather comprehensive data. Research with time-based design diary method is often concerned with ongoing experiences that can be assessed within the course of a typical period. However, the use of diaries in research may face challenges in terms of data validity (Frost et al., 2016). The subjective nature of diary entries and the reliance on self-reporting can introduce biases and inaccuracies (Manoj and Verma, 2015). Considering the need to gain a better understanding of designers' stages, behaviours, and concerns during the design process, as well as the value of the design tool, it is appropriate to use the fixed schedule time-based diary method. This method was applied in the evaluation study during DS-III with student designers.

3.7.3 Sampling strategy

Sampling is an important component of research design (Mujere, 2016). Here is the brief introduction of the sampling strategies used in this research.

Purposive sampling strategy

This method involves intentionally choosing participants based on the specific features that align with the objective of the study (Etikan et al., 2016).

Convenience sampling

It defines a process of data collection from population that is close at hand and easily accessible to researcher, allowing researcher to get responses in a cost effective way (Rahi, 2017).

Snowball sampling

In this method, the researcher makes initial contract with a small group of people and then uses them as referrals to contact with others (Parker et al., 2019), which is useful for accessing hard-to-reach populations.

Table 3.8 Summary of sampling strategies and simple sizes in this research.

Study stage	Research method	Sampling strategy	Participants
Consumer study in DS-I	Photo-elicitation with Semi-structured interview	Purposive sampling Convenience sampling	25 adult consumers in UK
Designer needs study in DS-I	Design task with Semi-structured interview	Purposive sampling Convenience sampling	10 professional designers 10 student designers
Tool testing in DS-II	Design task with Semi-structured interview	Purposive sampling	12 student designers
Tool testing in DS-III	Design task with Semi-structured interview Questionnaire Design Dairy	Purposive sampling	9 student designers
Tool evaluation in DS-IV	Design task with Semi-structured interview	Purposive sampling Snowball sampling	8 professional designers

Purposive sampling was used in each study of this research and combined with other sampling strategies in some studies. In the consumer insights study in DS-I, the purposive and the convenience sampling strategy were applied. It involved adult people who is living in the UK. These people could represent the general consumers who are able to access to the food and the packaging in UK market in their daily life. In the designer needs exploring study in DS-I, the purposive and the convenience sampling strategy were used. In this study, designers were recruited through social platforms, personal contract of the researcher and the design student at the university. In the support evaluation study in DS-II and DS-III stages, the purposive sampling strategy was carried out. The target participants were the master student designers who chose the research topic related design brief and consented to participate. In the evaluation study in DS-IV stage, the purposive and the snowball sampling strategy were adopted. The participants in this study were required to be the professional designers who have experience or knowledge or skills of food packaging design and currently are engaged in design work. Some qualified professional designers were initially contacted by researcher through personal contact, and then other designers were invited by them. The specific sampling strategy and sample size are illustrated in Table 3.8.

3.7.4 Data analysis methods

Both qualitative (thematic analysis (TA)) and quantitative analysis (descriptive statistics and pre-post comparison analysis) were adopted in this research.

TA is a method to identify, analyse, and interpret patterns of meaning within qualitative data (Clarke and Braun, 2017), providing a systematic procedures for generating codes and themes from qualitative data. Besides the preparation, the other steps are: generating initial codes, searching for themes, reviewing themes, defining and naming themes and final written-up (Maguire and Delahunt, 2017, Dawadi, 2021). Descriptive statistics provide a summary of data through measures such as mean, median and standard deviation, helping understand the central tendency and variability within a dataset (Dong, 2023). For instance, it has been employed to analyse students' performance and learning outcomes effectively

(Nusantara et al., 2021). Besides, presenting data visually through graphs and charts enhanced the interpretability of findings. Pre-post comparison analysis is a method used to evaluate changes over time by comparing measurements taken before and after an intervention (Priatna and Sari, 2022). By employing paired statistical tests, such as t-test, to observe whether changes are statistically significant, thereby providing further evidence for the effectiveness of the intervention.

The data of consumer study in DS-I was analysed based on the TA steps and use Miro to display the pictural and textual data from consumers. Besides, the descriptive statistics were used to analyse the frequence of the portion decision factors. The data of designer needs exploration study in DS-I was analysed by TA method to summarise the design needs of designers. The descriptive statistics and pre-post comparison analysis was conducted to explain the changes after using the design tool by measurements. The TA method was applied in all design tool evaluation studies to reflect the tool usefulness as well as some other insights.

3.8 Research design review

This chapter introduced and described selected research paradigm, research approach, research purpose, research strategy, research type, research methodology, research methods and the rationale of the application of them in this research. This research followed a constructivist epistemological stance and a constructivism-interpretivism theoretical perspective. A combination of inductive and deductive approach was applied. From a social science perspective, this research can be defined as an exploratory research and grounded theory was the research strategy. From a design research perspective, it can be seen as research for design combined with research through design. The DRM was adapted as the current research framework, each stage was described from RC, DS-I, PS-I, to DS-II, PS-II, DS- III, PS-III and DS-IV. This research was primarily qualitative research, integrating both quantitative and qualitative data collection methods within the evaluation study. Several methods were adopted in different stages to collect data: systematic review, photo-elicitation, semi-structured interview, questionnaires and

design diary/log. The purpose sampling, convenience sampling and the snowball sampling were applied to recruit participants. Thematic analysis, descriptive statistics and pre-post comparisons were used as the main analysis methods with the help of data display. Figure 3.7 illustrates the entire research process, including research methodology and the study conducted at each stage.

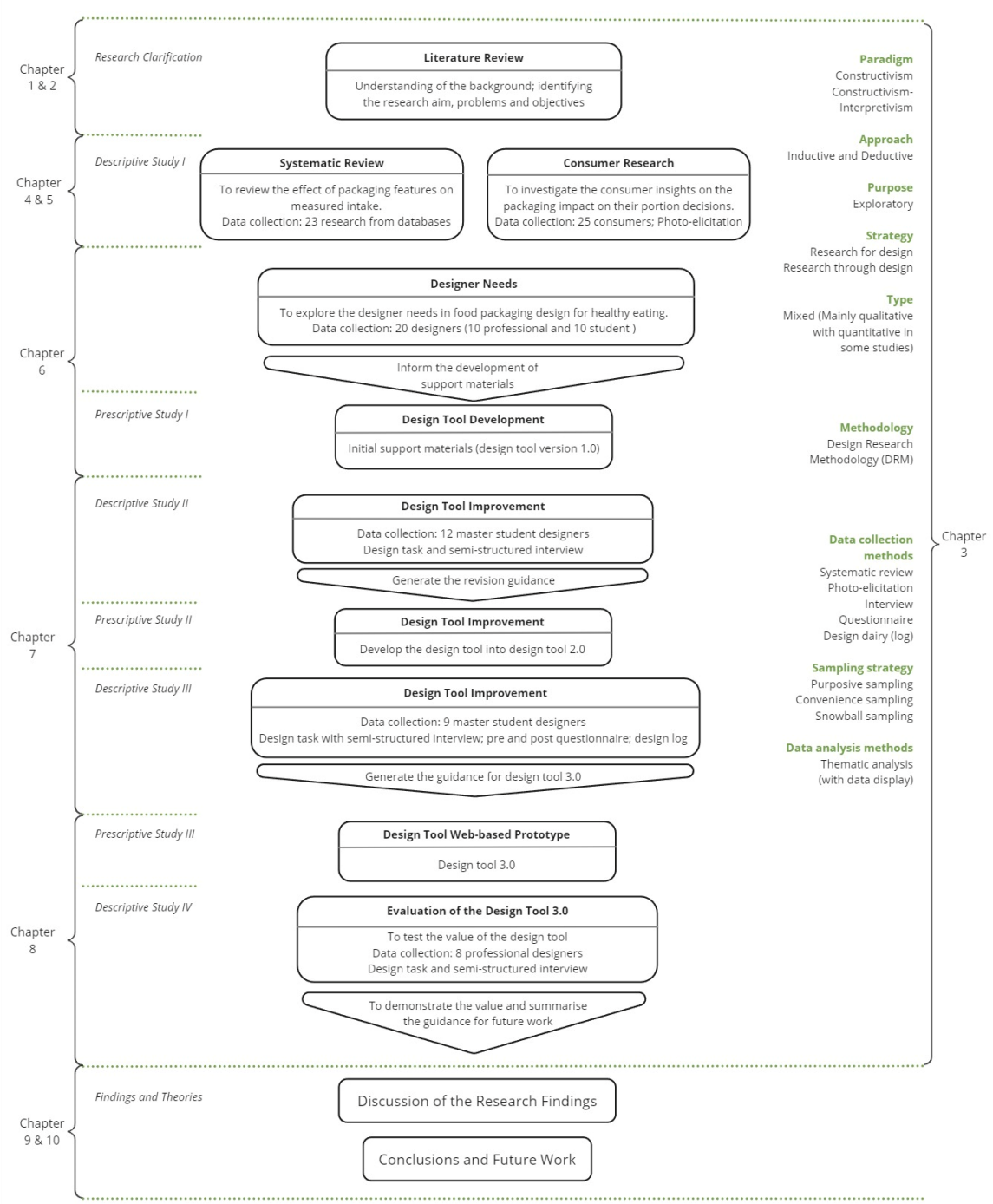


Figure 3.7 An overall map of the research design and the structure of the chapters in this thesis.

Chapter 4
EXPERIMENTAL RESEARCH ON THE EFFECT OF PACKAGING ON FOOD INTAK

This chapter describes a systematic review (SR) on the impact of packaging features on measured food intake. This study aimed to address objective 2: to investigate the impacts of packaging attributes on food intake and its characteristics. This chapter outlines the procedures of this study, as well as the key findings and subsequent discussions. These findings and discussions were used in the development of design support in Chapter 6. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 (https://www.prisma-statement.org/prisma-2020) was used as a guideline to present the study screening and results.

4.1 Methods of study

4.1.1 Study selection

4.1.1.1 Protocol registration and eligibility criteria

A specific protocol was created and followed to achieve the research aim of this SR: to systematically investigate the impact of different packaging features on food intake from the experimental-based studies. This protocol included the search strategy and criteria for inclusion and exclusion. The specific searching strategy was registered in the Open Science Framework (https://osf.io/6t2e3/). The defined criteria for including and excluding studies during the screening process were described as follows and the key points are summarised in Table 4.1.

Inclusion criteria:

1. Articles that conducted any form of experimental research (such as experimental trials, field experiments, or randomised controlled trials) on packaging were included, regardless of the period of the experiment (ranging from a few minutes to several weeks).

2. Participants (human being) in study from all age groups were included.
3. All categories of food that suitable for human consumption were included, such as snacks, meals, fruits, vegetables, and beverages etc.
4. All forms of measuring real or intended food consumption were considered, such as the amount consumed in terms of volume, quantity, and energy intake.

Exclusion criteria:

1. All review articles were excluded.
2. Articles related to animals or animal feeding were not considered.
3. Papers that did not report a relevant intake outcome were excluded, for example, the studies were primarily concerned with validation of the methods or questionnaires were excluded.
4. Research that focused on patients with conditions such as diabetes, infectious diseases, or eating disorders, as well as research that involved consumers with restrictive diets like pregnancy or vegetarian diets, were not included.
5. Articles were excluded if it only assessed estimated food consumption (no real food contract) rather than actual or intended intake.
6. Articles that only focused on the impact of on-pack labelling system that modified the nutritional content were not considered. In that these studies do not directly manipulate the packaging design attributes and have already been reviews comprehensively elsewhere (Anastasiou et al., 2019, Cecchini and Warin, 2016, Ikonen et al., 2020, Kiszko et al., 2014).

Table 4.1 The summary of the key points of the inclusion and exclusion criteria.

Inclusion	Exclusion
● Any experimental research ● All age of participants ● All categories of food for humans ● All forms of measurement	● Review articles ● Participants were animals ● No relevant intake results ● With patients or consumers with special diets ● No food presentation to the participants ● Research on labelling system

4.1.1.2 Data sources, search strategy and study selection

Four main databases were used, including Ovid Medline; Ovid PsycInfo; Ovid Embase and Web of Science. Then a systematic search approach was conducted from November to December 2019, specifically targeting publications in the previous decade (10 years). The chosen period was intended to maintain a manageable scope. The search strategy was organised around two main variables: packaging manipulations (any comparisons made based on food packaging) and food intake (measured actual or intended consumption). The keywords derived from previous relevant literatures, including the key words, article title and abstract, were used and adapted as the search terms. The searching limits were set as including all journal articles published in the English language since 2009. In addition, some articles were accessed via identified eligible research and some were further retrieved from other sources.

The literature retrieved was exported and followed with the remove of duplicates. Then, several rounds of screening were applied to identify the included studies in this SR (see Figure 4.1). Initial screening: all titles and abstracts of were evaluated to exclude irrelevant research. Second screening: the titles and abstracts of relevant articles were further screened following the inclusion and exclusion criteria. Third screening: a thorough evaluation of the full text of retained paper. Final screening: comprehensive discussions were conducted to address the eligibility of some particular studies, ultimately a unanimous agreement on included studies was achieved among all reviewers.

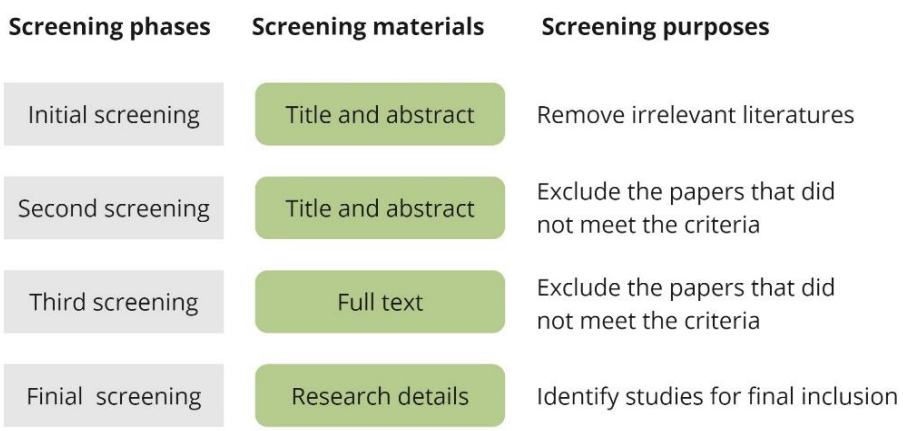


Figure 4.1 The procedure of the screening literatures for inclusion.

4.1.2 Data extraction and data synthesis

Data extraction is one of the key processes of SR that takes place after identifying inclusion studies and before analysing the data of each study (Taylor et al., 2021). In current research, a customised extraction form was created to suit the needs of this review and try to ensure the consistent and easy coding rules (Büchter et al., 2020) in completing the collection form. It includes the input of the study design, such as the authors, year, study type, and experimental setting. It also provides information about the participants, including the sample size, sex, and mean age. Additionally, the specific intervention items are included, such as the type of packaging intervention, food type, and condition settings. The primary outcome measures and a summary of the findings are also provided. The details of which could be seen in the following result sections.

The key results of each study were synthesised. The data format from these studies are not in uniform due to the variety of packaging attributes were used as the manipulation in the study and the multiple methodologies applied to assess food consumption. The main measure of food intake was recorded either by the number of food units consumed, deducting the weight of leftovers from the initial amount served, or translating the weight of the food into its equivalent energy content using nutritional composition tables. The intended consumption was reported by servings in the presence of actual foods. Thus, a qualitative synthesis was conducted instead of a quantitative synthesis (meta-analysis) due to the infeasibility caused by inconsistent measurement formats. Besides, an assessment the effectiveness of the packaging manipulation was made which was determined by whether the packaging manipulation established a significant difference in assessed food intake compared to a control group. The magnitude of this effect was calculated as a percentage change in intake relative to the control condition which will be further reported in the following results section. The analysis of qualitative material can be referred to as synthesis through interpretation (Rousseau et al., 2008). The interpretation continued even after synthesis has been accomplished. Certain syntheses may determine that the evidence is inconsistent or weak, which will prompt further investigation.

4.1.3 Risk of bias assessment

Each included study was assessed to identify potential sources of bias in respect to the methodology applied. For instance, it is important to check whether the procedures used were rigorous and whether the participants were carefully assessed beforehand for their preferences towards food items, any food allergies or intolerance they may have, and any dietary restrictions they were following. Likewise, it was determined whether the participants were informed of the actual purpose of the study. As stated by Nix and Wengreen (2017) and Robinson et al. (2018), eating behaviour can be altered by the awareness of the true experimental purpose or the perceived purpose. Subsequently, the participants' understanding of the study's objectives is assessed. This review recorded important experimental practices, such as offering a cover story to participants, using a distractor task, and documented individual information like sex, body mass index (BMI), and hunger level etc. These factors are known that may influence the outcomes of measuring food intake. The study's risk of bias was assessed using a checklist consisting of twenty questions, which yielded a maximum score of 21 and it enabled an overall quality evaluation score to be assigned to each research (Downs and Black, 1998).

4.2 Results of the systematic review

4.2.1 Study selection

The procedure of retrieving final included publications through searching and screening by the application of the eligibility criteria is shown in Figure 4.2, as indicated by the PRISMA guidelines. 2472 articles were identified from the databases and 1668 papers were screened after the remove of the duplicates. Additionally, four more articles were obtained from other sources which were screened together for eligibility. After the full text screening, 23 articles were included.

13 out of the 23 publications reported on more than one independent study. Therefore, the total number of experiments conducted within the included articles was 54. Fourteen of these studies measured alternative outcomes (e.g., estimations of energy content, perceptions of healthfulness) rather than actual or

intended food intake, and accordingly were excluded from the analysis. Thus, a total of 40 studies were reviewed. The remaining 40 studies includes two categories: laboratory-based experiments (25) and field-based experiments (15). Five of the field-based experiments were conducted at home, while 10 were conducted in other settings (e.g., school classroom, school dining room, office, theatre, club).

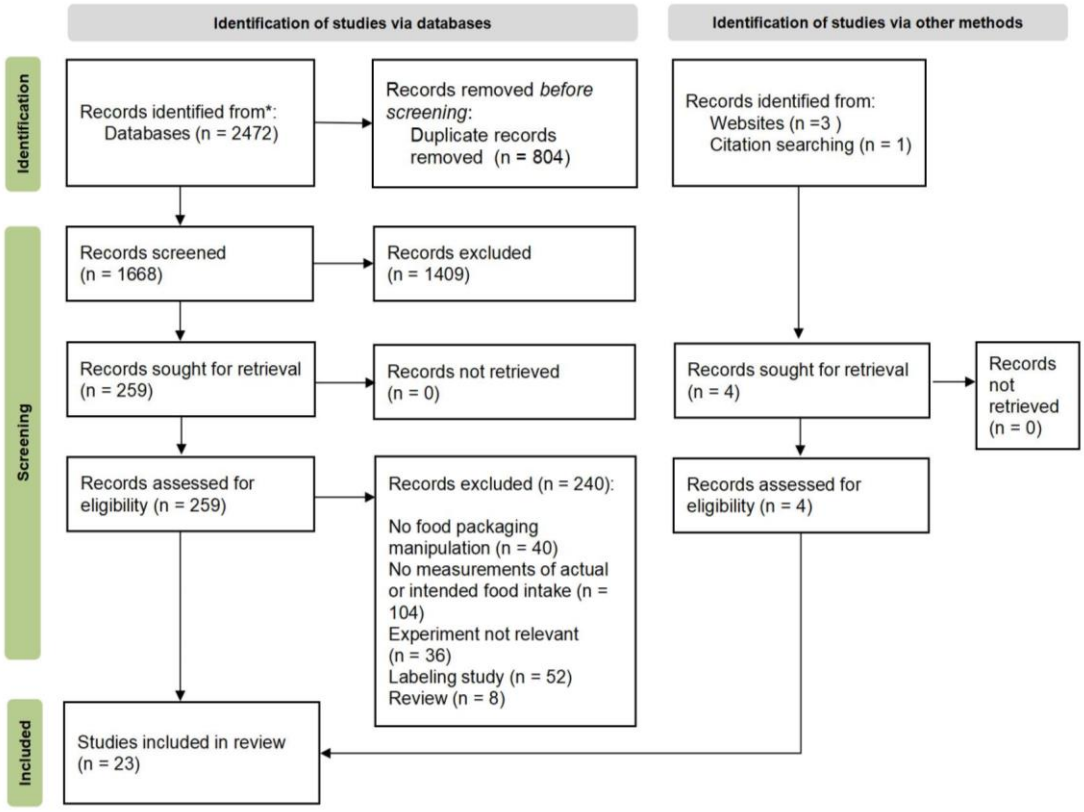


Figure 4.2 Systematic review PRISMA flow diagram.

4.2.2 Study main characteristics

A total of 14 distinct packaging design modifications were identified in reviewed studies which were classified into three categories: structural features, on-pack visual cues and other manipulations. The specific packaging manipulations are presented in Figure 4.3. These packaging manipulations were tested on varied food categories, including snacks, meals, fruits, vegetables and beverages.

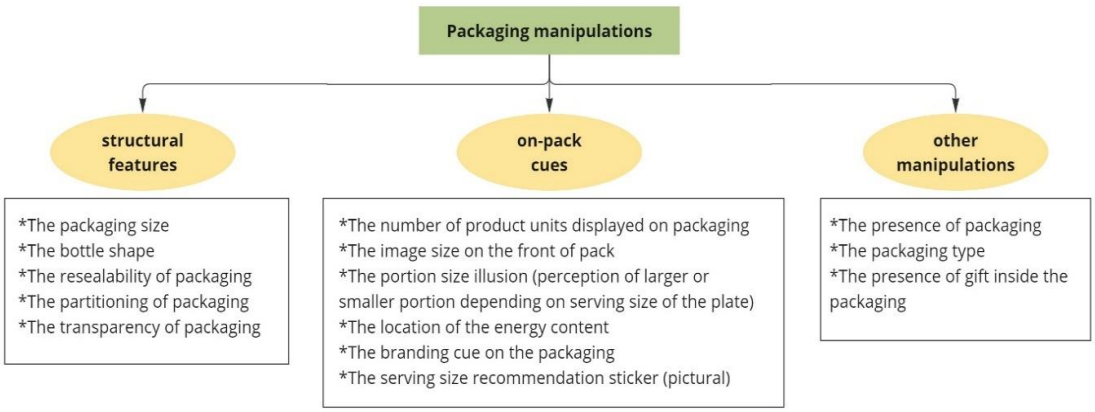


Figure 4.3 Three categories of the identified packaging manipulations.

Sample size and characteristics

The sample sizes in these studies ranged from 16 to 1680 people. Their ages ranged from 4.4 years to 70.5 years. Three age groups were included: children, young adults (aged 18 to 30 years), and adults (aged beyond 30 years). The majority of participants (24 out of 40 studies) were young adults, primarily college students. Children under the age of 10 were engaged in 10 studies. Only six research included adult volunteers from the general population who were employed in various occupations and two involved older adults (age$\geqslant$50 years).

Experiment design

The experiment duration was reported to vary from five minutes to a period of seven weeks. There are varied intake measurements: 1. Some was calculated by subtracting the remaining weight in grams from the amount first supplied; 2. Some of those studies also transformed the weight of food into its corresponding energy content or turned millilitres into energy content for beverages. 3. Another method applied involved quantifying the remaining units within the container. In some studies, measured intakes were self-reported by participants. Specifically, food diaries were employed to document food consumption. Participants were instructed to measure and photograph their uneaten portions or to weigh each food container before and after eating. Additionally, certain research assessed whether the participants were aware of the packaging alterations and the extent to which they relied on this information while making consumption decisions.

4.2.3 Risk of bias of selected studies

Research quality scores

All 23 papers were evaluated for quality using the Downs and Black checklist (Downs and Black, 1998), which assigns a score out of 21. The average quality scores were 16.5 out of 21, with 78% of them being classified as good quality. Based on the quality scores, most of the papers were scored of high quality and were consequently included for further review. The studies had good ratings in terms of reporting quality (M = 9.3/10, equivalent to 93% positive scores) and internal validity-bias (M = 4.8/6, equivalent to 80% positive). However, the ratings for external validity (M = 0.6/1, 61% positive) and internal validity-confounding (selection bias) (M = 1.8/4, 45% positive) were rather low. Appendix 1 presented further details.

Specific risk of bias review

Among the studies included, more than half employed a cover story, such as informing participants that the experiment was evaluating new food products) in order to enhance the validity of the results. However, 10 research did not provide information regarding the use of cover stories. In addition, just six research documented whether participants had correctly discerned the real purpose of the study. Overall, 12 research assessed the liking for certain foods. In certain instances, this preference was examined after participants consumed the food, either as a covariate or to match the cover story. Approximately 50% of these studies assessed body mass index and hunger level, factors that could potentially impact food consumption results (Amin and Mercer, 2016, Togo et al., 2001). Besides, four studies examined the tendency to consume the entire portion, such as eating the whole pack once it is opened and the tendency to clean everything on the plate. It is ideal that the research should strive for a balanced sex ratio by including an equal number of males and females (Fossett and Kiecolt, 1991, Spitschan et al., 2022). The sex balance was achieved in three studies, and broadly balanced in the remains. However, there was a clear imbalance in certain studies, with two of them involving over 70% male participants. and five studies using more than 70% females, whereas three studies from Argo and White (2012) only enrolled

female participants. These factors are illustrated in Figure 4.4 which could be take into consideration in research design to reduce the risk of bias.

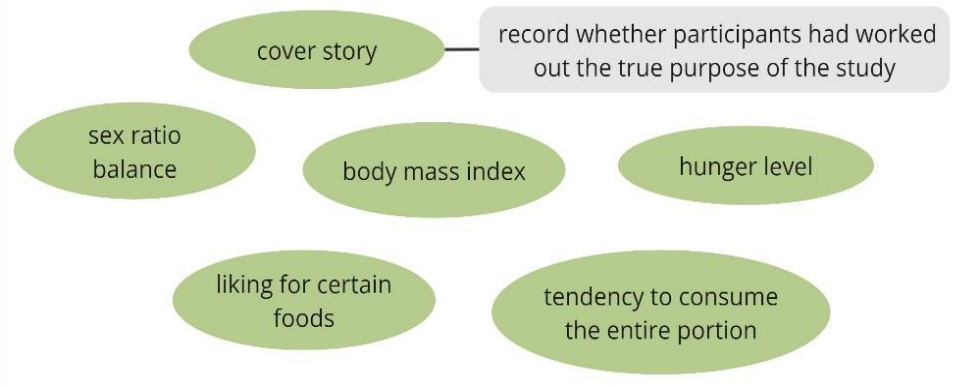


Figure 4.4 Factors revealed in research design of these included studies that may influence the risk of bias.

4.2.4 Synthesis of study results

The majority of studies reported substantial changes in food intake, as detailed in Table 4.2. The packaging attributes were categorised into clusters, including on-pack cues, structural features, and other manipulations as shown in Table 4.3. Appendix 2 contains further detailed information of these studies, including study design and participants' characteristics.

Table 4.2 The summary of the experiment features and the food intake results of the included studies

Reference	Packaging comparisons	Had impact?	Intake changes percentage (%)	Experimental food
(Aerts and Smits, 2017)	Small package VS Large package	Yes	48% ↓	Popcorn
	Small package VS Large package	Mixed	22% ↓	Cookies
			→	Carrots
(Aerts and Smits, 2019)	Small portion on-pack sticker VS Large portion on-pack sticker	Mixed	15% ↓	Grapes
			→	Chocolate nuts
	Small portion on-pack sticker VS Large portion on-pack sticker	Mixed	23% ↓ (first slice)	Bread spread
(Argo and White, 2012)	No package VS Present of package	Yes	56% ↓ (low ASEs)	Candies
	Non-partitioned packages VS Partitioned packages	Yes	NA	Candy-coated chocolates
	Opaque package VS Transparent package	Yes	45% ↓ (partitioned + low ASEs)	Candy-coated chocolates
	Back caloric information and No caloric information VS Front caloric information	Yes	40% ↓ and 43% ↓(low ASEs)	Chocolates

	No package VS Present of package	Yes	NA	Candy-coated chocolates
	No package VS Present of package	Yes	NA	Candy-coated chocolates
(Bui et al., 2017)	Partitioned packages VS Non-partitioned package	Mixed	37% ↓	Granola
			→	Cookie
(De Bondt et al., 2017)	Resealable package VS Non-resealable package	Yes	61% ↓	Jelly beans
	Resealable package VS Non-resealable package	Yes	31% ↓ 29% ↓ 12% ↓ 27% ↓	M&M's; Gummy bears; Mini cookies; Salted peanuts
(Deng and Srinivasan, 2013)	Opaque package VS Transparent package	Mixed	41% ↓	Froot loops
			→	Cheerios
	Opaque package VS Transparent package	Yes	37% ↓	M&M's candies
			40% ↑	M&M's cookies
	Opaque packages VS Partially transparent package	Yes	43% ↓	M&M's candies
	Opaque package VS Transparent package	Yes	47% ↓	M&M's candies
	Opaque package VS Transparent package and partially transparent package	Yes	85% ↑ and 71%↑	Baby carrots
(Eykelenboom et al., 2018)	Small jar VS Large jar	No	→	Peanut butter
(Gregori et al., 2013)	Gift inside the package VS No gift	No	→	Chocolates
(Gregori et al., 2014)	Gift inside the package VS No gift	No	→	Chocolates
(Holden and Zlatevska, 2015)	Non-partitioned package VS Partitioned packages	Mixed	62% ↓ (diet-consciousness was activated)	M&M's c candies
(Keller et al., 2012)	Unbranded containers VS Original branded packaging	Mixed	NA	Meals
	Unbranded containers VS Containers with the logo of a popular fast food	Yes	8% ↓ 14% ↓ (girls)	Meals
	Containers decorated with cartoon characters VS Plain containers	Yes	NA	Fruits and vegetables
(Koo and Suk, 2016)	Wider bottle VS Taller bottle	Mixed	16% ↓ (When primed to be mindful of calorie intake)	Mango smoothie
(Madzharov and Block, 2010)	Fewer product units on the package VS More product units on the package	Yes	73% ↓	Animal crackers
	Fewer product units on the package VS More product units on the package	Yes	40% ↓ 63% ↓ (no-load condition)	Animal crackers
	Fewer product units on the package VS More product units on the package	Yes	56% ↓ (at a high level of visual processing)	Pretzels
	Fewer product units on the package VS More product units on the package	Yes	87% ↓ (at a high level of visual processing)	Pretzels
(Mantzari et al., 2017)	Four different bottle sizes	No	→	Cola

(Marchiori et al., 2012)	Small container VS Large container	Yes	56% ↓	M&M's
(Neyens et al., 2015)	Larger image-size on the front of pack VS Smaller image-size on the front of pack	Yes	23% ↓ 32% ↓ (when sugar content was low)	Cereal
(Petit et al., 2018)	On pack food served in a smaller bowl VS On pack food served in a larger bowl	Yes	20% ↓ 23% ↓ (medium scores of mental simulations) 36% ↓ (high scores of mental simulations)	Cereal
(Raynor et al., 2009)	Single serving packages VS Non-portioned packages	Yes	18% ↓	Cereal and peaches
			12% ↓	Applesauce and cheese
(Stroebele et al., 2009)	100 kcal packages VS Standard size packages	Yes	45% ↓ (week 1) 15% ↓ (week 2)	Snacks
(Versluis and Papies, 2016)	Small package VS Large package	Mixed	Mixed	M&M's peanuts
(Versluis et al., 2015)	Package with the pictorial serving size recommendation sticker VS Package with no serving size recommendation sticker	Mixed	24% ↓ (according to Figure 3) (pictorial serving size recommendation was noticed)	M&M's peanuts
(Wansink et al., 2011)	Partitioned packages VS Non-partitioned package	Yes	25% ↓ 54% ↓ (overweight)	Crackers
(Werle et al., 2016)	Original package VS Plain package.	Mixed	23% ↓ (Males)	M&M's peanuts
	Original package VS Plain package and "Low Fat" label packaging	Yes	25% ↓ and 25%↓ →,and 36% ↓ (females) 37% ↓ and → (males)	M&M's peanuts

(NA = not available; ↑= increased;↓= decreased; → = no difference across different packaging conditions)

Table 4.3 Clustered packaging manipulations of the reviewed studies (n = 40) and whether it reported any change on the food intake

Packaging Cluster	Specific Packaging Manipulation	Changed intake?	Reference	Study number
On-pack cues	The number of product units displayed on packaging	Yes	Madzharov and Block, 2010	Study 1C
	The number of product units displayed on packaging	Yes	Madzharov and Block, 2010	Study 2
	The number of product units displayed on packaging	Yes	Madzharov and Block, 2010	Study 3A
	The number of product units displayed on packaging	Yes	Madzharov and Block, 2010	Study 3B
	The image size on the front of pack	Yes	Neyens et al., 2015	
	The portion size illusion	Yes	Petit et al., 2018	Study 2
	The location of the energy content	Yes	Argo and White., 2012	Study 3
	The branding cue on the packaging	Mixed	Keller et al., 2012	Study 1
	The branding cue on the packaging	Yes	Keller et al., 2012	Study 2
	The branding cue on the packaging	Yes	Keller et al., 2012	Study 3
	The serving size recommendation sticker	Mixed	Aerts and Smits, 2019	Study 1
	The serving size recommendation sticker	Mixed	Aerts and Smits, 2019	Study 2
	The serving size recommendation sticker	Mixed	Versluis et al., 2015	Study 3

Structural features	The packaging size	Yes	Stroebele et al., 2009	
	The packaging size	Yes	Aerts and Smits, 2017	Study 1
	The packaging size	Mixed	Aerts and Smits, 2017	Study 2
	The packaging size	Mixed	Versluis and Papies, 2016	
	The packaging size	No	Eykelenboom et al., 2018	
	The container size	Yes	Marchiori et al., 2012	
	The bottle size	No	Mantzari et al., 2017	
	The bottle shape	Mixed	Koo and Suk, 2016	
	The resealability of packaging	Yes	De Bondt et al., 2017	Study 2
	The resealability of packaging	Yes	De Bondt et al., 2017	Study 3
	The partitioning of packaging	Yes	Argo and White., 2012	Study 2
	The partitioning of packaging	Yes	Raynor et al., 2009	
	The partitioning of packaging	Yes	Wansink et al., 2011	
	The partitioning of packaging	Mixed	Bui et al., 2017	Study 3
	The partitioning of packaging	Mixed	Holden and Zlatevska, 2015	
	The transparency of packaging	Yes	Argo and White., 2012	Study 2
	The transparency of packaging	Mixed	Deng and Srinivasan, 2013	Study 1
	The transparency of packaging	Yes	Deng and Srinivasan, 2013	Study 2
	The transparency of packaging	Yes	Deng and Srinivasan, 2013	Study 3
	The transparency of packaging	Yes	Deng and Srinivasan, 2013	Study 4
	The transparency of packaging	Yes	Deng and Srinivasan, 2013	Study 5
Other packaging manipulations	The presence of packaging	Yes	Argo and White., 2012	Study 1
	The presence of packaging	Yes	Argo and White., 2012	Study 4
	The presence of packaging	Yes	Argo and White., 2012	Study 5
	The packaging type	Mixed	Werle et al., 2016	Study 2
	The packaging type	Yes	Werle et al., 2016	Study 3
	The presence of gift inside the packaging	No	Gregori et al., 2013	
	The presence of gift inside the packaging	No	Gregori et al., 2014	

4.2.4.1 Effects of the on-pack elements

This review included 13 research that explored the impact of on-pack cues on food intake. All of these investigations exhibited a significant impact on intended or actual food intake. However, in four research, the findings indicated the conditional effects, meaning that the packaging intervention only affected select participants or only functioned under specific circumstances. All of the studies (9 out of 9) that altered the visual representation of food on the packaging observed a notable decrease in the food consumed. Figure 4.5 provides graphical representation of these manipulated on-pack visual cues. These findings validated the impact of on-pack cues as vital factors in reducing food consumption, particularly when the packaging clearly indicates the recommended portion size through images.

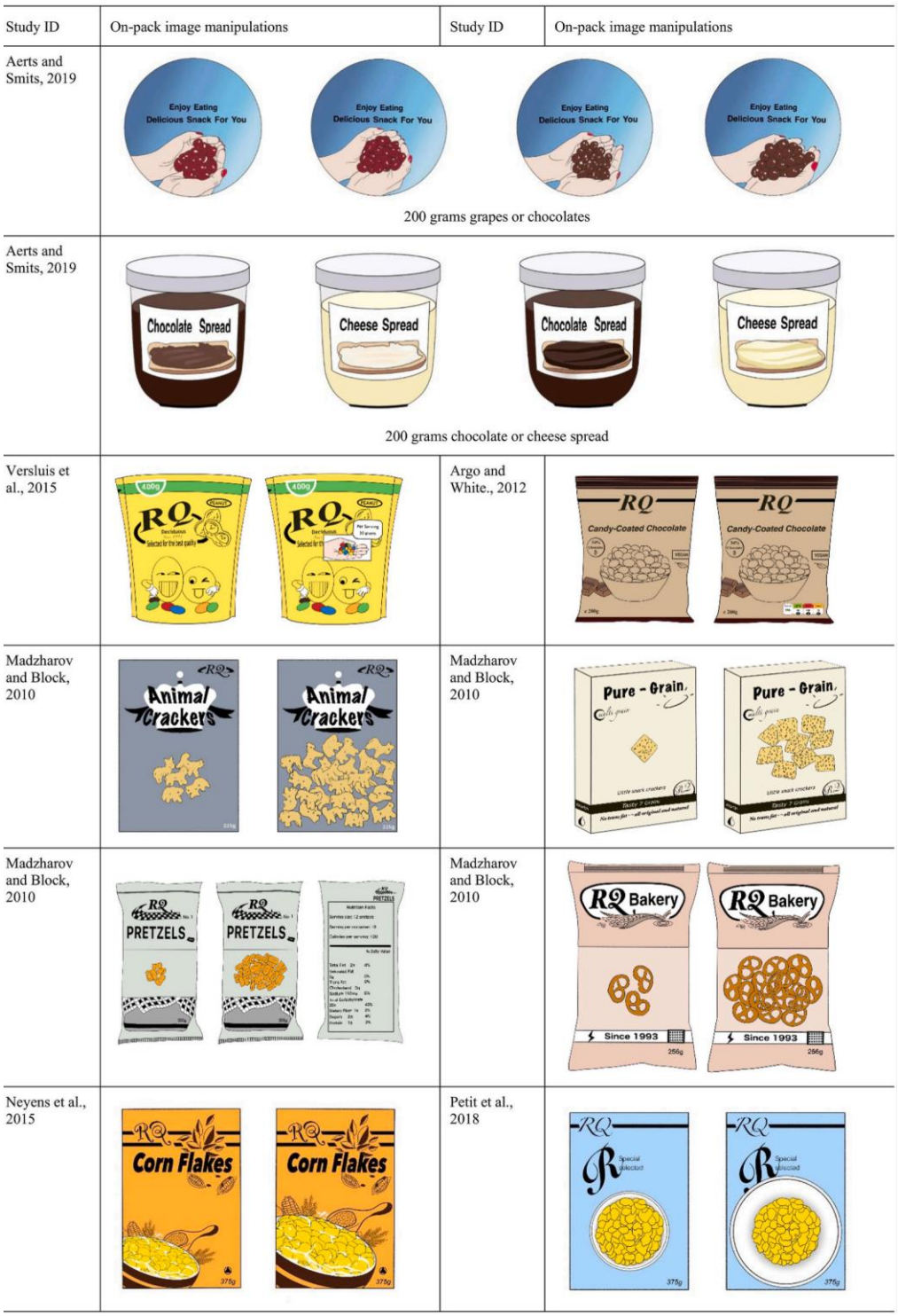


Figure 4.5 Schematic of on-pack cues used in included studies.

(Images were created on the basis of the pictures or description by the original authors)

The number of product units displayed on packaging

Madzharov and Block (2010) conducted four studies to test the unit number displayed on the front of the packaging. In this research, the participants were provided with written information on a card regarding the serving size. Although

the participants were exposed to this information, their consuming behaviour appeared to be unaffected by it. The decrease in the number of units displayed on the front of food packaging resulted in a reduction in food consumption. In other words, consumers consumed less food when they saw fewer food units on the packaging. The interaction between cognitive load and on-pack food unit number on food intake was also found in one of these studies which suggested that people only respond to on-pack product units when cognitive resources are accessible. Another study indicated that visual-processing level influence this impact.

The serving size recommendation sticker

Three studies examined the impact of pictural suggested serving sizes (were displayed as stickers on the packaging) on food consumption. Aerts and Smits (2019) investigated the impact of this packaging attribute on children. One study demonstrated that when the sticker indicated larger portion size it increased the consumption of grapes. However, this was not observed for chocolate nuts, suggesting that this effect is only effective for a relatively healthy food. In the other study, the kids were given bread and different types of spreads. The amounts of spread on the image of the front jar were different. The children consumed less spread on the first slice of bread when they had the jar with the smaller serving size sticker. But there was no change in how much they ate overall for the other slices. Thus, the pictural serving size recommendation may only affect the amount of food chosen at first, while, after that, the total amount eaten may rely on other factors, such as hunger level and food taste. Versluis et al. (2015) compared how many peanuts people ate from a bag that had a serving size sticker on it and one that didn't. The results showed that having a picture of the suggested serving size made people pour less food, but they only ate less food when they noticed the sticker. This implies that alterations in pictural serving size impact the portion that is served, but they may not impact the portion that is consumed, and the on-pack cue only works when it is being noticed. While, this study also set a restricted time frame of 13 minutes for eating, and only 10/89 participants consumed the portion they poured into the bowl, which could potentially impact the results.

The product image size on the front of pack

Neyens et al. (2015) assessed the planned and actual consumption of cereal with children who were shown either a reduced or an enlarged image of cereal on the front of packaging. It is observed that more cereal was poured and consumed from the container featuring a larger on-pack product image, and this impact was more pronounced for the cereal with lower sugar content. Petit et al. (2018) tested the Delboeuf illusion effect (potentially inducing a perceptual bias) (McClain et al., 2014) on the cereal packaging. The portion of cereals depicted remained same, however, they were presented in either a larger or smaller bowl as the image on the front of packaging. The results reported that participants poured a smaller quantity of cereal when they were presented with a bowl having a smaller rim as depicted on the packaging.

The branding cues on the packaging

Three studies by Keller et al. (2012) examined the impact of brand logos on the consumption of children. These studies showed that children had a higher food consumption during dinner when presented with a well-known brand logo on the container, compared to when the packaging was plain. It also revealed that brand cues were found to have a positive impact on the consumption of both nutritious foods (such as carrots and apples) and less healthy foods (such as a gammon and cheese sandwich and chocolate milk). This seven-week randomised controlled trial also confirmed the inclusion of a cartoon character on the packaging served as a significant branding cue, leading to an increase in the intake of healthy food. The intervention group (receiving F&V) in packaging with on-pack cartoon characters during treatment weeks) showed a more pronounced rise in their consumption compared to the control group (receiving the F&V in plain containers across all weeks), both during the treatment period and the subsequent follow-up period. This discovery implies that once consuming patterns are established or altered by packaging stimuli, their impact can last for a considerable period.

The location of the energy content on the packaging

The effect of the energy content location on food intake was only investigated by Argo and White (2012). This research compared the intake differences when the

consumers were provided with the food in a packaging with energy information (traffic label) on the back or on the front or without the energy content. The findings indicated a significant impact of the front of pack energy information, leading to an increase in chocolate consumption among individuals with poor scores on appearance self-esteem (ASE), as compared to the back-pack energy information or no presence of the energy information. In contrast, individuals with high ASE showed no difference in chocolate intake.

4.2.4.2 Effects of structural features of packaging

The predominant packaging manipulation in these studies (21/40) was structural features. 19 out of 21 studies have shown a correlation between structural features and food intake. The findings of these studies indicated that the size, partitioning, and the resealability of the packaging have a significant impact on reducing the intake both in the laboratory and field settings.

Packaging size

The results of five out of seven research indicated a significant impact of packaging size on food consumption. Stroebele et al. (2009) conducted a field study to investigate the effect of a smaller packaging on actual intake. Participants were randomly assigned to receive either 100 kcal snack packages or the standard size packets, and this allocation was alternated for the second week. Reduced intake was observed in both weeks when smaller pack sizes were received. In a lab-based study conducted by Marchiori et al. (2012), it was found that the consumption of sweets decreased significantly when they were presented in a smaller container, regardless of the controlled portion size inside. Aerts and Smits (2017) conducted two experiments, one also validated that a smaller packaging size resulted in less food intake of HED food, but the other study showed that there is no impact on the carrot consumption. Versluis and Papies (2016) did not found the significant impact of packaging size. Nevertheless, it was found that the diet prime can reduce the peanuts intake among the participants having diet goals.

In the study conducted by Eykelenboom et al. (2018), there is no significant impact of packaging size reported. Older adults were offered peanut butter either in a

large or small jar and how much they spread on bread was measured, the results of which showed that the intake was not influenced by jar size. The authors explained the habitual intake may have greater influence than jar size on the amount of spread consumed. The study conducted by Mantzari et al. (2017) also did not find any significant change in consumption across different bottle sizes. The quantity and regularity of providing sugar-sweetened beverages overpowered the impact of packaging size on the intake. The study also observed consumers' liking for the convenience of smaller bottles, which may alter the package size effect.

Packaging shape

Koo and Suk (2016) examined the impact of bottle shape on actual consumption. They found that participants consumed more smoothie from the elongated bottle compared to the wider bottle when they were exposed to the health message related to fruit smoothies. This indicated that the packaging shape has an impact on consumption only when it was paired with a health-related stimuli. Besides, the elongated packaging may create the perception of lower energy content compared to the wider packaging, which might lead the results.

Partitioning of packaging

Five out of five studies confirmed the effect of the partitioning features on food intake. Raynor et al. (2009) provided two types of breakfast foods that either in single servings or non-partitioned packages within a seven-weeks weight-control program. The partitioned packaging led to a significant decrease in the energy intake, indicating that the sub-packaging encouraged portion control. Similarly, participants ate less granola (Bui et al., 2017) and less crackers (Versluis et al., 2015) from partitioned packaging. While Argo and White (2012) demonstrated that individuals with low ASEs consumed more amount of chocolate when they were exposed to partitioned packaging. This outcome is in line with the "partitioning paradox effect" that partitioned packaging decreases the intake of general consumers, but it does not affect dieters unless diet concerns are activated (Holden and Zlatevska, 2015). This phenomenon can be explained by the fact that non-partitioned packaging increase the necessity for individuals with self-

regulatory concerns (Coelho do Vale et al., 2008) to carefully consider and plan their intake, resulting in a decreased intake.

Packaging resealability

Two field-based studies conducted by De Bondt et al. (2017) provide empirical evidence supporting the efficacy of resealability in regulating consumption in both theatre and home settings. Resealable packaging resulted in less intake in comparison to non-resealable packages setting. Interestingly, both studies only focused on HED, small-sized, and palatable snacks including Jelly beans, M&M's, gummy bears, mini cookies and salted peanuts.

Packaging transparency

Six laboratory-based studies investigated the transparency of packaging, all of which indicated a significant effect on food intake. 5 out of 6 studies were conducted by Deng and Srinivasan (2013) on different types of foods. One of the findings is that opaque packaging reduced the food intake compared to fully and partially transparent packaging for the visually attractive cereal (Froot Loops™) and candies (M&Ms) but did not influence the plain cereal (Cheerios™). Another study results showed that transparent packaging reduced the intake of chocolate cookie compared to opaque packaging. In addition, they also measured that less quantity of baby carrots was consumed from the fully and partially transparent packaging compared to the opaque packages. These findings indicated that the impact of packaging transparency is driven by other food factors such as food type, colour, attractiveness, and size. Argo and White (2012) also manipulated the packaging transparency, in which the packaging size was also altered and the levels of ASE of consumers was also measured. The findings indicated that the individuals with poor ASE consumed more candies when they were visible from the outside of the packaging and presented in smaller packages. It could be explained by this type of consumers may tend to rely on external cues to monitor their food intake to help with their self-regulation (Scott et al., 2008).

4.2.4.3 Effects of other packaging attributes

Packaging type (original packaging or plain packaging)

Seven studies investigated the impact of other packaging attributes, including packaging type (original or plain packaging), the presence of packaging itself and the presence of inside toy. Werle et al. (2016) conducted a series experiments to examine the impact of package type on intake. Less food was consumed from original packaging than from the plain packaging in two of these studies. However, this effect was observed exclusively in males. Besides, the presence of fat content label was also manipulated, interestingly, female participants consumed more from the packaging included the "Low Fat" label than from the plain packaging. These studies revealed the effects of packaging familiarity and labelling, which could be modified by gender. While the study conducted by Keller et al. (2012) found a mixed outcomes regarding the effects of plain packaging on children. Specifically, children who were in an overweight or obese status consumed less food from plain packaging. On the contrary, healthy-weight children ate more from plain packaging.

The presence of packaging

Argo and White (2012) conducted three studies to test the effects on food intake by providing food either with or without packaging. All three studies showed consumers ate more when the food was wrapped in several small packages than when it was provided without packaging, just in a bowl. This effect is more significant on the participants with low appetite self-efficacy (ASE). To be specific, one study revealed that individuals with low ASE consumed more candies when they were provided in smaller packages than when they were provided in bowls. As for the individuals with high ASE, there is no difference in food intake between two experiment conditions. In addition, under the packaging condition, the results indicated low ASE eaters ate more when they were informed that the energy content of the food was low than they were informed the food energy content is high or without any food energy information. Once again, high ASE eaters showed no consumption difference in all different information situations. Interestingly, it appears that only low ASE eaters exhibited the paradoxical behaviour of consuming

more food when the package is there compared to when it is not. This may be due to their heightened sensitivity to external stimuli (Polivy et al., 1988).

4.3 Main findings and discussion

40 studies from 23 identified articles, testing the impact of packaging attributes on food intake, were retrieved and reviewed. In general, the majority of the manipulated packaging attributes showed an impact on food intake, with only four studies not finding any effect on intake. Several studies also revealed the possibility of using packaging attributes, such as branding cue (Keller et al., 2012), partitioning (Raynor et al., 2009), and packing size (Stroebele et al., 2009), to achieve a long-term impact on portion control. The research also found that the impact of packaging attributes on food intake could be varied by the other factors, such as participant characteristics, food features and environmental stimuli etc.

4.3.1 Measured effective packaging attributes

Reducing the number of product units displayed on the packaging or suggesting a smaller serving size visually on the packaging (sticker or food product image) could reduce the intake. The study by McGale et al. (2020) also confirmed this effect with cereal that children served themselves and consumed significantly more when they were exposed to the larger portion size image than the smaller one. The image of food product on packaging might be seen as mental simulation, which activate reward, experience, and food-related regions of the brain which was demonstrated by neuroimaging research by Basso et al. (2018). Food presentations might activate social norm processes of consumers (Raynor and Wing, 2007, Sevilla, 2012), indicating that utilising food images to imply small portion sizes as "appropriate" portion to consume is influential and powerful.

Packaging size effect has been supported by many studies identified in this review that smaller packaging size could reduce the intake. Besides, another study provided further evidence of the effect of package size with smaller bottles reducing intake of wine (Codling et al., 2020). More support was provided by study conducted by Reister and Leidy (2022), the results demonstrated that the

packaging size of snacks have significantly influence on the energy consumption in healthy adults in their everyday lives. Partitioned packaging also powerful on portion control. It may be due to the multiple packages physically isolate the food, providing an external "brake" on intake or serving as a reminder to stop the continuous eating. However, for dietary restrainers, partitioning and smaller packaging size may have a paradoxical effect. This may be explained by dieters tend to thinking about food in terms of surrounding factors instead of focusing on feelings normally triggered by food (Scott et al., 2008), thus, the food in small packages is perceived as diet food which lead the overconsumption. Resealability was also proved as a useful packaging cue to help with the portion control. A study by Zuraikat et al. (2018) showed that the option of packaging the uneaten food after a meal reduced overconsumption from large portions the participants were exposed to. This may explain that resealable packaging reduced the intake due to it provide other options for later consumption which may assist with the self-regulation of consumption.

Using opaque packaging can significantly decrease the consumption compared to the transparent packaging when it comes to the visually appealing, small, colourful, and tasty goods. It may be explained by Chandran et al. (2009) that visually appealing food can increase the taste expectation and build trust, thus, when consumers see the appealing food from transparent packaging, they tend to eat more. However, it has opposite effect on healthier foods such as carrots and larger foods like cookies. Transparency could potentially increase consumption by activating expected taste and expected quality (Simmonds et al., 2018).

For larger size of foods, transparent packaging may invoke the self-monitoring, so that helping with the portion control. Regarding the healthier foods (e.g., F&V), the use of transparent packaging may enhance the visibility of the product but does not make it more appealing to consumers.

4.3.2 Other influential variables

4.3.2.1 Impact of food features

The same packaging attributes had varied effects on the intake of different types of food. The healthiness of the food, the attractiveness and the palatability of food and the food format showed close connection to the effect of some packaging attributes.

Food healthiness is one of the factors that differ the impacts. For example, Aerts and Smits (2019) reported that a larger food portion sticker led to an increased consumption of grapes but had no effect on the intake of chocolate nuts. Aerts and Smits (2017) revealed that reducing the size of packaging resulted in less intake of cookie, while it did not change the carrot intake. Furthermore, the consumption of granola was decreased as a result of partitioning, while the cookies consumption was unaffected (Bui et al., 2017).

Sometimes, the impact of packaging attributes on food intake may not stronger than the desirability for certain food. Some packaging attributes are not effective to resist the desirability for sweet foods, especially when it comes to children since they presented extremely strong preference on sweet food (Coldwell et al., 2009, Liem and de Graaf, 2004). According to Aerts and Smits (2017) and Neyens et al. (2015), for foods with low sugar content (less palatability), both smaller packaging and smaller on-pack food product image resulted in a reduction intake. However, these two packaging manipulations had no effect on the consumption of the foods relatively high in sugar (more palatability).

Food format may also modify the impact of packaging attributes on intake. For example, all reviewed studies except two studies, presented the significant effect of the packaging size on food intake. One study is conducted by Eykelenboom et al., (2018), in which the food format was semi-solid food (peanut butter) that the habitual use may dominate the intake instead of the jar size. Mantzari et al., (2017) used liquid (a sugar sweetened beverage), for this format product, convenience may be explained no packaging size effect was found since the smaller bottle may be seen as convenient to carry and consume which balanced the intake difference it supposed to reflect.

4.3.2.2 Impact of individual characteristics

Taking these studies into general consideration, some participant characteristics are showed a high association with the impact of packaging attributes on food intake. These include sex, body weight, visual focus, and the level of ASE etc.

At first, it has been revealed that females and males respond differently to some packaging attributes. The findings of the study conducted by Werle et al. (2016) revealed that males consumed more when the food was presented with plain packaging compared to the original packaging (with brand) or packaging labelled as "low fat". On the contrary, females consumed more when the packaging was labelled as "low fat". Similarly, the study by Keller et al. (2012) also found the sex difference in the results that female participants consumed more from the packaging with a well-known brand than from unbranded packaging, whereas the intake of male participants were not affected by the presence of a brand logo. The interaction effect of sex on the eating behaviour was also reported in the study by Robertson et al. (2020). It tested the impact of the on-pack visual reminder on portion control, while the effect on males is stronger than females. These studies revealed that female and male may show different intake responses to the packaging manipulations.

In addition, the individual bodyweight status also influenced the impact of the packaging. For example, the overweight/obesity consumers ate more from the branded packaging than from the plain packaging, but the individuals with healthy weight ate less from branded packaging. In another study by Wansink et al. (2011), the partitioned packaging helped with portion control. But the main impact was driven by overweight/obesity consumers, the healthy weight consumers showed no significant intake difference to the packaging partitioning status. The less response from individuals with healthy weight status may be explained by the lack of the experience in utilising the external cues in their self-regulation, on the contrary, overweight/obesity consumers have a heightened awareness of these visual food cues (Castellanos et al., 2009, Doolan et al., 2015). Furthermore, Argo and White (2012) revealed the impact of ASE level of consumers that could modify the effect of packaging cues on food consumption. The packaging attributes had a

significant impact on the individuals with lower ASE than to these with higher ASE, indicating that they primarily rely on external cues to adjust their intake, similar to the characteristics of the restrained eaters (Fedoroff et al., 2003). These findings may be understood in relation to heightened reactivity to external food cues in some consumers (Meyer et al., 2015).

Individuals exhibit varying levels attention to the environmental stimuli which means the effect of the packaging attributes depends on whether the packaging design has been noticed. To be specific, three studies (Madzharov and Block, 2010, Versluis et al., 2015) found that the intake only influenced by the product units presented on the packaging and the portion size recommendation stickers when the participants paid attention to the on-pack features of the packaging. Moreover, the findings by Argo and White (2012) also provided the support to this that the impact of packaging attributes on intake is only significant when individuals are not cognitively occupied, allowing them to focus their attention on the packaging attributes.

4.3.2.3 Other environmental stimuli- diet prompts

Several studies have suggested that the effects of packaging attributes were moderated by additional environmental variables, one of which is the activation of diet-consciousness. Four studies raised the diet-consciousness by using varied methods when testing the effect of packaging attributes, including providing information on the energy content of food, requiring participants to complete a body image questionnaire, instructing participants to read a newspaper article about nutrition of a specific food, and showing diet commercials. In sum, these results showed that packaging presence, partitioning, packaging shape and packaging size may not have any effect on food intake without providing a diet prompt at the same time. This aligns with other studies on diet prompts (Buckland et al., 2014, Papies and Veling, 2013). The study by Buhrau and Ozturk (2018) also indicated the inclusion of healthy eating advertisements in packaging design, such as pictures and text, has a noticeable impact on consumer eating behaviour.

Conclusion

As far as we know, this is the first review that systematically summarised the influence of various packaging exposures on food intake from 40 studies of included 23 articles. This review offers a comprehensive analysis of how various packaging aspects affect food consumption. The packaging attributes were clustered into three main categories (on-pack cues; structural features and other packaging manipulations), although these categories were somewhat broad and inclined to some degree of overlap. Overall, more than 90% of the studies reported packaging exposures leaded intake changes which revealed that most tested packaging attribute are effective on portion control.

On-pack images (e.g., the number of product units displayed on the packaging or visually suggesting a smaller serving size) and structural characteristics (e.g., packaging size, resealability, portioning and transparency) of the packaging are found effective to help with portion control. Moreover, some other variables could modify the intake behaviours, including the food features (e.g., food healthiness, attractiveness and format), individual characteristics (e.g., consumer sex, body weight status, visual attention, and level of ASE), and other environmental stimuli (e.g., diet-consciousness activation). However, due to its an emerging field, there is still more packaging features have yet to be thoroughly investigated. Nevertheless, based on this review, packaging can be seen as a valuable tool to guide the consumption for foods and beverages. These investigated packaging attributes can serve as various forms of nudging (e.g., soft push; guidance) (Arno and Thomas, 2016, Cadario and Chandon, 2020), to either encourage the intake of healthier food or help limit the consumption of highly palatable, HED items.

This chapter provides a comprehensive summary and experimental data supported interpretation of the impact of various packaging attributes on food intake, as well as other relevant variables, based on the identified studies. The next step is gaining insights from the consumer perspectives to further understand the packaging deign on promoting healthy eating. Specifically, further studies were designed to identify which packaging attributes capture consumers' attention, what elements influence their food consumption, and the factors that determine their portion size decisions in their daily life.

Chapter 5
CONSUMER PERSPECTIVES ON FOOD AND DRINK PACKAGING

Previous research reviewed in Chapter 4 showed the significant impact of food packaging on intake through controlled experiments. However, the consumer perceive in natural setting and the complexities of portion decision-making in real life may be not captured in experiments. Thus, this study recruited consumers to describe the packaging of the food product they purchased to achieve the following objectives : (1) to capture the eye-catching packaging elements; (2) to explore which packaging attributes are influential on their intake based on their experience; (3) to investigate how consumers interact with the food packaging and utilise them in their portion decisions.

5.1 Methods

5.1.1 Photo-elicitation method

This study applied a qualitative and exploratory method: photo-elicitation, to elicit insights and explanations from adult consumers. Due to its benefits on deep level discussion and rich dimensions it covers, it is widely applied in Anthropology, Sociology, Psychology (Dowdall and Golden, 1989, Green et al., 2021, Harper, 2002). It is also used in design to elicit insights and explanations, but usually called as “culture probes” (Gaver et al., 2004, Mattelmäki, 2005). The description and discussions of the photos they took help them feel more control in the following interview and help researchers better interpret their responses (Loeffler, 2004, Van Auken et al., 2010). The ethic review and protocol of this study was approved by the School of Design Ethics Committee (LTDESN-139) (see Appendix 3).

5.1.2 Study procedures

Each contacted individual who showed interests in participation was sent with consent form and a description of the study procedures. Consent form and the demographic information (including gender, age, weight, height and dieting status)

of participants were required send to the researcher if they agree to take part in this study (details are presented in Appendix 4). Then, participants were informed the instructions of the three tasks: (1) Take five photographs of packaging that are with salient ("eye-catching") elements respectively from the breakfast, meal, salty snacks, sweet snacks and beverage; (2) Take five photographs of food packaging to present where the packaging helped attend to portion size/ serving size from the same food contexts that mentioned above (while, the photographs of the food packaging that made consumers feel confused about the portion size could be taken instead if it is hard to find suitable helpful food packaging examples in any food category); (3) Participate an online interview to discuss the photographs and answer some food packaging related questions. Each participant was required to upload the photographs they took for this study through a secure link. Once the uploaded photographs were received, arrangements were made for follow-up online interview. Figure 5.1 presents the timeline and procedures of the study.

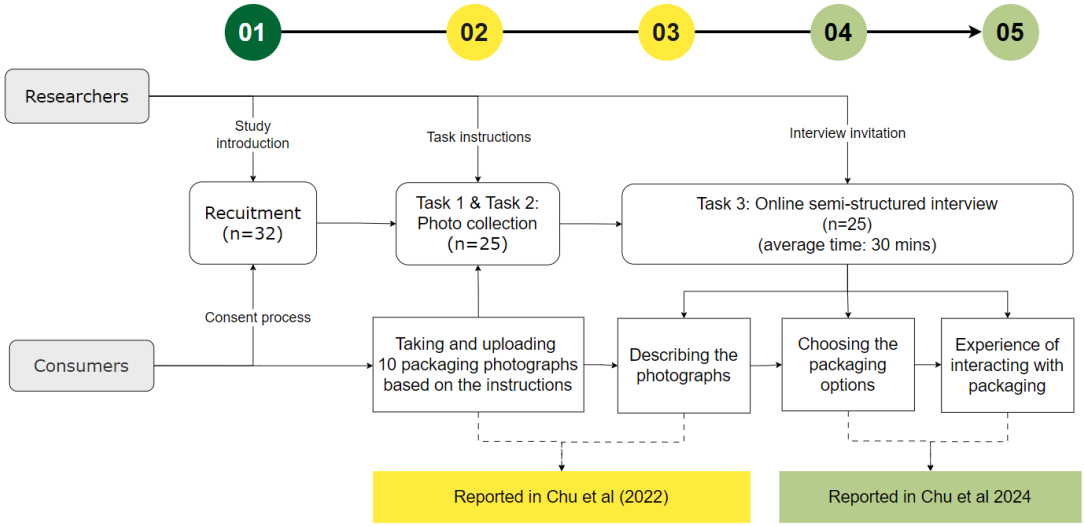


Figure 5.1 Procedure of this photo-elicitation study with consumers.

There are three main sections during the semi-structured interview (see Appendix 4.3 for details). The interview began with the interpretation of each photograph and the rationale behind it. Then, 21 food packaging feature and related options were provided to participants, from where they were required to choose at least five options that influence their portion size decisions and provide the justifications. Subsequently, participants were posed to some open-ended

questions to investigate how they use the serving size recommendation on the food packaging and how they determine the food portions they consume. In addition, they have the opportunity to provide any suggestions or expectations on how packaging can be improved to contribute to portion control.

5.1.3 Participants recruitment and their characteristics

Participants were informed that this is a study that aimed to examine current packaging and develop the new packaging of food or drink. In total, 32 participants have signed the consent form and sent it back to the researchers after reviewing the details about secure data storage, anonymization of data, and the right to withdraw at any stage. However, seven of participants withdrew from the study, some due to the impact of the pandemic, while others did not provide a specific reason (one option stated on the consent form). Therefore, 17 females and 8 males consisted of the final sample (N = 25), completing all the tasks of this study. The participants were consisted of 16 Chinese, 7 British, and 2 individuals of other nationalities, ranged from 20 to 32 years old. The majority of the participants in this study (23/25) were full-time students at the university and possessed a bachelor's or higher degree. Based on the body mass index (BMI), 64% of the participants (n=16) were in healthy weight status and 28% (n=7) were in overweight status and 8% (n=2) were in underweight status. 60% of participants (n=15) reported that they were not restrain their diet to lose weight. Table 5.1 presents the demographic information of the participants in this study.

Table 5.1 Descriptive characteristics of the participants.

Participants	Mean ± SD (n = 25)	Range
Female: Male (ratio)	17:8 (68%:32%)	-
Not dieting: Dieting (ratio)	15:10 (60%:40%)	-
Age (years)	25 ± 3	20 - 32
Weight (kg)	65 ± 13	48 - 90
Height (cm)	167 ± 9	152 - 189
BMI (kg/m^2)	23 ± 3	18 – 29
Native English speaker*: Others	9:16 (36%:64%)	-

**Most participants' first language is Chinese which is as the same as the researcher.*

Each participant was assigned a study ID (gender (male (M) or female (F))-number-diet status (dieter (D) or non-dieter (ND)) In order to establish an ID context for the quotation. For example, F_01_D means a female participant, the first participants, and she is on a diet.

5.2 Results of the photo reflections

According to the photographs and the explanations consumers provided, three aspects of themes were generated. (1) Participants pointed out some packaging design created confusion around portion size, either because portion information was unavailable, or the existing guidance made it difficult to accurately portion out the food. (2) Consumers tend to pay attention to the packaging elements that could build trust, arousing appetite, and find self-identity from the products. (3) Structural reminders, health prompts and some portion stimuli were considered to be effective in enhancing the portion size awareness.

5.2.1 What packaging design created confusion around portion size?

The results showed that there is portion confusion when the portion guidance was absent. Besides, if there were no clear methods for portioning out food products due to the inconvenience in understanding or application, misleading or confusion about the portion may be aroused. Table 5.2 presents the packaging image and relevant quotations to support the findings.

Specifically, portion guidance was absent on the packaging of some food products, such as some amorphous foods (i.e., jam) or some food products that there were a large number of units are packaged together (i.e., candy, nuts). With the absence of explicit serving sizes, participants expressed uncertainty regarding the suitable amounts for a single setting. Besides, in certain contests, they believed that this lack of information promoted over-consumption and induced feelings of guilty. In addition, while some food packaging does provide portion recommendations, these are often difficult to notice or implement, leading to challenges in following the suggested portions. For example, the texts font may be too small or hard to locate (e.g., on the back of the packaging and among a huge amount of information). In

other cases, it is challenging for consumers to portion out which prevented them from following the portion instructions. Specially, participants expressed that it is difficult to convert the weights information to actual portion measures. For example, when a serving of chips is suggested to be 30g, the consumer has no specific idea about how many chips are 30g.

Table 5.2 Packaging design that created confusion on portion size

Portion guidance omission		
 Image a	 Image b	*It is not controllable because it didn't say anything about the serving. How many spoons of this jam will be enough for one person? It didn't say anything. That's why sometimes, I feel I eat too much and feel guilty. (F_11_D) (Image a)* *The roasted pistachio tastes really good, once you start, it is hard to stop …… I am not sure if there is any suggested amount for each time. Just imagine that you are watching TV, having fun with your friends, it is really easy to overeat. (F_09_ D) (Image b)*
Inconvenient to portion out		
 Image c	 Image d	*The nutrition and serving size information is on the back, not very obvious. The on-pack image also has nothing to do with the portion size or something. So, I think its portion size is quite confusing. (M_18_ND) (Image c)* *Although one serving is about 30g which is written near the ingredient table, the number still needs to be further calculated, which is difficult to know what the portion is it refers to. If I consumed a handful of chips, I can't intuitively link the portion to the gram. (F_01_D) (Image d)*

5.2.2 What packaging features consumers typically pay attention to?

5.2.2.1 Trust building

The results showed that consumers' attention was usually directed on the attributes that contribute to the trust building. Some consumers reflected that packaging served as a method of establishing trust between themselves and the food products due to the present of some packaging attributes (see Table 5.3). The transparent panels of the packaging offered a sense of reassurance regarding the contents inside, which let the consumers be able to see the "real" product instead of an idealised image representation. This makes consumers felt they can trust the product since they know what they would get. Similarly, the realistic food image

provides a “real” vision of the food product that raised the trust to the product. Furthermore, certain claims, such as "pure" and "premium" gained attention from consumers by conveying the "quality" of the products, which evoked a sense of trust to the product. In addition, some participants found images depicting ingredients were eye-catching because these images directly provided a simple communication to inform the main information of the product without the use of words, which also makes food authentic.

Table 5.3 Packaging design that contribute to the trust building.

Transparent element		
 Image a	 Image b	*I suppose there is a see through in the middle, so you can see what is actually in it. And you can compare it with the picture. In the middle, (it) makes you focus on the real product. (M_17_ND) (Image a)* *I can see both the food image on pack and the real food inside the pack through the transparent window. And they are similar which wins more trust from me. (M_07_ND) (Image b)*
Realistic food image		
 Image c	 Image d	*The image of rice cakes is close to the real product, which is attractive, it is similar like the transparent packaging that I can see what the products looks like. (F_24_ND) (Image c)* *Also, there is an image of the real ice cream which makes me feel it is quite delicious. (F_25_ND) (Image d)*
Quality claims		
 Image e	 Image f	*There are lots of seaweed I could pick, but I think it also says “PREMIUM” on the top pf the packaging as well, so I will say it is in good quality. (F_13_ND) (Image e)* *It seems like there are a lot of “pure” elements on the packaging. (M_14_D) (Image f)*
The image of ingredients or flavour		
 Image g	 Image h	*The ingredient of the food has been shown makes me know quickly about it and trust it. (F_05_ND) (Image g)* *It shows the original ingredients, the comparison between the original food and the product inside makes it more attractive, I think. The picture of jelly is quite real. (M_15_ D) (Image h)*

5.2.2.2 Appetising

Some packages were reported to stimulate the appetite by incorporating eye-catching visual elements, including the bright and high contrasting colours of packaging, on-pack food renderings (displaying the ideal presentation of the food once it is prepared) (see Table 5.4). Bright colours, such as red, yellow, green, and orange, were seen as visually attractive, especially the contrasting colours (e.g., red and black) were applied at the same time on the packaging. These colours increased the perception of the freshness and the quality of the product which made the consumers appetising. Participants also found it is appealing to have a visual depiction of the prepared food (especially the meal) on the packaging. The food renderings stimulated the imagination of the "delicious taste", making the food product enticing and appetising.

Table 5.4 Packaging attributes stimuli the appetite.

Bright or contrasting colour		
 Image a	 Image b	*The yellow colour used in the whole package makes me feel it is very refreshing. This colour also increased my appetite. (CP_15_M_D) (Image a)* *This packaging could increase my appetite. The combination of the black and red colour makes it high in quality, quite different from other crisps, just a feeling. (F_08_ND) (Image b)*
Food renderings		
 Image c	 Image d	*It showed what the food would be like after the processing which increased my appetite. (F_04_D) (Image c)* *The image of the food after it has been processed. I couldn't stop imagining how delicious it would be. (F_05_ND) (Image d)*

5.2.2.3 Self-identity

Some packaging elements were identified as eye-catching due to their association with customers' values or identities, such as their pursuit of health goals or their interest in their own or other cultures (see Table 5.5).

Some on-pack claims which reflected the healthiness of the product (e.g., "no added sugar", "less fat" or "high fibre") from the component perspective drew attention from the consumers. They were especially important and appealing to

the consumers with health goals, for example, the consumers on a diet tended to pay more attention to the descriptions aligned with their goals of healthy eating. Besides, these claims were presented on the packaging in a way that stands out from its surroundings, making them easier for consumers to notice. Furthermore, the recognition of cultural identification through texts, presentative national icon/image or symbolic design style was eye-catching and appealing for some consumers. Interestingly, participants were not only drawn to packaging that incorporated elements from their own culture, but also interested in some features from other cultures they knew.

Table 5.5 Packaging attributes that were associated with values and self-identity.

Health claims		
 Image a	 Image b	*There is no added sugar in it. I do look for that, so, this is "no added sugar". (F_13_ND) (Image a)* *The different coloured label on the side, it kind of tells me it is for veggies, high in fibre and there is no refined sugar. So, I am quite interested it because I am trying to eat as healthy as I can. (F_24_ND) (Image b)*
Culture interests		
 Image c	 Image d	*There is a nice panda logo, a kind of Chinese style. (M_14_D) (Image c)* *The packaging gives a kind of Scottish feeling, the red colour and the green colour that like reminds me (of) the Scottish kilt. (F_19_ND) (Image d)*

5.2.3 What packaging attributes has been noticed influential on intake?

5.2.3.1 Structural segmentation

Some structural characteristics of the packaging were seen as portion cues to restrict the consumption of a single serving, including the partitioned packaging and individual/single servings (see Table 5.6). To be specific, it is noted that when a large packing contains numerous small packs, it helped limit the over-consumption. Besides, the pre-packaged servings also served to maintain product freshness and restrict intake. Furthermore, participants indicated that they typically ate less when buying the product in a smaller, individual packaging, perceiving it as a convenient way to control the intake and avoid food waste.

Table 5.6 Photographs and elicited commentary: structural segmentation.

Partitioned packaging		
 Image a	 Image b	*This product includes eight packs. I understand that one pack (is) just for one serving...Actually, they didn't say anything about serving portion, but I can understand that one pack is just for one time as a snack. (F_11_D) (Image a)* *The individual package of the crisps will at least guarantee that I can eat a small portion rather than eating too much at once. (F_19_ND) (Image b)*
Individual servings		
 Image c	 Image d	*These are smaller pots, I can use these if I am going to work, I can take this small pot with me. One pot one portion. (M_23_ND) (Image c)* *As you can see, it is a handful package. It is quite small. I can hold it with one hand. So, I guess it is perfect for one portion. (M_15_D) (Image d)*

5.2.3.2 Health-related prompts

The health-related prompts on the packaging were considered as a main factor for the decisions to purchase and consume in some consumers. Table 5.7 presents the provided photographs and related quotations.

Table 5.7 Photographs and elicited commentary: health-related prompts.

Independent energy content		
 Image a	 Image b	*It is more appetising as a healthy snack. The fact is that on the packaging it says it is 102 calories, very clearly. (F_20_D) (Image a)* *If you were cautious about the portion size, it has the "40" at the bottom. It means it is 40 calories, if you are cautious, it will be there for you to notice that it is like a low calorie. So, I think it is a good option for hot chocolate. (F_21_ND) (Image b)*
Traffic lights		
 Image c	 Image d	*On the top of the packaging, you got different colours, red, amber or green on the amount of the nutrition information. When you see those things, you will think, ok, maybe the portion size should be smaller. So, it is quite helpful. Especially, when it is something red on it. (M_17_ND) (Image c)* *It clearly shows the nutrient contents of the whole can. To me, it is a kind of standard portion for one sitting. There is no red label which means it is quite healthy. (F_25_ND) (Image d)*

To be specific, a clear numbered on-pack energy (kcal) content (as shown in table 5.7 image a and b) was acknowledged as a significant and prominent signal to the portion decision. It was also noticed that the number was usually highlighted that using design to make it eye-catching. Furthermore, consumers reported that the nutrition and energy content on the packaging, specifically, “traffic lights”, worked as a portion reminder. The colour red indicating a warning for high content of macronutrients (e.g., high fats, high sugar), whereas the colours green or amber represent lower levels of content. These results indicated that individuals valued a straightforward, visually salient and health-related prompts on the packaging when making decisions about portion sizes.

5.2.3.3 Portion awareness stimulus

Some attributes of packaging prompt consumers to think about portion sizes, including the transparent or partial transparent packaging and the suggested unit number displayed on the packaging (see Table 5.8).

Table 5.8 Photographs and elicited commentary: portion awareness stimulus.

Transparency		
 Image a	 Image b	*The packaging is partially transparent. I can see the puff biscuits inside and I think there are quite a lot and can be consumed multiple times. (F_02_ND) (Image a)* *It is transparent, you can easily observe how much you eat and how much is left. (M_03_D) (Image b)*
On-pack unit content		
 Image c	 Image d	*It includes eight bars. It means one bar is equal to one portion. I notice the number “8” on the packaging, so I know the meaning. (F_11_D) (Image c)* *It tells me there are nine bars inside the packaging. So, I know I may eat just one bar each time. (F_10_ND) (Image d)*

The transparent panel made the remaining amount of food in the package easily be observed by consumers, aiding in the management of intended consumption. The unit number displayed on the packaging was also seen as a significant indicator for portion size by some consumers. These packaging attributes provide an intuitive

stimulus in relation to the awareness of the portion size and intake planning among consumers.

Overall, these results revealed the portion confusing situation: portion guidance omission or inconvenient to portion out. In addition, the attributes of packaging that contribute the trust building, appetising, presenting a consistent or interested value identity were eye-tracking for the consumers. Furthermore, the results also indicated the prominence of structural segmentation, on-pack health-related prompts and the value of some portion awareness stimulus on portion control. Figure 5.2 illustrates above results. Unexpectedly, no participants in this photo reflection stage noted the serving size information, indicating it is not significant to consumers. Besides, no consumers considered it is influential to the intake.

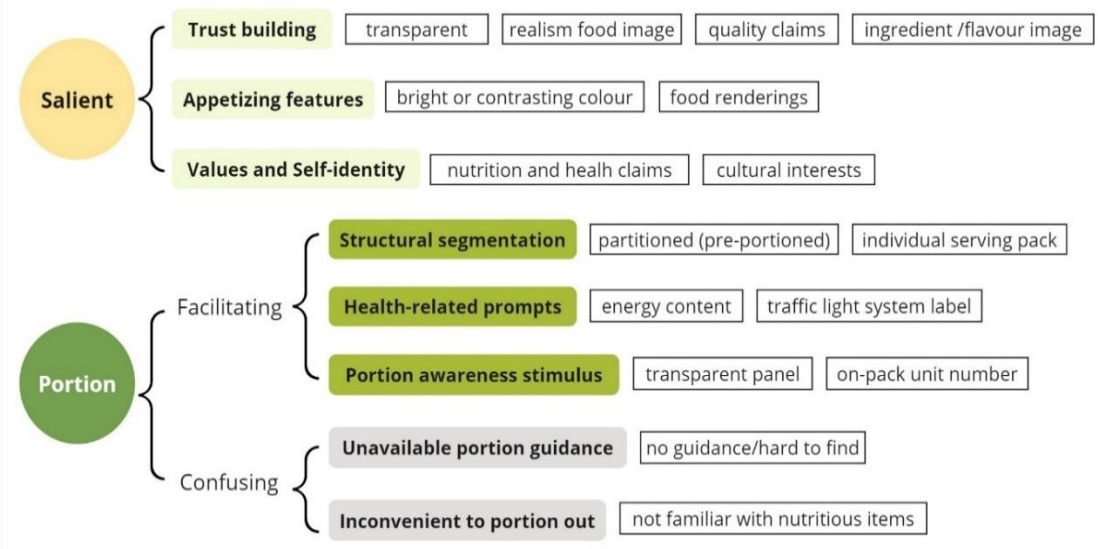


Figure 5.2 Summary of the photo reflection.

5.3 Results of the further interview

5.3.1 The results of the portion related factors

Participants commonly associated packaging size and on-pack weight quantity, considering them to be the primary factors influencing their food intake. As the size of the packaging increases, there is a corresponding increase in food/drink consumption. In addition, the energy content and its positioning (i.e., on a pack, on the front, in the corner) also differed customers' intended consumption. To be specific, some participants would reduce their intake upon realising that the

product has a high energy content. The packaging's portioning and resealability were identified as variables in the decision-making process regarding portion size. Specifically, they preferred following the pre-arrangement of the packing and tended to eat less when resealable packaging was available since the packaging can easily make the food last longer. Figure 5.3 displays the frequency of participants' selections that had an impact on their portion decisions.

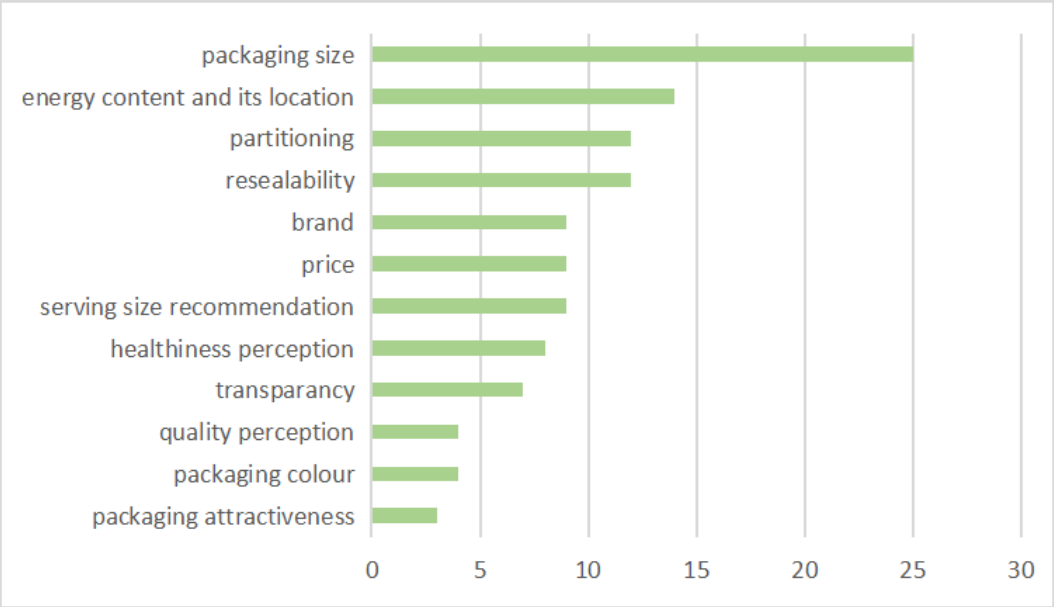


Figure 5.3 Frequency results of the influential packaging related features. (choosing up to 5 options from 21 packaging related features in portion decisions).

Some overarching themes were generated based on the participants' responses in the interview. Several participants indicated that they usually ignore the on-pack recommended serving size due to their indifference towards the recommended portion and their actual intake. Some participants regarded serving size as a reference for the restrained diet. Interestingly, the attitude of “resistance” towards following the on-pack textual serving size information was revealed among some participants. Some packaging attributes, such as packaging size, partitioning, and resealability, were deemed acceptable and beneficial for portion control. The perceived healthiness of a product can be seen as a reminder for the intended portion to be consumed due to the health concern of consumers. However, certain health-related clues on the packaging might be misleading and viewed as permission for overeating. In addition, the individual context of the eating is also a

key factor to the portion decisions, including the food type, the state of the hunger and the emotions of individual. Figure 5.4 outlines the main themes, sub-themes and their relationships. Four main themes were introduced in detail below.

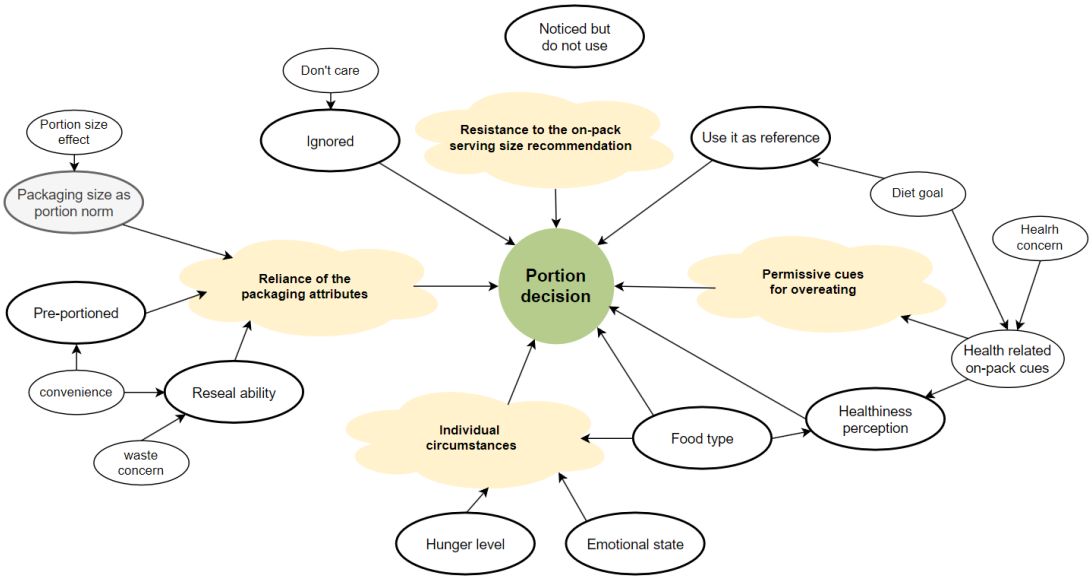


Figure 5.4 The portion decision related themes generated from the qualitative data of the interview.

(including the initial sub-themes (presented in oval shape) and the summarised four main themes (presented in cloud shape).

5.3.2 Deliberate resistance to the on-pack serving size recommendation

Many participants reported that they did not consult the serving guidance on the food packaging due to their indifferent to the portion size or had never paid attention to it and some even expressed some sort of resistance to the recommended serving size (see Table 5.9). To be specific, some participants argued that they have the freedom to consume any amount they like instead of following the “rules”. They also preferred avoiding any restriction on eating. Besides, some considered checking the portion instructions is time-consuming and they were capable of decide their own intake independently without relying on any extra recommendation. This view was particularly shown for beverages, indicating that consumers typically ignored any portion limitations on liquid food.

Table 5.9 The resistance to the on-pack serving size information.

ID	Quotations
F_13_ND	"I don't like to follow any rules, any serving recommendations. So, I do not really check."
F_08_ND	"I don't like to check. And I don't like to be restricted. I think I can control by myself."
M_03_ D	"The point is, I bought it, I can eat/drink any portion I want."
M_18_ND	"Probably not. The main reason is I think it is rare to see such information on the food I usually buy. And I don't like to find it either. I do notice that most of the drinks would tell you how many servings it contained, but, still, I won't follow it because I only drink it with meal, I won't drink too much"
F_20_ D	"If I have a goal or something, I would like to know my portion size more than anything. Especially when it is lockdown, I won't look at that, I just eat everything."

5.3.3 Reliance on packaging attributes

Results showed that the portion size decision was affected by the design features of the food packaging which were supported by the content in Table 5.10. Some consumers realised the correlation between large packaging and overeating, based on their daily experience. Consumers expressed the intention of consuming the whole contents in a single packaging which demonstrated that customers considered packaging as a general portion norm. To be specific, consumers may eat the whole pack even if the food inside was supposed to be consumed by more individuals or for multiple servings. Besides, when the packaging designed into single serving pack, it assisted in restricting their consumption. Interestingly, some consumers reported their preference for a smaller package size even if there is lower value for money compared to the bigger packaging options due to the waste and health concerns. In addition, the presence of partitioned packaging or resealable functions of packaging also helped with the portion control, particularly for snacks and beverages. These features provided convenience to consumers in supporting the portion control.

Table 5.10 The quotation presented the reliance on packaging attribute.

ID	Quotation
F_10_ ND	"When the packaging size is small, I will eat less, when it is large, I may eat all as well, which means I will eat more."
F_06_ ND	"I usually choose the small one. I am trying to eat less junk food and avoiding food waste. I will still accept it if the smaller one is more expensive, I mean it is less value for money comparing with the bigger pack."
F_20_ D	"It makes you feel like it is not a one setting kind of thing. You feel like it is not supposed to be eaten at one time."
M_17_ ND	"I usually plan the amount I think I should consume and then during eating if you feel like full or something, then I stop eating. For snacks or drinks, it depends, if they have been already portioned out, I will just eat the portion. If they are not, I will probably eat until I don't want to eat any more."
F_13_ ND	"I can reseal it, Oh, you don't need to eat it all once I open it, like it just makes everything easier."

5.3.4 Permissive eating cues

Participants indicated that they were more likely to consume less portions when a food is labelled as high calorie since they are concerned about their health. Because of that, the perception of the product being healthy was understood as a permissive indicator for consumers to eat more in that it is acceptable to have more "healthy" food. For example, the "low-calorie", "baked instead of fried", and some other health related claims were seen as the permission for more intake. Furthermore, compared to those who are not on a diet, individuals who are following a diet exhibit a greater level of attention towards the healthy/nutrition-related claims provided on the packaging. Participants also expressed that if a product is considered to be healthy, it could be consumed without feeling guilty. Permissive cues of packaging is a compelling illustration of the "Snackwell effect" (Walsh, 2014), where the promotion of low-fat or low-calorie foods actually leads to an increase in consumption, even overeating, which negating the intended benefits of eating food that with reduced fat, sugar, and energy content. Table 5.11 presents the comments details from the participants.

Table 5.11 Packaging cues that were seen as the permission for eating more.

ID	Quotation
F_24_ ND	"If it is like unhealthy food and the portion size is made very obvious, then I will pay attention to it."
F_22_ ND	"I probably eat more when I think the food is healthy."
F_20_ D	"If I know something is low calorie, I will happily eat more of it. Like if it is a big bag of popcorn, you won't feel that guilt. If it is a whole cheesecake, you may feel guilt more."
F_13_ ND	"If it looks healthy, it is fine to eat more."
F_19_ ND	"I think I would eat more if I saw the food as healthy."
M_18_ ND	"I tend to eat more if I think it is a kind of healthy food. If I know it will lead to gain weight, I won't eat too much."
M_07_ ND	"When I notice the food is low in calories, I will be happy to eat more. Similar effect if it is organic or non-fried food. When there are some expressions on the packaging that reflect the safety and health of food, I will eat more."

5.3.5 Individual feelings and circumstances

Participants also reported some individual factors that influence their intake, such as their level of hunger, emotional status, and social situations (see Table 5.12). Particularly for meals, several participants showed their reliance on their hunger feelings to determine the timing and the intake. There is high chance that higher hungry level may make people be more likely to respond to packaging that presents larger portion size or convenience. Sometimes, eating food is one of the approaches to seek comfort, thus, the portion size is not considered by consumers during the eating in this situation. To be specific, some consumers ate chocolate or other snacks when they felt depressed, they would not pay attention to the portion, they just wanted to eat more. The food or packaging convey a positive emotional value tends to be more attractive to consumers. During certain circumstances (e.g., social events or family reunions), individuals may not consider the intake since their primary focus is to enjoy eating and the social interaction, rather than imposing restrictions on food choices or limiting the consumption. Thus, under some social contexts, packaging that is visually appealing or easy to share may be more attractive for consumers.

Table 5.12 Individual feelings and the context are involved in portion decisions.

ID	Quotation
M_16_ND	"I do try to only eat when I am hungry. So, I usually decide how much to consume based on how hungry I am feeling and how much physical activity I did during a day."
F_02_ND	"For meals, it truly depends on the degree of hunger. For a beverage, it depends on the capacity of my cup, I just drink a cup of cola. For Doritos, I will eat them all after opening the packaging. For cakes, I just eat whatever I can and then put the rest into the fridge."
F_11_D	"For snacks, chocolate, I think they are for emotional eating, you will eat it when you feel depressed. In the evening, I just want to eat some snack. I am not hungry, I just want to eat something. At that time, I don't read the serving portion because sometimes I eat too much, two- or three-persons' portion."
F_20_D	"If I am in a social situation and I am enjoying myself, I just wouldn't think of that. If I have a goal or something, I would like to know my portion size more than anything. Especially when it is lockdown, I won't look at that, when it is lockdown, I won't look at that, I just eat everything."

In sum, participants reported that they rarely attend to serving recommendations on the packaging and indicated some resistance to them. Some structural features (small/single serving, pre-portioned and resealable packaging) were identified as facilitators of portion control. In contrast, the healthy perception of the product from packaging attributes were described as a permissive cue to eat more of the product. Sometimes, current context (hunger, emotion, social circumstance) presented a barrier to healthy eating.

5.4 Consumers needs and suggestions

Participants provided some suggestions on the packaging design for promoting portion control and healthy eating, highlighting into four aspects.

- *Highlighting the healthiness of the product*

  It is important to clearly deliver the message regarding the product's healthiness. Consumers prefer visually salient and comprehensible information to be seen on the packaging.

"I hope the packaging can better reflect the healthiness of food, highlight the low calories if it is. I think it will be so helpful to the people who care about healthy eating." (M_15_D)

"I would say maybe the food can tell you it is really high in fat or high in salt in big, bold letters. Because I think currently it is just the tables on the bottom, if it is really high in fat, it should be in big bold letters. Sometimes, the food may be considered as healthy food, but they are actually not…. so, it is necessary to let people aware and understand it." (F_22_ND)

- *Presenting obvious and clear portion related information*

  Besides, the portion size-related information or image should be highlighted on the packaging to gain attention from consumers.

"I think the portion related recommendation should be highlighted. Make them more obvious, like on the front rather than on the back. Sometimes I need to find really carefully some kind of recommendations which could be improved." (F_10_ND)

"Some unpartitioned products may give the nutrition information for each serving, however, I used to be misled that it is the calorie of the whole pack. I would think it is so healthy because of the small numbers, then I happily ate the whole pack without any concern. But the truth is I had too much energy intake. I hope such things could be avoided somehow." (F_25_ND)

- *Providing single serving and offering multiple sub-packs*

  It was also suggested to offer single serving and multiple sub-packs, which provides consumers with convenience to reduce waste and limit the intake.

"A smaller portion, a handful size maybe, will let people have a sense that it is for one serving." (M_15_D)

"It is hard to find a smaller portioned product that is suitable for one person. Once it is opened, you can never keep the taste the same as before...you will just eat the whole big pack without noticing, you can't imagine how many calories you consumed." (F_12_D)

"I do hope food could be divided into small packs or for a single serving. Like the biscuit, it will be helpful if fewer pieces are in a small pack." (F_04_D)

"The Kinder chocolate, when we open this product, we just face different separate packages. I think it is a good strategy to control the portion. Also, it will be beneficial for keeping the product fresh and its flavour." (F_11_D)

- *Understandable ways to present the portion recommendation*

  Additionally, visualising the content by presenting energy content in more understandable way has been suggested, for example, using an equivalent number of eggs to show the appreciate portion for single serving.

  "Find more ways to show the recommended portion or remind people about the intake, like providing other images as references." (F_05_ND)

  "Quantify or visualise the ingredients to something people are familiar with. For example, if the food is high in protein, I would like to know it is equal to how many eggs? Also, the calories in numbers. It is hard to understand. I prefer that the packaging could tell me the calorie of this food equals how many bowls of the rice. I think it is a more direct way to explain such information." (F_08_ND)

5.5 Findings and discussions

Overall, the results reflected issues around the current packaging where raise the confusion regarding the portion size, the ignorance and resistances to following the on-pack textual serving size recommendations and some health-related cues seen as a permission of overeating. Furthermore, the eye-catching packaging attributes, the attributes facilitating the portion control and how participants use packaging cues to make portion decisions have been revealed. Besides, some design suggestions were collected from the consumers. Based on these findings above, three consumers values were revealed to explain the portion decisions and several suggestions for food packaging design are proposed in the following sections.

5.5.1 Consumer values on food portion decision

5.5.1.1 Autonomy control

The findings of the present study indicated that participants tend to ignore the recommended serving sizes provided on the packaging, and some even admitted to intentionally disregarding the recommendations provided on the packaging. Similarly, EU Guidelines for Daily Amounts labelling did not affect soft drink portion choice in a field experiment (Vermeer et al., 2011). Current finding also corroborates a previous review (Faulkner et al., 2012) which found that there is less

willingness among consumers to follow the serving recommendations, although acknowledging the potential usefulness (Vermeer et al., 2010, Anderson et al., 2008). This finding revealed that although individuals may be aware of serving size recommendations, this does not always result in changes in their eating habits which is known as the knowledge-behaviour gap (Juvan and Dolnicar, 2014, Scholes-Balog et al., 2012).

Participants demonstrated a noteworthy level of autonomy and control over their food intake. Consumers tend to understand it as a way to limit their food options and consumption by an external authority, which might result in emotions of frustration, defiance, and opposition. According to Self-Determination Theory (Ryan and Deci, 2017), individuals play an active role in making decisions about their behaviour rather than being passive influenced by external factors. Thus, it can explain that individuals who exhibit a greater refuse to portion suggestions due to their stronger needs to control over their own eating behaviours.

Partitioned packaging and resealable packaging were reported as facilitator for the portion control which are consistent with the previous findings (De Bondt et al., 2017, Raynor et al., 2009) that confirmed the impact of these packaging attributes on food intake. One explanation of why consumers found these packaging attributes more acceptable compared with the textual serving size recommendations is that they create the perception of a wider range of portion options are provided which makes consumers have a greater sense of control. For example, consumers can choose to eat one sub-pack or two or more from partitioned packaging. Similarly, they also feel a sense of autonomy in deciding whether and when to use the sealing function of the packaging. According to Veitch and Gifford (1996), increased choice leads to a greater sense of control, resulting in a favourable impact on acceptance.

5.5.1.2 Convenience

The significance of convenience was also demonstrated, considering structural attributes such as partitioning, size, and resealability. Consumers typically adhere to the default environmental settings, which refer to the pre-selected options or

default choices provided in eating-related situations (Jachimowicz et al., 2019). According to Johnson and Goldstein (2003), individuals are more inclined to agree with and accept default settings since it is convenient (Candel, 2001). For example, above structural packaging features make it easier and more effective to reduce the intake of consumers who choose to eat larger portions of food at one time due to concerns about freshness and waste issues. This supports previous research which revealed the importance of enhancing the convenience of behavioural change (Hanks et al., 2012, Thaler and Sunstein, 2008), which demonstrated how behaviours can be positively changed through the implementation of minor, subtle changes to the environment.

The convenience value for consumers revealed here also aligns with the concept of "nudging", which operates by leveraging individuals' cognitive biases to subtly guide decisions towards the target behaviours (Hansen and Jespersen, 2013). The study conducted by Cadario and Chandon (2020), found that "convenience enhancements" can effectively encourage healthy eating. For example, the size of packaging provides a standard portion norm (Robinson et al., 2019), which is clear and convenient for consumers to decide how much to eat. It can be concluded that facilitating embodied behaviour is better to create convenience for consumers rather than to require additional effort to promote the desired behaviour.

5.5.1.3 Healthiness perception and "paradoxical" overeating

The health-related prompts were reported as important on intake decisions, showing that many consumers concern on the healthiness of the product and the impact of consumption on their own body health. As consumer awareness of health increases, the significance of features of packaging design that evoke perceptions of healthiness will grow in importance. This is because consumers need reassurance on the nutritional worth of certain food products since most people make decisions that result in more favourable future consequences (Loewenstein, 1996). For example, the findings of the current study support this notion, demonstrating that health claims and food descriptions such as "low-calorie" and "high in fibre" are observed and utilised in the process of making food choices and

consumption decisions. Consumers place importance on the perception of a product's healthiness, but this perception might have a "paradoxical" influence on their consumption. While one approach involves assisting consumers in reducing their consumption of "unhealthy" food, the other approach involves promoting the consumption of "perceived healthy" food, which may result in overeating.

On one hand, when a product is considered "unhealthy", health-conscious consumers, especially dieters, consume less of it intentionally. A perceived "unhealthy" product does not correspond with consumers' health goals, so they self-monitor and eat less which is consist with a previous study by Sanchez and Casilli (2008), revealing that health claims can assist consumers choose healthier foods. This can be explained by that perceived unhealthiness increased the guilt feeling about eating too much of "unhealthy" food (Faulkner et al., 2014, Hur and Jang, 2015).

On the other hand, consumers view health-related cues as "permission" to eat more than suggested portion size. This finding aligns with the concept of "guiltless eating" as identified by Spence et al. (2013). The researchers conducted ten focus groups in which participants highlighted challenges related to portion control. The results showed that portion control was unnecessary for "healthy" food which reflected that "healthy" food can be eaten guiltlessly. This also supports the "Snackwell effect" proposed by Walsh (2014), in which marketing of "low-fat" or "low-calorie" on-pack items paradoxically increases the food intake, negating the fat, sugar, and energy reduction benefits to consumers. In addition, the "health halo effect" may result from labelling foods and drinks as healthy. For instance, organic and high-protein labelling may exaggerate a product's health benefits (Schuldt, 2011), influencing consumers' choice through healthy perception rather than actual benefit of the product. Besides, the established health halo effects may be hard to change. For example, presented "Good source of protein" claims boosted perceived healthfulness of the product, and the traffic light warning was noted but did not shift the healthiness perception on this product among consumers (Fernan et al., 2018). Overeating may occur if individuals take nutrition content or health claims as permission to consume larger quantities of food. Which can be supported by a previous study that found presenting meals as "healthy"

may unintentionally encourage unhealthy eating (Her and Seo, 2017). To be more specific, highly health-conscious consumers were less affected by a healthy meal (health halo) and were less likely to order dessert after meal, while less health-conscious consumers were more likely to order dessert after a healthy meal.

5.5.1.4 Summary of the consumer values on portion decision

Participants' views of the impactful package attributes, together with their regular engagement with the packaging, uncovered consumer values on their portion decisions. Figure 5.5 summarises how the overarching influences of consumer values, food type, and packaging attributes on food/drink portion decisions. Food type and package attributes are defined as external factors that impact decisions regarding the food or drink portions. Meanwhile, consumer values are seen as internal motivators that influence these portion decisions that mediate the impact of packaging attributes on portion decisions.

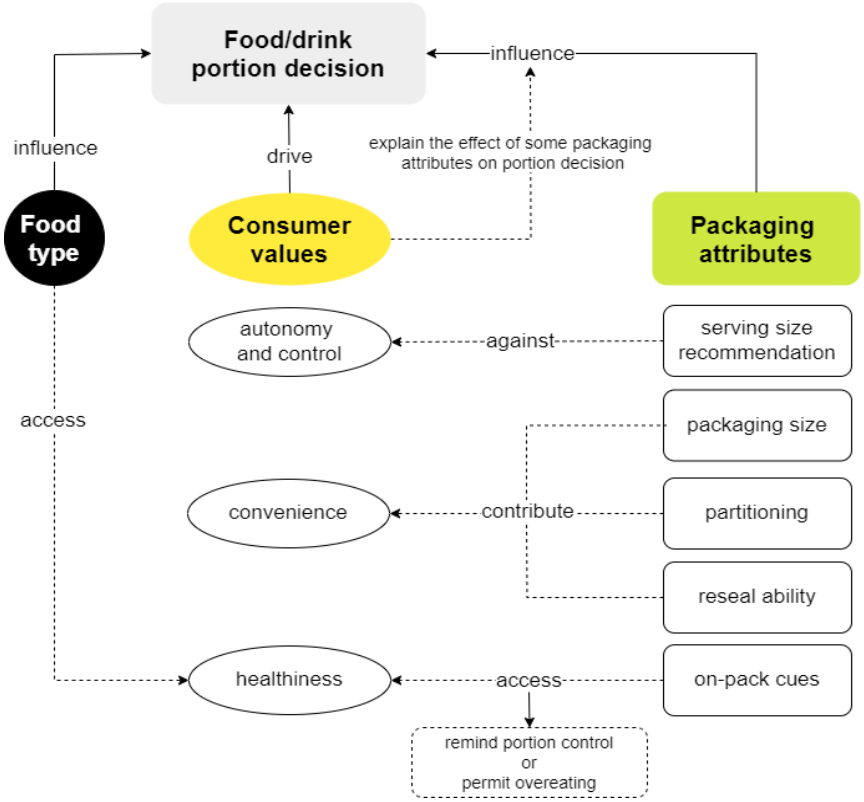


Figure 5.5 Diagram to summarise how the overarching influences of food type, consumer values and packaging attributes on food/drink portion decisions.

*Dotted lines represent an influence as reported by our participants.

5.5.2 Packaging design implications

5.5.2.1 Utilising salient features for healthy eating and downsizing

In current market, visually appealing package elements typically used for HED products to make the product widely popular, such as vibrant colours and enticing designs (Keller et al., 2012). Thus, applying salient features on ND or LED food could contribute to the positive impressions (Silayoi and Speece, 2007) and might encourage the consumption of healthier food. Consumers tend to pay varying degrees of attention to different components on packaging. Previous research (Cholewa-Wójcik and Kawecka, 2015, Clement et al., 2013) indicated that brand, logo, and graphic aspects are visually prominent for consumers. Current study investigated consumer attention to packaging elements, three additional themes were revealed: trust building, appetising, and self-identity.

Any elements facilitate the trust to the product is eye-catching for consumers, as highlighted by Coveney (2008), trust plays a key role in food choice. Besides the brand and label revealed by previous study (Lassoued and Hobbs, 2015, Rupprecht et al., 2020), product quality descriptions realistic product image or ingredient portrayal also facilitate the trust building. Accurate visual portrayals of what consumers would expect from the product can built reassurance and credibility for the product. Consumers tend to believe what they see more than what they read (Hoegg, 2015), for example, through a transparent panel to see the real food or presented with realistic food image. Thus, any packaging design on healthier food that boosts customer trust in a product could encourage more healthier choice and intake, but this would be moderated by individual differences, such as the health motivations (Siegrist et al., 2015).

Consumers were shown to be attracted to packaging characteristics that stimulate appetites. This is consistent with other research findings (Lee et al., 2013, Spence and Velasco, 2018), consumers are attracted by vivid colours, such as bright and contrasting colour. Food renderings and other appealing food pictures also stimulate appetite. Experiments show that appetite stimulation increases food consumption (Drapeau et al., 2005, Spanos et al., 2015, Zhou et al., 2021). This creates a conflict between the aspiration to maintain a nutritious diet and the

allure to indulge in HED foods. Thus, increasing appetite via packaging may be a good marketing approach to promote the intake of nutritious foods.

Salient characteristics of packaging also encompass aspects that cater to health objectives or cultural identities. Consumers showed high interest in on-pack health claims that supported their health goals (Jung and Bice, 2019, McCarthy et al., 2017). Consumers looking to reduce weight or eat healthily also value low energy content promises such as low sugar or less fat (Andrews et al., 2014). Furthermore, the study by Shen et al. (2015) found that cultural connotations displayed on packaging, such as language, imagery, and colours, were perceived as attention-grabbing by consumers due to the personal relevance and importance. This may be related to personal experience and preference for certain nations or associations with home (Bernard and Zarrouk-Karoui, 2014). The results indicated that incorporating health-related and personally relevant elements on packaging design can motivate consumers to buy and consume products based on their personal identities (Shafiq et al., 2011). For example, displaying images of athletes to symbolise healthy lifestyles (Schifferstein et al., 2022) could be employed on the intake of LED or ND foods.

5.5.2.2 Enhancing structural features to remind the portions

The findings demonstrated that packaging structural attributes and visual cues help limit intake of HED food more than information. To be specific, small size, partitioned, and resealable structural settings were found to be effective portion control strategies compared to the on-pack serving size guideline.

Pre-portioned unit facilitated portion control (Rolls et al., 2004b) since it removed deliberation from the process, making the choice of consumers effortless (Coelho do Vale et al., 2008). Re-sealable packaging offers the advantage of preserving the freshness of the product, which encourages mindful consumption and helps to minimise potential food waste. Furthermore, small packages and partitions also promote purchase intention in that consumers feel more in control and predict less food waste (Petit et al., 2020). Consumers eat less from small packaging since less food is provided (Rolls et al., 2004a), which could be explained by the

“segmentation effect” that consumers eat only what contained in the packaging (Geier et al., 2006, Kerameas et al., 2015). Thus, utilising current packaging contexts could support portion control, offering pre-portioned and reseal options to suit the value of convenience, catering to different eating scenarios.

Transparency, whether it is fully transparent or in the form of a panel, was both recognised as significant and effective in assisting portion control. Consumers utilise the food visible panel to check their intake and the leftover portions. Nevertheless, transparency might have contradictory consequences (Deng and Srinivasan, 2013), as it both stimulates consumption by making the product more noticeable and attractive (salience effect) and increases monitoring of the consumption (monitoring effect), depending on food categories. Similarly, transparent panels enhanced attractiveness, though the extent of improvement depended on the inherent attractiveness of the food (Ma et al., 2020). Thus, when applying transparent elements on the packaging, it is necessary to consider the food category and the attractiveness of the food item.

5.5.2.3 Addressing and communicating the portion related information

The lack of effectiveness of the serving advice displayed on the packaging has been demonstrated in this study which also supports the findings of Johnson et al. (2009). Rippin et al. (2019) also found that several products had no serving size displayed on the packaging. As reported by consumers, some products are difficult to portion out, for example, the serving size is specified on some products but poorly implemented for consumers. In sum, the findings indicated that serving size information may not effectively fulfil its intended purpose of guiding intake, as originally intended (Ueland et al., 2009). How to address the portion recommendations and better communicate this information with consumers via packaging design is worth to consider by designers.

According to the findings by Noar et al. (2016), altering the wording on packaging has limited impact on customers. Specifically, graphical warnings were more successful than text-only warnings in 12 out of 17 effectiveness outcomes. Besides, Versluis et al. (2015) found that graphical serving sizes on packages lowered

intended intake from large packs. As expressed by consumers, there is the need to offer easily noticed and practiced portion cues via packaging, particularly for HED items. This is due to the intense rivalry among various packaging attributes on the HED food (Husić-Mehmedović et al., 2017). In order to ensure its visibility, recommendations should be given in a way that highlights their relative surface size, position (such as the distance to the centre), and contrast with the background (Orquin et al., 2020, Peschel and Orquin, 2013). In addition, consumers often have communication challenges due to their unfamiliarity with certain nutrition terms (Spiro and Wood, 2021). In this study, other creative portion measurements or presentations were favoured over displaying in grammes or calories. For example, hand image can be used to depict recommended portion sizes (Benelam and Stanner, 2019), which as visual presentation is easier for the brain to understand compared to numerical or textual information (Smith et al., 2015).

5.5.2.4 Presenting health-related reminders but avoiding misinformation of product healthiness

Food packaging plays a significant role in consumer choices and perceptions regarding the healthiness of products. For example, packaging that emphasises health-related assertions and offers consumers details regarding the nutritional composition, prospective advantages, or overall impact on health of the product. This enables individuals to make well-informed decisions that are in line with their long-term health objectives. The WHO has identified clear nutrition information on packaging as a strategy to promote healthier food choice (Neve and Isaacs, 2022). As shown in current study, presenting reminders of low energy or high nutrient content in an appealing way was deemed beneficial for healthy eating. To be specific, enhancing the health-related packaging elements on nutritious food is considered as useful to encourage healthier choices. The use of basic numerical indicators and traffic light systems effectively highlights and displays the healthiness of the product (André et al., 2019, Carrillo et al., 2014). The participants specifically emphasised the significance of the red traffic light as a prompt to restrict consumption which is consist with the study by Lunardo et al. (2021).

However, consumers may disregard or misunderstand nutritional information due to their limited knowledge, time constraints, or lack of motivations (Andrews et al., 2021, Spiteri Cornish and Moraes, 2015). These labels, along with health claims and nutrition claims on packaging, can mislead consumers into believing that certain products are healthier than they actually are, especially when targeted at children (Binder et al., 2020). The overstating of the nutritional value and health advantages of products can exacerbate misconceptions and impede consumers' ability to make well-informed and health-conscious food choices (Morrison and Schuurman, 2012). In order to address these issues, it is imperative to enforce strict regulations on food industry and educate consumers on how to effectively interpret information provided on food packaging. Furthermore, from design perspective, it is necessary to employ health claims that resonate with consumer interests, avoiding misinformation conveyed by packaging. For example, displayed health-related information should not only focussing on positive aspects like "low fat," but also identify potential risks, such as "high sugar", if relevant.

5.5.2.5 Summary of the design implications

Packaging serves as a direct path for attracting consumer attention and a method for conveying information about health and portion size. The insights provided by participants could serve as valuable guidance for designers to enhance food and beverage packaging in order to match their expectations (Ampuero and Vila, 2006). In light of the above findings from consumers' responses and subsequent discussion, a number of recommendations for design practice can be summarised. Specifically, four themes in a design implication framework have been generated below to provide guidance for future packaging design practices (see Table 5.13). The co-designed design themes are about how to enhance public health by leveraging current commitments to social responsibility (Knai et al., 2018). More importantly, designers should take the consumer values into account while creating package interventions, acknowledging that consumers prioritise these values when making food decisions. This contributes to promote the acceptability and execution of measures connected to packaging.

Table 5.13 Summarised design implications in design practice.

Design practical implications	Description
Increase the packaging appeal of healthier food	→ Utilise the features that could contribute to trust building, make food appear appetizing or cater to some healthy needs and identities to increase the attractiveness and the intake of ND or LED food.
Enhance portion reminders of HED food	→ Set structural segmentation to prevent over consumption. → Raise the portion awareness to trigger effective self-monitoring.
Better communicate portion-related recommendations	→ Combine the portion size related information or image with visually salient elements to gain attention from consumers. → Illustrate the portion information using specific measures instead of in grams or ml, making it is easy to understand and follow.
Providing health reminders without misinformation	→ Highlight the health benefits of the product with straightforward, clear and accurate signposting, also, ensure no omission of the risks.
General principle: take consumer values into account during design practice for promoting healthy eating: Autonomy and control; Convenience; Healthiness.	

Conclusion

In conclusion, the study highlights the impact of packaging attributes on consumer behaviour regarding food portion management. Consumers have claimed that the serving size recommendations are inconvenient to implement and sometimes there is a lack of related information, which has led to confusion on the appropriate portion. The packaging features that could promote trust, increase appetite, and align with healthy goals or cultural norms are revealed as eye-catching design attributes for consumers. Besides, structural segmentations, health prompts, and easily understandable portion size reminders showed potentials in regulating the intake and encourage customers to establish better eating habits.

The framework of consumer values when making portion decisions was proposed, like autonomy, control, convenience, and healthiness have a significant influence on how individuals engage with packaging and make decisions about food portion sizes. It was found that consumers do not habitually notice or follow portion size

recommendations on food packaging. Instead, there was resistance to textual portion limitations, as they contradict the autonomy and control valued by consumers. On the contrary, packaging features like smaller size, partitioned, and resealable function were well accepted and useful in portion control since they are in line with the value of control, convenience and aid in reducing food waste. In addition, individuals' health-conscious derive advantages from the presence of health cues on product packaging, while these indicators might occasionally paradoxically result in excessive food consumption.

Current study provided four aspects of practical recommendations for future packaging design for promoting healthy eating and attached a principle to align packaging design with consumer values. Implementing visually appealing packaging elements for food that have a low energy density and high nutritious content could enhance their appeal and promote consumption. Enhancements in visual communication of portion size, along with physical attributes that facilitate shrinking, will encourage customers to embrace portion control. Furthermore, the presentation of health-related information must be both notable and accurate. These findings offer valuable insights for food industry and lawmakers. They suggest that food companies can improve packaging designs to better meet customer demands and promote healthier eating habits, while regulatory decisions could support and facilitate these efforts.

Chapter 6
DESIGNER NEEDS AND DESIGN TOOL DEVELOPMENT

Chapter 4 and Chapter 5 investigated the impact of packaging on food intake, both from experimental studies and from consumer insights. The above two chapters revealed many packaging attributes that have the potential to promote healthy eating among consumers. This chapter is structured into two main sections. The first section discusses a study conducted with designers to identify their understanding, challenges and needs in developing food packaging aimed at promoting healthy eating. While the second section outlined the development of a design tool informed by the feedback provided by the designers during the study.

6.1 Introduction of the designer needs study (DNS)

The relationship between food packaging features and consumer consumption is becoming evident (Chu et al., 2021). Consequently, there is a rising need for novel packaging design strategies to help consumers make better food choices and manage portion sizes more efficiently (Chu et al., 2022, Chu et al., 2024b). Designers can play an important role in supporting a healthy lifestyle (Chatterjee et al., 2022, Lau et al., 2018). For example, designers influence consumer food choices and consumption through visual cues (Kelly et al., 2024) and structural design elements (Chu et al., 2021). The study conducted by Tang et al. (2022) has identified potential design concepts for food company to attain mutually beneficial and financially advantageous results by assisting consumers in selecting healthier food and helping with portion control of HED foods through packaging design. Designers are responsible for not only communicating business messages effectively through visually compelling packaging but also providing supportive environment for consumers to embrace healthier eating habits.

Both food company and designers need to consider the ways to develop a better food environment by recognising this new responsibility. However, the insight from

designers continues to be inadequately reflected. Having a deep understanding of designers' viewpoints is essential for the development of packaging that effectively promotes healthy eating. Thus, this study aimed to investigate the challenges faced by designers and identify their support needs in designing food packaging to encourage healthy eating. Figure 6.1 provides an overview of the research background and outlines the key objectives of this study.

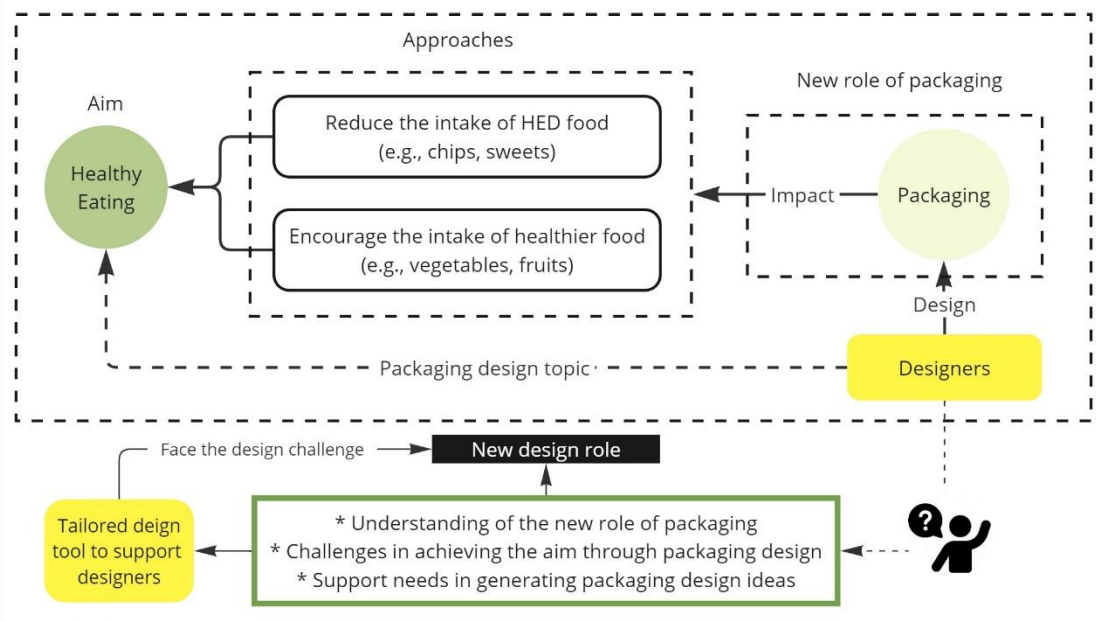


Figure 6.1 Introduction to the research model and the objectives of this study.

6.2 Methods

6.2.1 Study design and procedures

This study employed a qualitative exploratory method, as it is particularly suitable for investigating unexplored areas (Mohd Som et al., 2020, Wondirad et al., 2022), having a deep understanding of designer perspectives. To achieve the aim, semi-structured interviews were used as the primary data collection method, which were preceded by a design task to inform the discussions (see Figure 6.2).

The study obtained ethical approval from the School of Design, University of Leeds, UK (LTDESN-139). Both professional and student designers were recruited to provide a comprehensive understanding of designers' needs (Gonçalves et al., 2014). While professional designers contribute industry experience and practical insights, student designers may approach design challenges with more creativity

and open-mindedness with their fresh ideas and theoretical understanding. The recruitment approach of professional designers including personal connections, social platforms and professional networks. Student designers were the student either enrolled in design programs at universities or involved in design study.

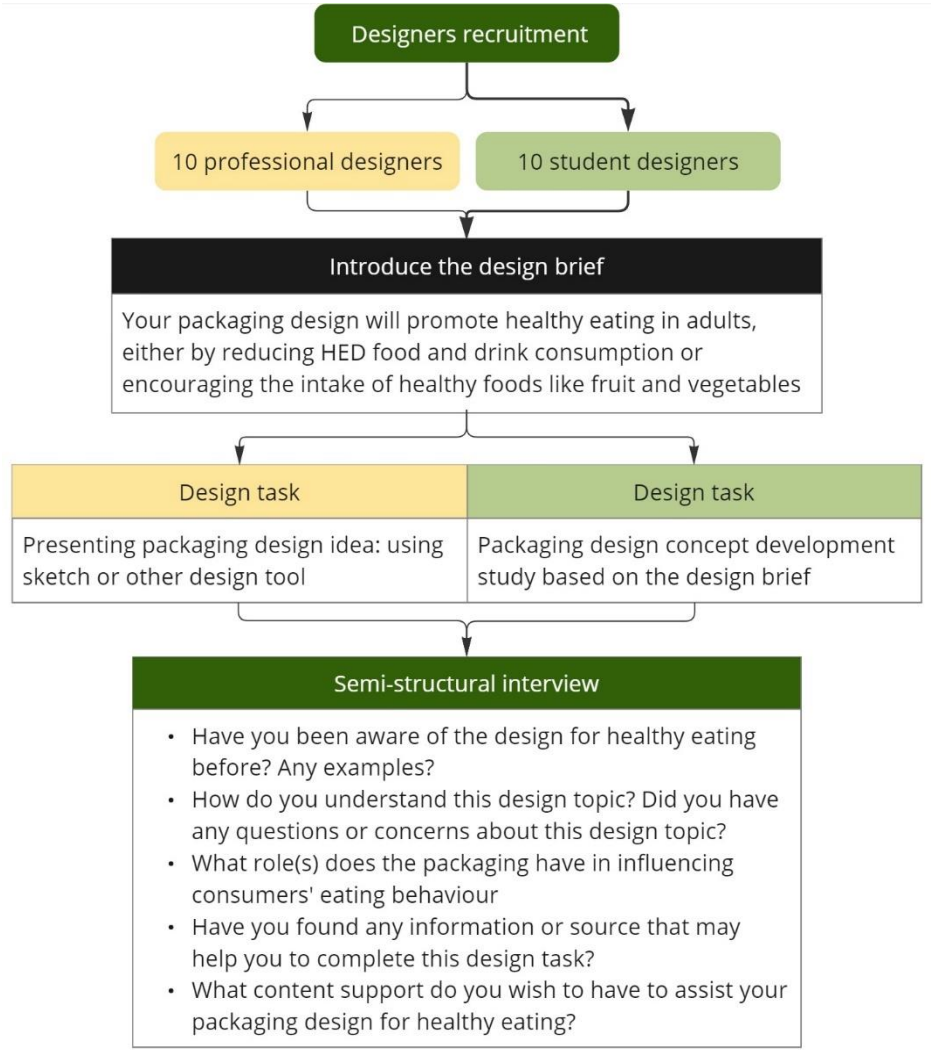


Figure 6.2 The timeline and procedures for the designer needs exploration study

Prior to the study, all prospective participants were notified that the main purpose of the research was to explore the food packaging design. Participants who agreed to take part were required to sign a consent form and provide demographic information. Designer participants were introduced to a design brief, outlining the importance of supporting a healthy diet and highlights the influence of food packaging as an environmental component on consumer eating behaviours. They were then assigned a design task to encourage them to think deeply about the

specific topic of packaging design (Driver et al., 2011). The recruited designers were given one week to familiarise themselves with the design topic, gather relevant resources, and develop packaging design ideas. Subsequently, a semi-structured interview was carried out with each designer to investigate their understanding of the design topic and their challenges in this field of packaging design (see details in Appendix 5). All recruited designers completed the whole study, with interviews averaging 40 minutes in duration.

6.2.2 Participants

A total of 20 designers were recruited for the study, comprising 10 professional designers and 10 student designers. Designers were drawn from several specialties such as industrial design, product design, and graphic design (see to Table 1). This variety of experience can contribute novel viewpoints and innovative resolutions to design problems (Caico et al., 2022). The professional designers were actively engaged in design practice. The student designers were university students in design, such as Ph.D. and master's degrees who were actively involved in conducting design research. They have two to seven years of design experience.

Table 6.1 Designer profiles

Professional designers' profiles			
No.	**Design area**	**Years of expertise**	**Occupation**
PD1	Customised furniture design	5	Product Designer
PD2	Packaging design, illustration, logo design, UI	3	Designer
PD3	Packaging, Web, UI, VI (illustration, logo)	3	Designer
PD4	Interior and exterior design of automobile	2	Car Designer
PD5	Industrial design, 3d rendering, graphic design	7	Product Designer
PD6	Visual design	2	Visual Designer
PD7	Typography design	2	Graphic Designer
PD8	Product design	5	Visual designer
PD9	Graphic design	2	Illustrator
PD10	Interactive design	4	Designer
Student designers' profiles			
No.	**Design area**	**Level of study**	
SD1	Product design	PhD program in Design	
SD2	Graphic design, visual design	Postgraduate Programme in Design	
SD3	Brand design, graphic design	Postgraduate Programme in Design	

SD4	Visual Design	Postgraduate Programme in Design
SD5	Graphic design	Postgraduate Programme in Design
SD6	Graphic design	Postgraduate Programme in Design
SD7	Packaging design, visual design, logo design	Postgraduate Programme in Design
SD8	Visual Design	Postgraduate Programme in Design
SD9	Product design, graphic design	Postgraduate Programme in Design
SD10	Graphic design	Postgraduate Programme in Design

6.3 Results of the interview

The data collected from the designers was anonymised as promised and each interview assigned a new ID to ensure confidentiality. The data was analysed using thematic analysis. This involved getting a general understanding of the data, extracting factual information, identifying key subjects, and summarising the findings (Sandelowski, 1995). The data analysis resulted in three main clusters: the designers' understanding of the packaging design issue for healthy eating, their challenges and needs in design practice and the requirements for other supports to enhance their design generation for healthy eating.

6.3.1 Understanding of the packaging design for promoting healthy eating

6.3.1.1 Limited awareness of the impacts of packaging design on food intake

The findings revealed limited awareness among designers regarding the potential of packaging design to promote healthy eating. Although several designers reported their previous experience in health-oriented designs, there is still a noticeable lack of connection between packaging design and consumer health.

> *“I have had a short internship experience in packaging design and basic knowledge of packaging design, but I have not been exposed to the field of healthy eating.” (SD5)*

> *“I haven’t paid attention to the healthy food packaging design.” (SD7)*

Some related design examples noticed by designers included creative food container designs and material innovations, which were deemed advantageous for customer health. However, their primary attention was on packaging for "healthy food”, such as light food and organic foods. In addition, designers were found prioritise packaging design for healthy foods, focussing on making it visually

appealing or effectively communicating the nutritional or health benefits to encourage healthier food choices.

> *"I have done some design for health food packaging, like the packaging of the organic oats and organic fruit." (PD3)*

> *"I have paid attention, but not much. I know there are some vegan restaurants opened in my home area, I've seen the decoration of the store and door logos and so on. Or some designs of boxes and takeaway bags for light food, like salads. Mainly see related packaging for agricultural products." (PD10)*

6.3.1.2 Conflicts concerns between business and health

The findings indicated that designers have concerns over the marketing acceptance to the packaging designs which intended to promote health eating and the actual application of the design ideas. To be specific, they concerned that these packaging intended to limit the portion of HED food could potentially have negative effects on product sales. The designers primarily considered the marketing profitability, which emphasises the importance of packaging appeal and its influence on actual sales. An appealing food packaging was regarded by designers as key to attracting consumers for purchasing and facilitating the consumption of healthier food. However, many designers, especially among the professional designers, perceived a conflict between packaging attractiveness and its effectiveness in portion control. Therefore, they stressed the importance of balancing public health promotion with commercial viability in packaging design. In addition, many student designers showed a strong desire to obtain feedback or insights from consumers. They recognised the importance of addressing consumer preferences and needs to promote healthy eating through packaging design.

> *"Has it ever been the case that if the design intends to reduce people's high calorie intake, will it be too much negative impact on the sale of the product itself?" (SD1)*

> *"The first thought of mine is to change the colour of the crisps to suppress the appetite, but I passed on this idea, because I am concerned it may go against the willingness of the food seller. There's a conflict. So, the design should provide a little bit restriction, but consumers should still love to buy it. The balance needs to be found here" (PD9)*

6.3.2 Challenges and needs for healthy eating via packaging design

According to the designers, online searching is the primary method for accessing the materials they need to solve this packaging design problem. However, many of them found it is time-consuming. Additionally, determining which materials are valuable and reliable remains challenging. Specifically, several designers expressed dissatisfaction, noting that the information outputs were low in quality, poorly summarised, and lacked consistency. This made the accessible materials unreliable and inefficient to utilise.

> *"Search online. But hardly to find any data I trust. Some apps for fitness ca find related information, but still not consistent among different apps." (PD7)*

> *"It's a bit difficult for me to gather these sources, I need to find what I think is useful in a pile of complicated content, which is a time-consuming task for me. There is some content that is difficult for me to tell whether it is useful or not just by myself." (SD2)*

By discussing the challenges faced by designers in conceptualising this new and purposeful packaging design, two aspects of needs become apparent. One is the need for acquiring topic relevant information to reference during design. While, on the other hand, there is a desirable need for inspiration to guide the design.

6.3.2.1 Information needs

Need for information about food and healthy eating

Designers explicitly highlighted a strong need for extensive information about food and healthy diet to support their food packaging design for promoting healthy eating. It includes information from different areas, primarily categorised into two clusters: target food selection support and general knowledge about a healthy diet (see Table 6.2).

Table 6.2 Summary of the information needs about food and healthy eating

Clusters	Quotations
Target food selection	*"There is some question as to exactly which high calorie food to apply the design to" (PD5).* *"Clear food target; The recommended daily portion intake of a person. This is important for me to decide the details of the design" (PD8)*

General healthy diet knowledge	*"I have had a short internship experience in packaging design. I have some basic knowledge of packaging design, but I have not been exposed to the field of healthy eating." (SD5)* *"To get relevant healthy diet recommendations for daily intake. The recommended energy intake per day, daily protein or sugar intake for an adult are the key factors for the design of packaging details" (SD6)*

Designers were looking for more information to assist them in determining appropriate target foods for the packaging design. They were unsure which food should be chosen, for example, what is the options of HED or ND food, which food consumption should be considered to be limited. Designers also stressed the need for accurate nutritional information about foods (e.g., nutrition, ingredients, benefits, and risks). In addition, designers pointed out that they lack knowledge about healthy eating, highlighting the need for access to relevant information to support their packaging design.

Need for solid data and insights to understand packaging impacts

Designers highlighted the need of obtaining reliable data on the effects of packaging and consumers insights. Specifically, all designers in this study acknowledged the impact of packaging on food consumption, however none of them possessed knowledge regarding the specific packaging features and their corresponding effects on consumer intake. The solid data can help designers understand the impact of various package features on consumer behaviour and food consumption, enabling them to make better use of them. In addition, they reported the absence of the data regarding the consumer insights related to packaging design and food intake, posing a challenge for developing purposeful and well-informed packaging designs.

> *"It would certainly be helpful to have solid data and conclusions. It is like applying medicine according to indications." (PD10)*

> *"I know that packaging features could influence the intake but can't say more specific. I think it is very useful to access to that information. Especially the field experimental data, make design more reasonable." (PD11)*

> *"I need data on target audience preferences and behaviours for healthy food packaging." (SD4)*

6.3.2.2 Inspiration needs

The results demonstrated that designers also need additional support to inspire them in packaging design. They specifically highlighted the importance of packaging design examples and the psychological theories that underlie consumer behaviour to guide their design work under this specific design topic.

Several designers specifically reported a lack of packaging design examples for healthy eating in the current market, and that it was difficult to find related design concepts even from internet sources. In addition, designers acknowledged the need of well accepted packaging examples to identify common attributes and draw inspiration for developing their own packaging design ideas. This situation hinders their capacity to acquire knowledge from the existing market and other design concepts, thereby limiting opportunities to enhance design efficiency.

> *"Tried to find some related design examples. But limited findings. It will take a long time to search everywhere online. Not convenient. I need to get some inspirations from other design area." (PD9)*

> *"Equally positioned packaging success cases, study the characteristics and identify commonalities" (PD3)*

Furthermore, designers expressed a desire to gain relevant knowledge (e.g., colour theories, psychology theories) to develop a deeper understanding of consumer behaviour and apply these insights effectively to their packaging designs and achieve desired impacts.

> *"I wish to get more colour theories and psychological theories." (SD7)*

> *"It was relatively poorly organised and summarised for specialist theoretical knowledge, such as the psychological dependence of obese people on high-calorie foods" (PD6)*

6.3.3 Tool expectation-preferred format and characteristics

Furthermore, some expectations for support materials, focusing on two primary aspects: usability and information visualisation. Designers highlighted the convenience and unrestricted availability as key aspects of usability for design

tools. They prioritised tools that were user-friendly and easily available, allowing them to effectively access the support they require.

> *"Convenient and easy to use." (PD2)*
>
> *"Easy to use and could reach a wider audience." (PD3)*
>
> *"Allows users to search and browse for information freely. (PD5)"*

In addition, designers indicated a preference for simple and visually appealing information visualisation. It is reasonable, as the effective visualizations enhance communication, foster creativity and improve decision-making (Edgecomb et al., 2024). They underscored the importance of concise information communication, emphasising the value of visually representing words, data, and design ideas or examples through graphics or images.

> *"Visualising the words or data; more pictures." (PD6)*
>
> *"Inspire designers in a clear and concise way. Tell designers what you want to communicate in one sentence. This tool should let designers to easily find the information they need. Graphics-based, with a focus on visualization. Too many words will not have a good impact. If charts and data presentation are necessary, it is best to keep it simple and visualised" (PD10)*

Meeting these requirements is important to equip designers with the resources they need to develop impactful packaging designs to promote healthy eating.

6.4 Findings and discussion of the designer needs study

6.4.1 Building understanding of the new role of food packaging

Food packaging design has expanded beyond its conventional purpose (e.g., food protection, product appeal) to influence eating in many ways. Current perspectives emphasise packaging as a tool for communicating brand identity, providing product information, and influencing consumer behaviour (Malešević and Stančić, 2021, Vyas and Bhuvanesh, 2015). As research on food packaging and its impact on consumer eating behaviours continue to gain more attention from researchers and responsible food companies (Deng and Srinivasan, 2013, Donini et al., 2023), designers must recognise and respond to the evolving demands of public health-oriented packaging design marketplaces.

However, the study revealed a gap in designers' understanding of their emerging responsibility in using food packaging design to influence portion control without compromising its attractiveness (*"Concerned that the design will not appeal to consumers"*). Specifically, designers prioritise the promotion of healthier food choices (*"I have done some design for health food packaging, like the packaging of the organic oats and organic fruit."*). However, this suggests that designers may be overlooking opportunities to use packaging design as a tool to reduce the intake of HED foods. This may be due to designers' lack of understanding of research showing that food packaging can impact portion control as reviewed by Chu et al. (2021). In addition, designers' marketing concern may also stop them from paying more attention to the portion control for HED foods. Viewing packaging as a key marketing tool (Rundh, 2013), portion control strategies in food packaging design are often avoided due to designers' concerns that they may diminish visual appeal, leading to negative consumer feedback and reduced sales. However, Tang et al. (2022) proved that packaging intended to facilitate portion control can also be attractive for consumers. This suggests that well-designed packaging can subtly influence behaviour by making portion-controlled products more visually appealing. The findings indicate that designers should consider a broader range of strategies, such as reducing the intake of HED foods to promote healthy eating, rather than only focusing on encouraging the consumption of healthier foods. Thus, designers need further support to understand how packaging aids portion control, while also considering consumer preferences as highlighted by this issue.

6.4.2 Challenges of gathering useful materials for design idea generation

Designers in the field of food packaging must navigate the complexities raised from multiple disciplines, including design, nutrition, and psychology. Nevertheless, many designers have knowledge and experience in traditional food packaging design yet face difficulty applying available resources and knowledge when designing packaging to promote healthy eating. The lack of familiarity highlights the need to expand designers' knowledge to equip them for exploring new design domains (Vijaykumar and Chakrabarti, 2008). Even though many governments around the world, such as the UK (GOV.UK, 2016) and the Chinese governments

(Wang et al., 2016), have published official dietary guidelines for their populations, these resources are often overlooked by designers.

Designers emphasised the complex nature of the difficulties in obtaining trustworthy information across different fields when working within this new design areas. They pointed out that collecting relevant information is time-consuming and is further complicated by inconsistent information. This suggests a urgent need for reliable information to assist designers in developing targeted designs (Alemanni et al., 2011), specifically in the context of packaging design for promoting healthy eating.

Designers also highlighted the challenge of the limited number of design examples, emphasising the necessity for a wider range of sources of inspiration. This is supported by Sarkar and Chakrabarti (2008), which presented that external stimuli can enhance creativity in the concept creation stage. However, design fixation may result from exposure to external design examples (Viswanathan et al., 2016). Specifically, designers risk being overly influenced by existing packaging design examples, which may constrain their creativity. Furthermore, designers believed that psychological theories are essential to support their ideation processes. This is because such theories provide guidance in learning and problem-solving (Lee et al., 2011), offering valuable insights on consumer motivation and behaviour.

6.5 Design tool development (DTD)

The purpose of the design tool development was to provide with the support materials designer need to adapt to the new role of packaging and address healthy eating problems through packaging design. Thus, this design tool was developed to provide tailored support materials to address the specific challenges designers face. The framework and content details are outlined in the subsequent sections of this chapter.

6.5.1 Design tool framework

As shown in the results, designers highlighted the importance of having access to detailed background information, including specific food categories, nutritional

data, and guidance for a balanced diet. Song et al. (2002) also emphasised the significance of supporting information in directing certain design tasks. In addition, designers expressed the need to know more about the impact of specific packaging features on food intake. Furthermore, designers mentioned the importance of acquiring insights regarding the influence of packaging on consumers' eating behaviour to guide the packaging design. Integrating these materials into the design process is essential for equipping designers with relevant insights to effectively approach their design tasks (Lu et al., 2021) and develop impactful design concepts.

Overall, based on the literature review on design tools and the identified needs of designers, two key aspects need to be addressed: information support and inspiration support. Information support helps designers easily access to relevant and well-organised information to address gaps in food and portion knowledge (Kim and Lee, 2017). Thus, it not only reduces the time spent searching for relevant but unfamiliar information, but also improves the quality of decision-making. The inspirational support provides summarised data, insights and strategies to assist designers in making informed design decisions (Won, 2021), thereby enhancing their creative output during the ideation phase. Figure 6.3 presents the framework of the design tool. The aforementioned materials are addressed in section 6.5.2 of the design tool content, with further details described in the following sections.

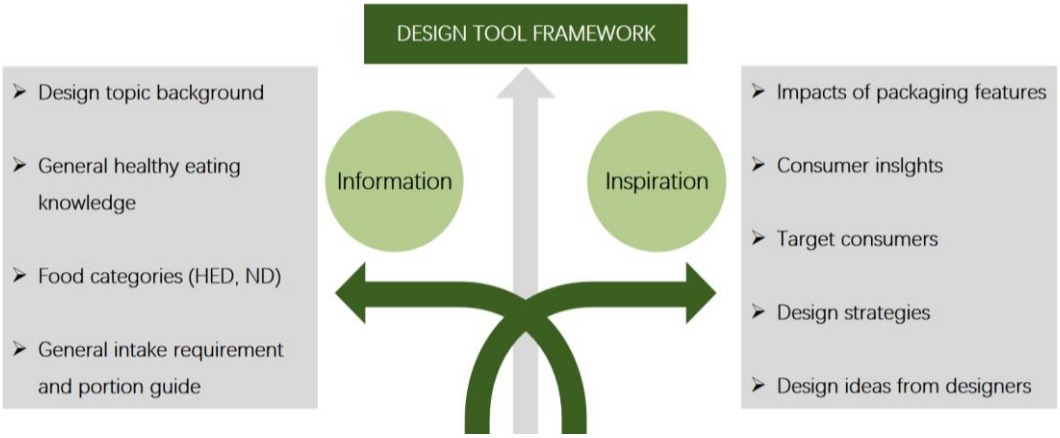


Figure 6.3 The framework of the design tool

6.5.2 Design tool content

As introduced in section 6.5.1, two main materials are needed: information materials and inspiration materials. The development of the content and the illustration of each sub-part are introduced in the following sections.

6.5.2.1 Information section

- ***Information- Design topic background***

To introduce designers to a new design field, it is essential to consider the role of background knowledge (Christensen and Ball, 2016). According to Li and Brennan (2021), the understanding of design background and problem framing are indispensable for designers facing new interdisciplinary design challenges. Thus, this design tool gathered the general background information of population-level unbalanced diet to explain why this topic is important. The health risks associated with poor diets, along with their economic impact, were highlighted to emphasise the need for finding solutions to solve this dietary problem, as shown in Figure 6.4. To make the information easier to understand, an image presenting the unbalanced diet was created. On the left is an image of HED foods, generally processed and often over-consumed by consumers, while on the right is an image representing healthy foods, generally fresh, natural and unprocessed foods whose consumption currently does not meet recommendations. It aimed to make the concept of an unbalanced diet clearer to designers.

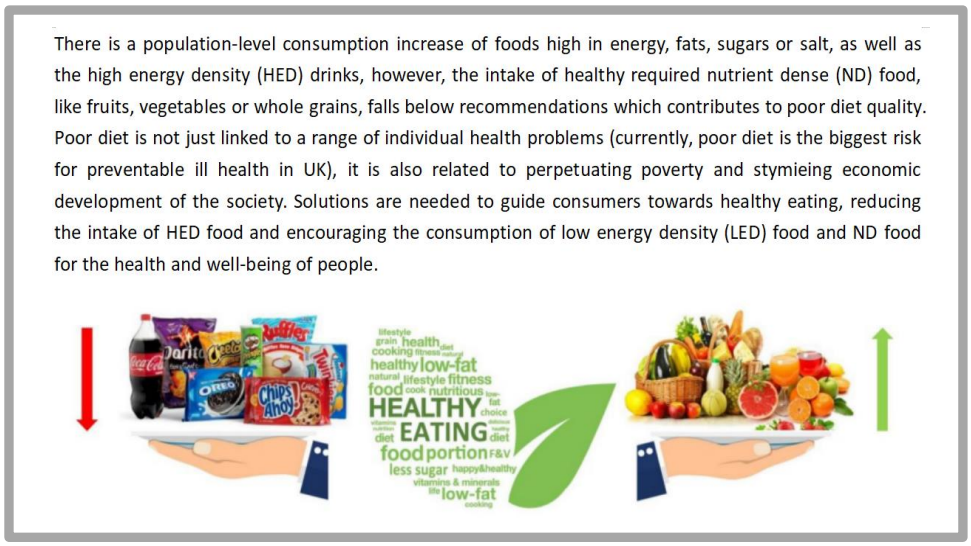
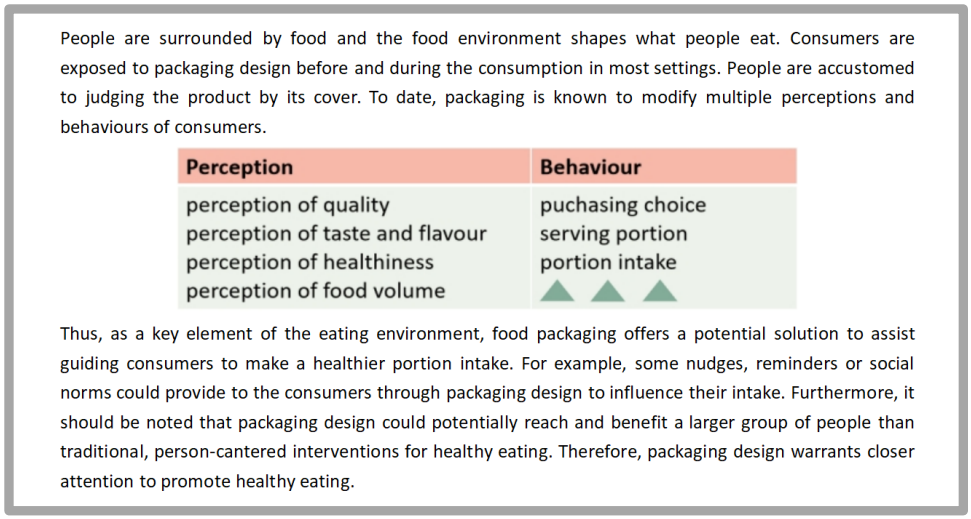


Figure 6.4 The presentation of the content of the background information.

Food packaging is recognised as a key environmental element due to its daily use by consumers. According to the review in section 2.3.2, food packaging has a significant impact on consumers, particularly influencing their perceptions and behaviours. To introduce the emerging role of packaging to designers, the effects of food packaging were condensed and depicted in a table, as shown in Figure 6.5. Moreover, the significance of packaging on food intake was highlighted. The advantage for reaching broader and diverse audiences was stressed to underscore the importance of giving more attention to food package design to promote healthy eating.


People are surrounded by food and the food environment shapes what people eat. Consumers are exposed to packaging design before and during the consumption in most settings. People are accustomed to judging the product by its cover. To date, packaging is known to modify multiple perceptions and behaviours of consumers.

Perception	Behaviour
perception of quality	puchasing choice
perception of taste and flavour	serving portion
perception of healthiness	portion intake
perception of food volume	▲ ▲ ▲

Thus, as a key element of the eating environment, food packaging offers a potential solution to assist guiding consumers to make a healthier portion intake. For example, some nudges, reminders or social norms could provide to the consumers through packaging design to influence their intake. Furthermore, it should be noted that packaging design could potentially reach and benefit a larger group of people than traditional, person-cantered interventions for healthy eating. Therefore, packaging design warrants closer attention to promote healthy eating.

Figure 6.5 The impact of the food packaging and its potentials.

- ***Information- General healthy eating knowledge***

As emphasised by Zhang et al. (2024), knowledge modelling is important in the product design process. Furthermore, Casakin and Singh (2019) stressed the essential role of knowledge in design thinking across disciplines. Besides, many designers reported a lack of relevant knowledge. Thus, it is necessary to provide designers with the basic healthy eating knowledge to address this emerging design field effectively.

To clarify the concept of healthy eating for designers, general descriptions of healthy and unhealthy diets were provided. To emphasise the importance of healthy eating for individuals, the diverse benefits of consuming a nutritious diet, ranging from improved physical well-being and cognitive abilities to enhanced daily

productivity, were illustrated through icons. In addition, the health risks associated with a poor diet were also highlighted (see Figure 6.6). WHO recommendations were subsequently presented to provide designers with basic, globally recognised dietary guidelines (WHO, 2020) (see Figure 6.7). Specifically, more intake of fruits and vegetables is needed for individuals to obtain essential vitamins and minerals, while reducing intake of fat, sugar, and salt is recommended.

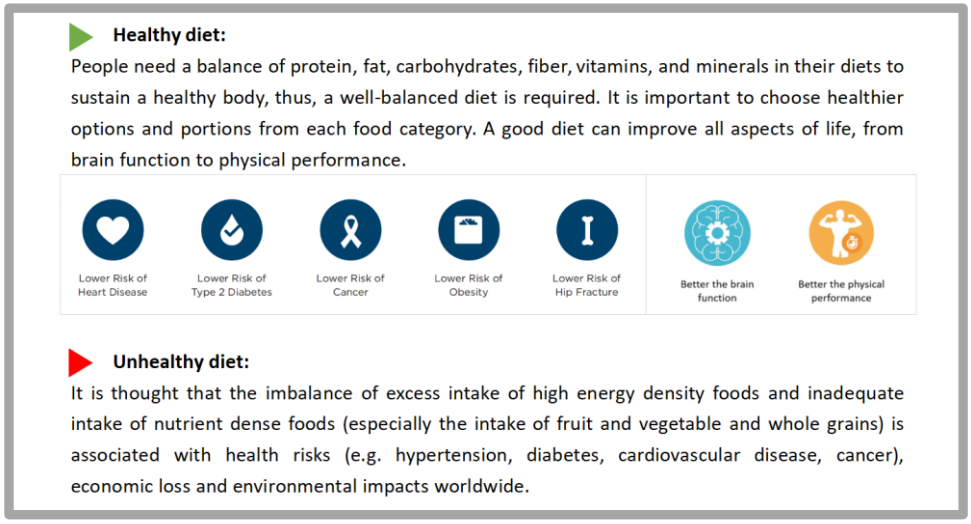


Figure 6.6 The presentation of the description of healthy and unhealthy diet.

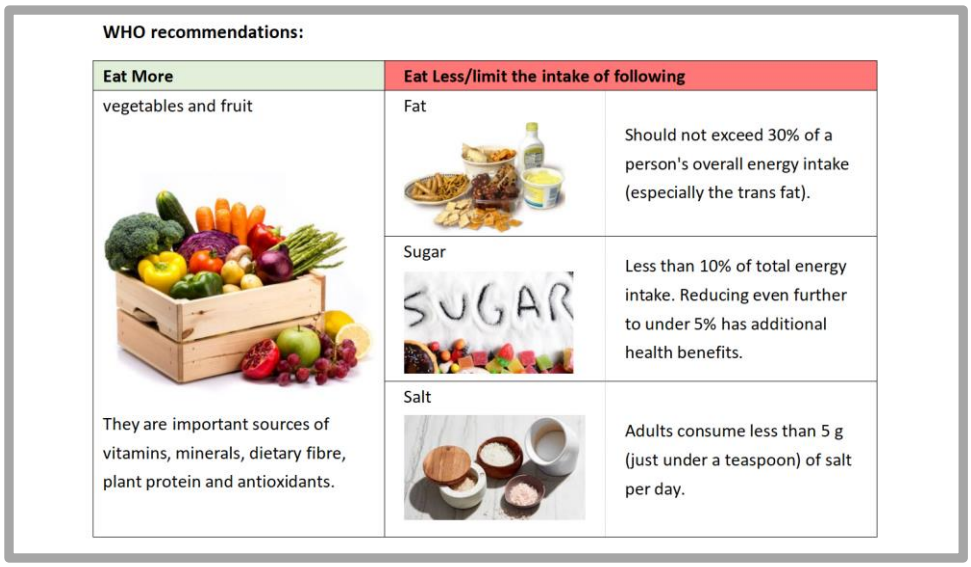


Figure 6.7 The illustration of the intake recommendation from WHO (2020).

- ***Information- Food categories (HED, ND) and food portion***

The importance of domain-specific knowledge in enhancing creativity and problem-solving capabilities is well-established (Wynder, 2007), suggesting that problem-specific knowledge has a significant impact on design outcomes. However, according to designers' responses, they lack expertise in the fields of food and nutrition. Therefore, this section was designed to equip designers with information on specific food categories to identify target foods for packaging design while enhancing their understanding of food energy density and portion sizes.

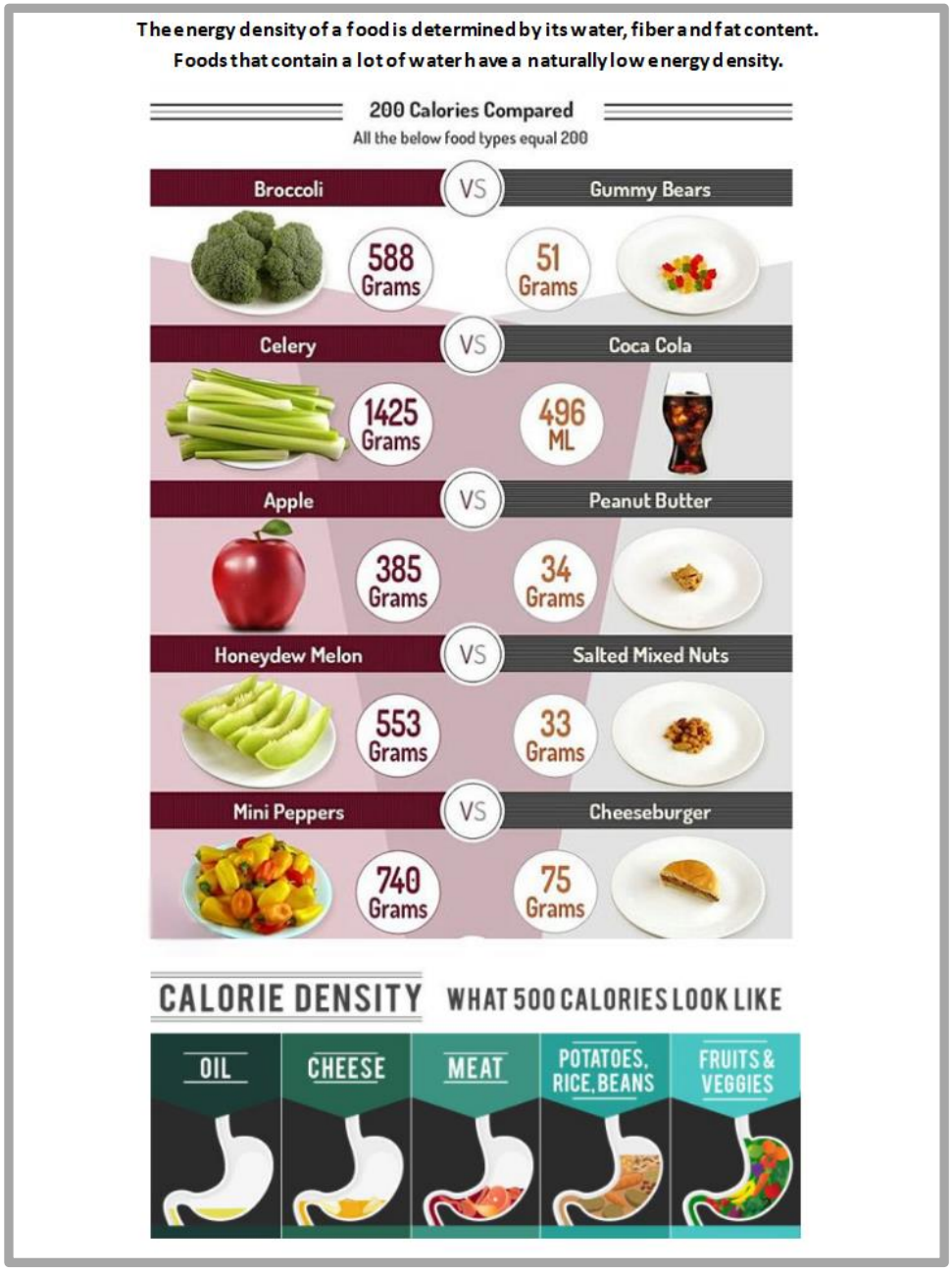


Figure 6.8 A visual illustration of varied food portions with the same energy content.

Food energy density and portion

The energy density of foods is defined as the available energy per unit weight, and it influences dietary choices, amount consumed and ultimately body weight over time (San Martini et al., 2021, Stelmach-Mardas et al., 2016). Research showed that people with poor awareness of portion sizes tend to overestimate the appropriate amount of food to consume (Almiron-Roig et al., 2013). Thus, it is important to equip designers with the basic food energy density knowledge and clarify its relationship with portion size. Specifically, to illustrate portion differences among foods with the same energy content, a visual representation was provided (see Figure 6.8), adapted from Esser (2018) and Triantafyllou (2015), offering insights into visualising food portions and energy content.

High Energy Density (HED) foods

HED foods are those containing above 10·5 kJ/g (2·5 kcal/g) (Albar et al., 2014), such as crisps and peanut butter. The manipulation of food energy density has been studied concerning daily energy intake and its influence on weight gain over time (Robinson et al., 2022). In addition, when the energy density of food is surreptitiously altered, consumers tend to consume similar amount of food while simultaneously increasing their energy intake (Stubbs et al., 2000). From the energy density perspective, certain food categories contributing more to energy density than others (Horgan et al., 2022, Lyons et al., 2016). As results indicated, designers face difficulties in recognising the target food. Therefore, to provide designers with the target HED foods, the definition and representative HED foods from varied categories were presented in the design tool (see Figure 6.9).

High energy density (HED) food:

HED food is defined as foods and beverages that contain more than 2.5 kcal/g (10.4 kJ/g). From a health perspective, most HED food is energy dense but nutrient poor.

Here are some examples of HED food:

Category	Food Examples				
Drinks	Fruit juices 	Sodas 	Sugary drinks 		
Snacks	Candies 	Cookies 	Crisps 	Chocolates 	Biscuits 
Pastries/Desserts	Doughnuts 	Ice creams 	Muffins 	Cakes 	Puddings 
Processed grains/fruit	Sweetened cereal 	Sweetened corn flacks 	Dried fruits 		
Condiments	Jams 	Ketchup 	Mayonnaise 	Cooking sauces 	
Prepackaged meal/ highly processed foods	Pizzas 	Pies 	Fried foods 	Sausages 	Bacon 

Figure 6.9 The presentation of some examples of HED foods.

Foods high in fat, saturated fat, sugar, or salt (HFSS)

Evidence suggested that reducing the consumption of foods high in fat, saturated fat, sugar, or salt (HFSS), particularly added sugars, helps prevent a range of health issues (Jahan-Mihan et al., 2023, Rippe and Angelopoulos, 2016). Therefore, to assist designers in gaining a deeper understanding of the concept of HFSS foods and how it is labelled on current food packaging, the definition, criteria, and the traffic light labelling system applied to current food packaging were summarised and included in the design tool (see Figure 6.10).

How to define the food high in fat, saturated fat, sugar or salt (HFSS):

Nutrition	High	Low
Total fat	≧ 17.5g / 100g	≦ 3g / 100g
Saturated fat	≧ 5g / 100g	≦ 1.5g / 100g
Sugars	≧ 22.5g / 100g	≦ 5g / 100g
Salt	≧ 1.5g / 100g (or 0.6g sodium)	≦ 0.3g / 100g (or 0.1g sodium)

***Check the nutrient table to compare with the numbers in the table above to make a judgement about whether the food is belong to HED or HFSS foods.**

Traffic Light System:

Some front-of-pack nutrition labels use red, amber and green colour coding.

Red	High
Amber	Medium
Green	Low

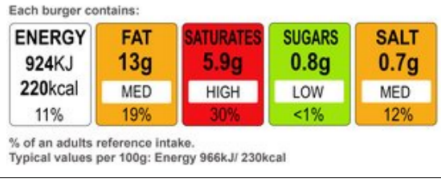


Figure 6.10 The identification of HFSS food and relevant on-pack label example.

Nutrient-dense (ND) food

ND foods are rich in essential nutrients relative to their calorie content, making them valuable for maintaining optimal nutrition (Comerford, 2015, Drewnowski and Fulgoni III, 2014). Promoting the intake of ND foods is essential for overall health. Market-based solutions can effectively promote the acceptability and affordability of nutrient-dense foods, ensuring they are appealing to consumers and prioritise nutritional benefits (Henson and Agnew, 2021). Therefore, the design tool provides a comprehensive depiction of ND foods, including the key categories, criteria and numerous specific examples (FOOD&DRUG, 2021). This helps designers develop a general understanding of ND foods and provides examples of foods that should be encouraged (see Figure 6.11).

Nutrient dense (ND) food:

Nutrient-dense foods are rich in vitamins, minerals and other nutrients important for health.

Category (basic and typical foods/drinks)			
Vegetables	Fruits	Meat and fish	Nuts and seeds
Eggs	Dairy	Beans and legumes	Herbs and spices

Examples of the most ND foods:

Percent Daily Value (DV) is a guide to the nutrients in one serving of food. It tells you whether a food is high or low in a specific nutrient, defined as follows:

Low: 5% or less of a nutrient High: 20% or more of a nutrient

Parsley	Total DV in 100g	Swiss Chard	Total DV in 100g	Kale	Total DV in 100g
	2634%DV (36 calories)		1337%DV (19 calories)		1457%DV (28 calories)
Spinach	**Total DV in 100g**	**Watercress**	**Total DV in 100g**	**Mustard Greens**	**Total DV in 100g**
	1077%DV (23 calories)		534%DV (11 calories)		1105%DV (26 calories)
Lettuce	**Total DV in 100g**	**Oysters**	**Total DV in 100g**	**Liver**	**Total DV in 100g**
	394%DV (15 calories)		1383%DV (68 calories)		3490%DV (175 calories)
Mushroom	**Total DV in 100g**	**Sweet Peppers**	**Total DV in 100g**	**Arugula**	**Total DV in 100g**
	407%DV (22 calories)		367%DV (27 calories)		336%DV (25 calories)
Spring Onions	**Total DV in 100g**	**Broccoli**	**Total DV in 100g**	**Carrots**	**Total DV in 100g**
	406%DV (32 calories)		443%DV (35 calories)		439%DV (35 calories)

Figure 6.11 The identification of ND food and ND food examples.

- ***Information- General intake requirement and portion guide***

Energy intake requirement and references for adults

Dietary reference intakes (RIs) are established by European regulations to provide guidance on the amount of energy and essential nutrients that individuals should consume daily to maintain a healthy diet (Meyers et al., 2006). These values are not personalised recommendations, age, gender, and physical activity levels should also be considered. Adherence to recommended dietary guidance can impact energy intake, with initiatives such as nutritional labelling to combat issues like overconsumption (Srinivasan, 2013). To equip designers with knowledge of intake

energy requirement and nutrition portion, along with their labelling on food packaging, this information was gathered and presented in the design tool (see Figure 6.12).

Average Adult Requirements for Total Energy Intake

Age (Year)	Energy requirements (kcal/day)	
	Male	Female
19 - 24	2772	2175
25 - 34	2749	2175
35 - 44	2629	2103
45 - 54	2581	2103
55 - 64	2581	2079
65 - 74	2342	1912
75+	2294	1840

Reference Intakes (RIs) of Different Nutrient for Adults

Energy or Nutrient	Reference Intake (per day)	Note (current situation or special notice)
Energy	2000 kcal / 8400 KJ	Avoid excessive or too little energy intake
Fat	70g	The intake should not more than 35%
Saturates	20g	Too much intake of saturated fat
Carbohydrate	260g	The intake should not more than 50% of energy intake
Total sugars	90g	Too much intake of added sugar
Protein	50g	0.75 g of protein per kg body-weight per day
Salt	6g	Maximum intake per day
Fibre	30g	Generally, the intake is not enough

- Reference intakes are set by European law, as a guide for the amount of energy and key nutrients that can be eaten on a daily basis in order to maintain a healthy diet.
- They are not individual recommendations, it also depends on age, gender and physical activities.
- Food labels show the percentage of the RIs that is provided per 100 g/100 ml and/or per portion of the food item.

Guideline Daily Amounts (GDA) : it is based on international dietary guidelines for the average daily amount of calories and nutrients that people need.

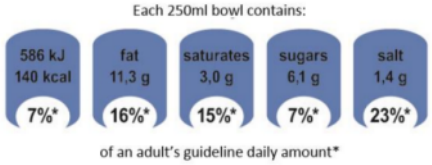


Figure 6.12 The intake references and how its labelled on the packaging.

Portion guide

In the context of developing effective portion size guidance, portion sizes for main food groups were discussed using data from the UK National Diet and Nutrition Survey (Benelam and Stanner, 2019). Several barriers to healthy portion size control were identified, lack of clarity in serving size guidance is one of them (Spence et al., 2013). However, it showed that existing food portion size guidance resources are ineffective as they have poor reach and impact (Porter et al., 2023). Designers facing challenges in accessing food portion guidance materials is also a significant issue, similar to the limited access of such information by general consumers. To address the lack of focus on portion guidance, this design tool introduced three types of portion guidance to assist designers in promoting portion control: the Eatwell Guide (Public Health England), the Handy Guide to Portion Size, and the Food Fact Sheet.

a. Eatwell Guide from Public Health England

Main messages:

1. 5 portions of a variety of fruit and vegetables every day.
2. Base meals on potatoes, bread, rice, pasta or other starchy carbohydrates; choosing wholegrain versions where possible.
3. Have some dairy/dairy alternatives (e.g., soya drinks); choosing lower fat and sugar options.
4. Eat some beans, pulses, fish, eggs, meat and other proteins (including 2 portions of fish every week, one of which should be oily).
5. Choose unsaturated oils and spreads and eat in small amounts.
6. Drink 6-8 cups/glasses of fluid a day.
7. If consuming HFSS foods and drinks, have these less often and in small amounts.

Figure 6.13 The presentation of Eatwell Guide from Public Health England.

The Eatwell Guide, introduced by Public Health England (GOV.UK, 2016), serving as a tool to guide healthy eating. It aligns closely with international dietary guidelines and provides a visual representation of the UK's dietary recommendations for adults and children (Buckland et al., 2023). Improving the communication of the Eatwell Guide, have been identified as essential for supporting the transition towards sustainable diets in the UK (Culliford et al., 2023). Thus, to introduce the portion guidance to designers, the Eatwell Guide image and the main recommendations were presented in this design tool (see Figure 6.13).

b. Handy guide to portion size:

Hands are perfect for measuring the right portion size for people.

The handful (hf) diet rules(the practical measures using hands)	
Protein	2 hf for men, 1 for women at every meal
Carbohydrates	2 hf for men, 1 for women at every meal (customize to goals and needs)
Green veggies	≧ 1 hf for everyone at every meal
Fruit	1-2 hf per day
Fats	1-2 hf per day

Here are the specific examples:

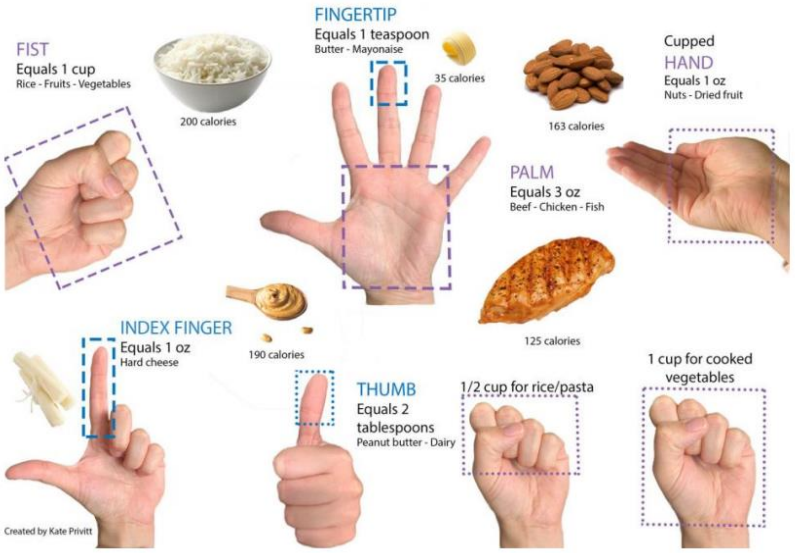


Figure 6.14 The presentation of handy guide to portion size.

Easily understandable portion size descriptors are important for effectively communicating appropriate food portion sizes (Flynn et al., 2012). For example, hands can be a practical tool for estimating food portion sizes, as they are readily available to individuals at all times (Gibson et al., 2016). Thus, using parts of the

hand (e.g. finger, palm, fist) to measure the food portion to guide the intake was introduced in the design tool, the image was adapted from (Privitt, 2019) (see Figure 6.14) to provide designers with new insights of the food portion measurement and portion guidance. Furthermore, commonly accessible objects, such as a tablespoon, glass, and cards, can also be utilised as visual representations of portion scales. The information presented in the design tool was adapted from (BDA, 2021), as depicted in Figure 6.15.

c. Food Fact Sheet: recommended portion sizes of typical foods:

Portion size is defined as the amount of food an individual intends to consume at single eating.

Category	Food	One Portion
Carbohydrates 	Bread	1 medium slice
	Pasta (boiled)	2 - 3 tablespoons (tbsp)
	Rice (boiled)	2 - 3 tbsp
	New potatoes (boiled)	2 egg sized
	Baked potato (with skin)	1 medium
	Breakfast cereal	3 tbsp
	Porridge oats	3 tbsp
Dairy 	Milk	200ml (1/3 pint) / 1 glass
	Calcium fortified soya alternatives	200ml (1/3 pint) / 1 glass
	Yogurt	125g / 1 standard pot / 3 tbsp
	Cheese (hard)	30g / A matchbox size piece
Protein 	Cooked meat	60g-90g / A deck of cards
	Cooked white, oily or canned fish	140g / Palm of hand
	Eggs	120g / 2
	Baked beans or beans	150g / 4 tbsp
	Pulses (lentils/chickpeas)	150g / 4 tbsp
	Soya/tofu, vegetable based meat alternative	100g / 4 tbsp
	Nuts or peanut butter	30g / 1 tbsp / A handful
Fruit and vegetables 	An apple/pear/orange/banana apricots/kiwis/satsumas /plums (2)	80g
	Grapes/ berries	80g / A handful (10-12)
	Dried fruit (e.g., raisins or sultanas)	A small handful/ 1 tbsp
	Peas/carrots/sweetcorn/mixed vegetables	80g / 3 heaped tbsp
	1/2 pepper/a medium tomato/ a medium parsnip	80g
Oils and spreads	Butter or spread	5g / 1 tbsp
	Oil	3g / 1 tsp

Figure 6.15 The presentation of Food Fact Sheet.

6.5.2.2 Inspiration section

Designers often rely on various stimuli to inspire and guide their creative processes during design idea generating. Study revealed the importance of integrating frameworks (like reflective framework) into practical work to help designers contextualise the meaning of design, find inspiration, and develop individual stances on the purpose of design (Dankl, 2017). Incorporating theories and methodologies from various disciplines can also enhance the design process of complex design problem (Beaudouin-Lafon et al., 2021), as it allows for a more comprehensive understanding of the problems at hand and fosters innovative solutions. By promoting a transdisciplinary educational approach, students are better equipped to tackle complex design challenges that span multiple domains (Sharunova et al., 2017). Besides, the study by Vechakul and Agogino (2021) also demonstrated the value of integrating diverse perspectives in the design process.

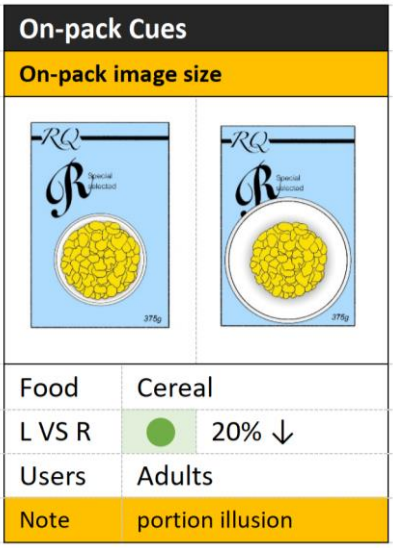
Thus, this design tool synthesised essential materials to offer a range of inspirational resources, including relevant research findings, user insights, target audiences, applicable theories, and design concepts as examples, thereby enhancing designers' creativity and problem-solving capabilities for health-focused food packaging design. The details of the content are introduced and presented in the following sections of this chapter.

- ***Inspiration- Impacts of packaging features on food intake***

Drawing inspiration and generating ideas in design can be enhanced by leveraging existing knowledges or academic findings (see section 2.4.2.4). The importance of available knowledge was emphasised in determining suitable design methods (Chen et al., 2018). Current design topic is about utilising the impact of the packaging features on food intake to guide healthy eating. However, the study with designers (see section 6.3.1) demonstrated that designers have limited knowledge of packaging design's impact on food intake, largely due to limited accessibility and comprehension of academic findings. To bridge the gap, it is essential to translate complex academic findings to ensure that designers are grounded in empirical evidence, leading to more effective packaging design solutions. It has been

recognised that the knowledge need to be packaged differently for diverse audiences (McCall and Groark, 2000). In this research, the target audience is designers; therefore, their needs and preferences should be considered, particularly their requirement for visualising and simplifying data. Visualizations has been shown to effectively communicate research findings to both academic and general audiences (Francis et al., 2014). Thus, to communicate the experimental findings with designers, this design tool translated these relevant results (from Chapter 4) into digital card due to its simple, easy to use and intuitive, which is typically used to present summarised content (see section 2.4.2.6). These cards were designed to convince designers of the potential of food packaging design to influence food consumption and to provide additional insights, broadening design opportunities through summarised and visualised experimental results (see Table 6.3 for the description of the card details).

Table 6.3 The digital result card presentation and its description.

<table>
<tr><th>Card example</th><th>Description</th></tr>
<tr><td rowspan="6"> 
</td><td colspan="2">The category of the packaging feature</td></tr>
<tr><td colspan="2">Specific manipulated packaging feature</td></tr>
<tr><td>Bigger container image (bowl)

Same size of cereal image</td><td>Smaller container image (bowl)

Same size of cereal image</td></tr>
<tr><td colspan="2">The food inside the packaging is cereal (product)</td></tr>
<tr><td colspan="2">Left pack reduced food intake by 20% compared with providing the Right food pack to consumers.</td></tr>
<tr><td colspan="2">Target user is adults</td></tr>
<tr><td colspan="2">Specific note: It is known as portion illusion</td></tr>
</table>

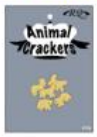
The cards are categorised into two groups based on the characteristics of the packaging attributes, including on-pack cues (see Figure 6.16), highlighted in orange, and structural features (see Figure 6.17), highlighted in green.

As many research revealed, the food intake could be changed by manipulating the packaging feature. Here, it has been summarized what packaging feature has been tested and its result showed that it changed the food intake more or less. To make it more understandable, these packaging features are categorized into on-pack cues and structural features.

CARDS:

On-pack Cues	
On-pack product unit	
	
Food	Crackers
L VS R	63% ↓
Users	Adults
Note	No other load

On-pack Cues	
On-pack product unit	
	
Food	Pretzels
L VS R	87% ↓
Users	Adults
Note	high visual attention

On-pack Cues	
On-pack product unit	
	
Food	Animal crackers
L VS R	73% ↓
Users	Adults
Note	

On-pack Cues	
On-pack product unit	
	
Food	Pretzels
L VS R	56% ↓
Users	Adults
Note	high visual attention

On-pack Cues	
On-pack image size	
	
Food	Cereal
L VS R	20% ↓
Users	Adults
Note	portion illusion

On-pack Cues	
On-pack image size	
	
Food	Cereal
L VS R	23% ↓
Users	Children
Note	higher on low sugar

On-pack Cues	
Depicted portion size	
	
Food	Grapes
L VS R	18% ↑
Users	Children
Note	

On-pack Cues	
Depicted portion size	
	
Food	Bread spread
L VS R	23% ↓
Users	Children
Note	first slice

On-pack Cues	
The location of calories etc.	
	
Food	Chocolates
L VS R	43% ↓
Users	Adults
Note	with low ASE

On-pack Cues	
Pictorial portion size	
	
Food	M&M's peanuts
L VS R	24% ↓
Users	Adults
Note	If it is noticed

On-pack Cues	
On-pack cartoon characters	
	
Food	F & V
L VS R	20g/day ↑
Users	Children
Note	portion illusion

Figure 6.16 The tested on-pack visual cues and its influence on food intake.

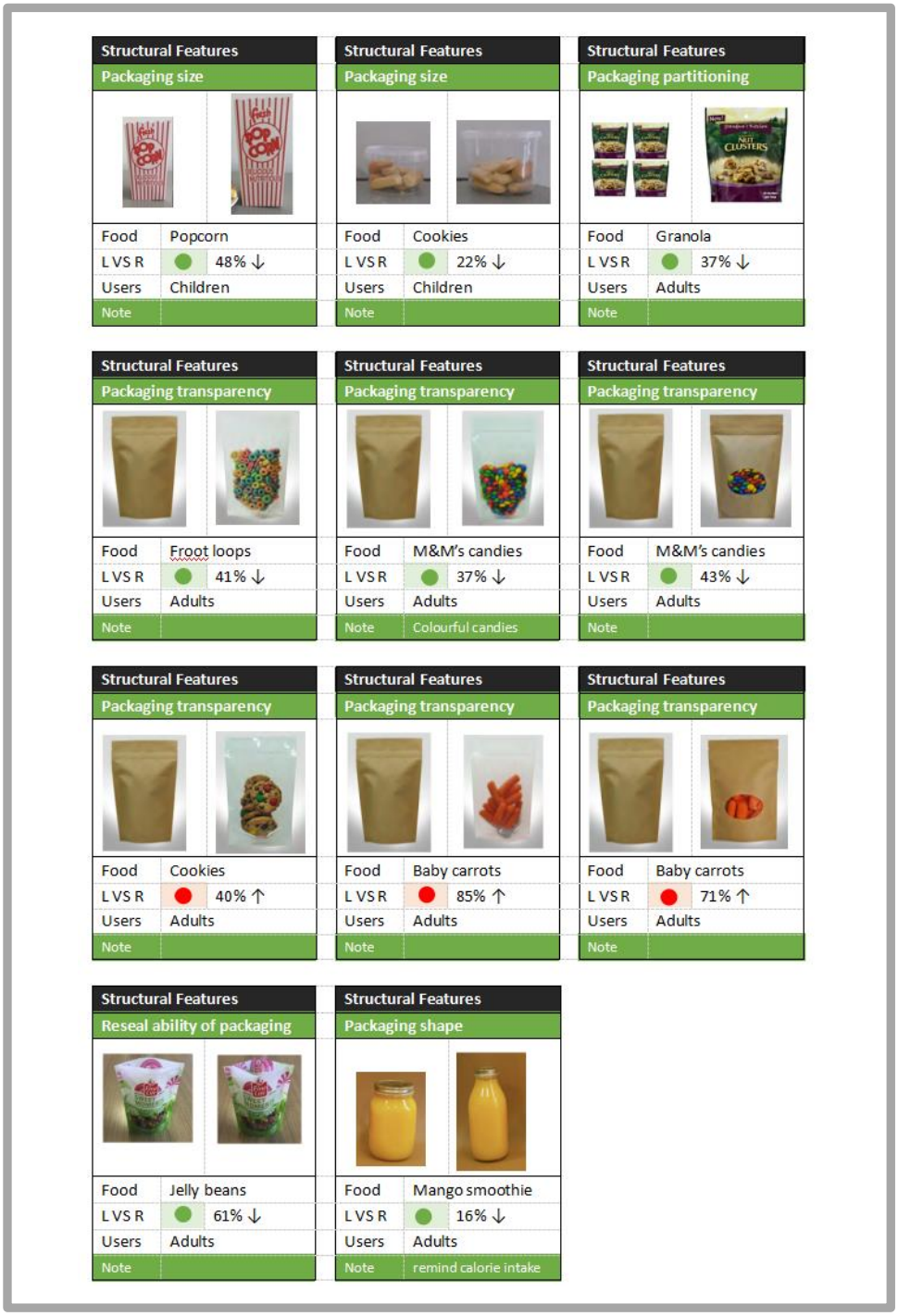


Figure 6.17 The tested structural features and its influence on food intake.

Furthermore, to clarify for designers the prerequisites that enable packaging features to function effectively, practical tips for applying these findings were also provided, based on discussions from the SR study (see Figure 6.18). For example, the results showed that some packaging images have impacts on food intake, but the pre-condition is the image is noticed by consumers. In addition, these tips aimed to inform designers that the influence of design modifications in packaging

attributes on intake is contingent upon the inherent qualities of the food and various consumer factors. They also aim to encourage designers to consider food characteristics, consumer attributes, and other influencing factors when implementing these packaging features.

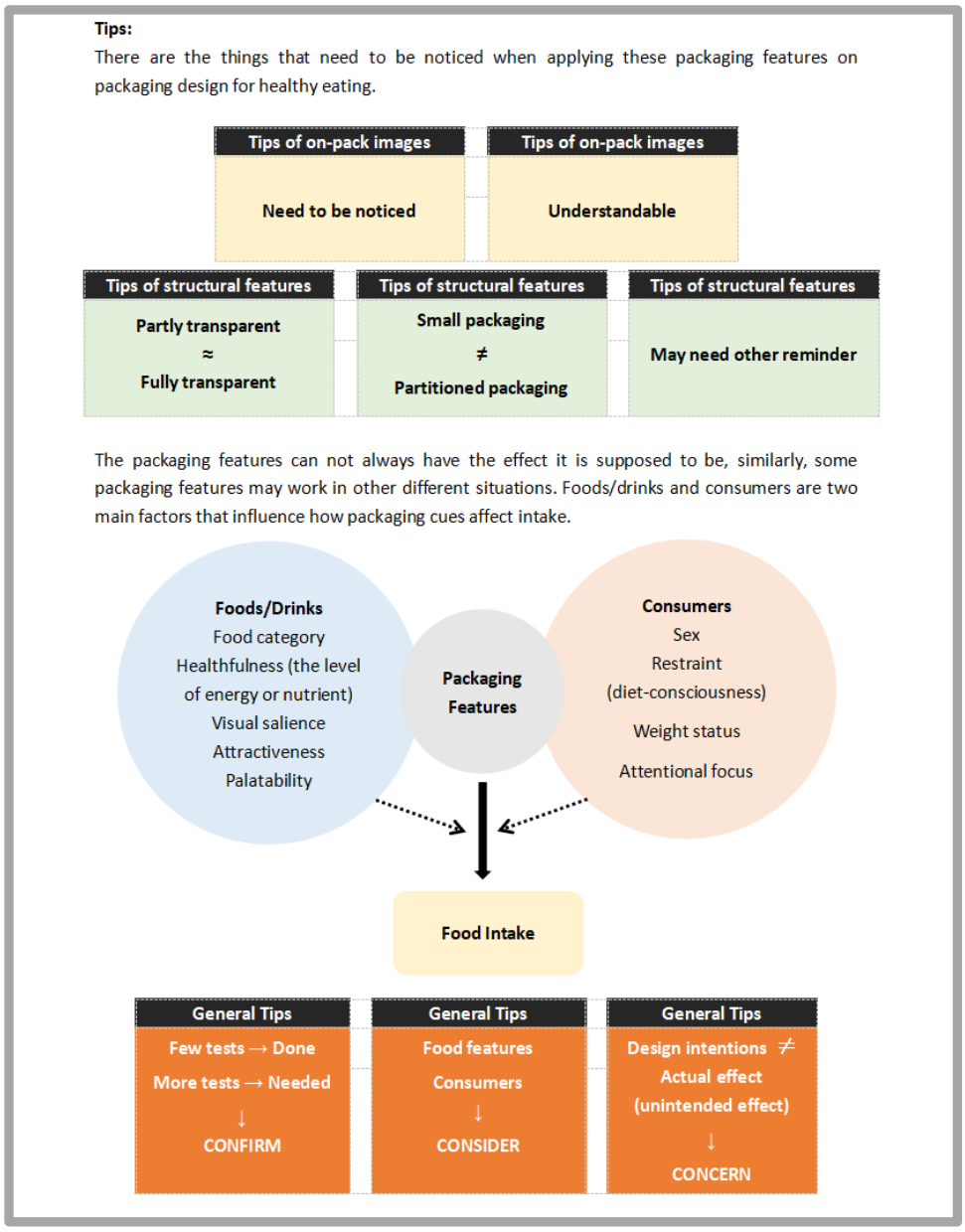


Figure 6.18 The presentation of the tips of using these study findings.

- ***Inspiration- Salient features and noticed portion control cues***

Consumer perceptions of food packaging and its potential to reduce food waste are essential considerations for researchers, packaging designers, and food companies to promote acceptance and effective utilisation of packaging solutions (Brennan et

al., 2023). This aligns with designers' considerations regarding the market and consumer acceptance, as evidenced by the findings in section 6.3.1.2. This tool summarised the findings from the consumer research in Chapter 5 to provide consumers with a better understanding of the main packaging features that are attractive for consumers (see Figure 6.19) and those that, in consumers' experience, can help with portion control (see Figure 6.20 and Figure 6.21).

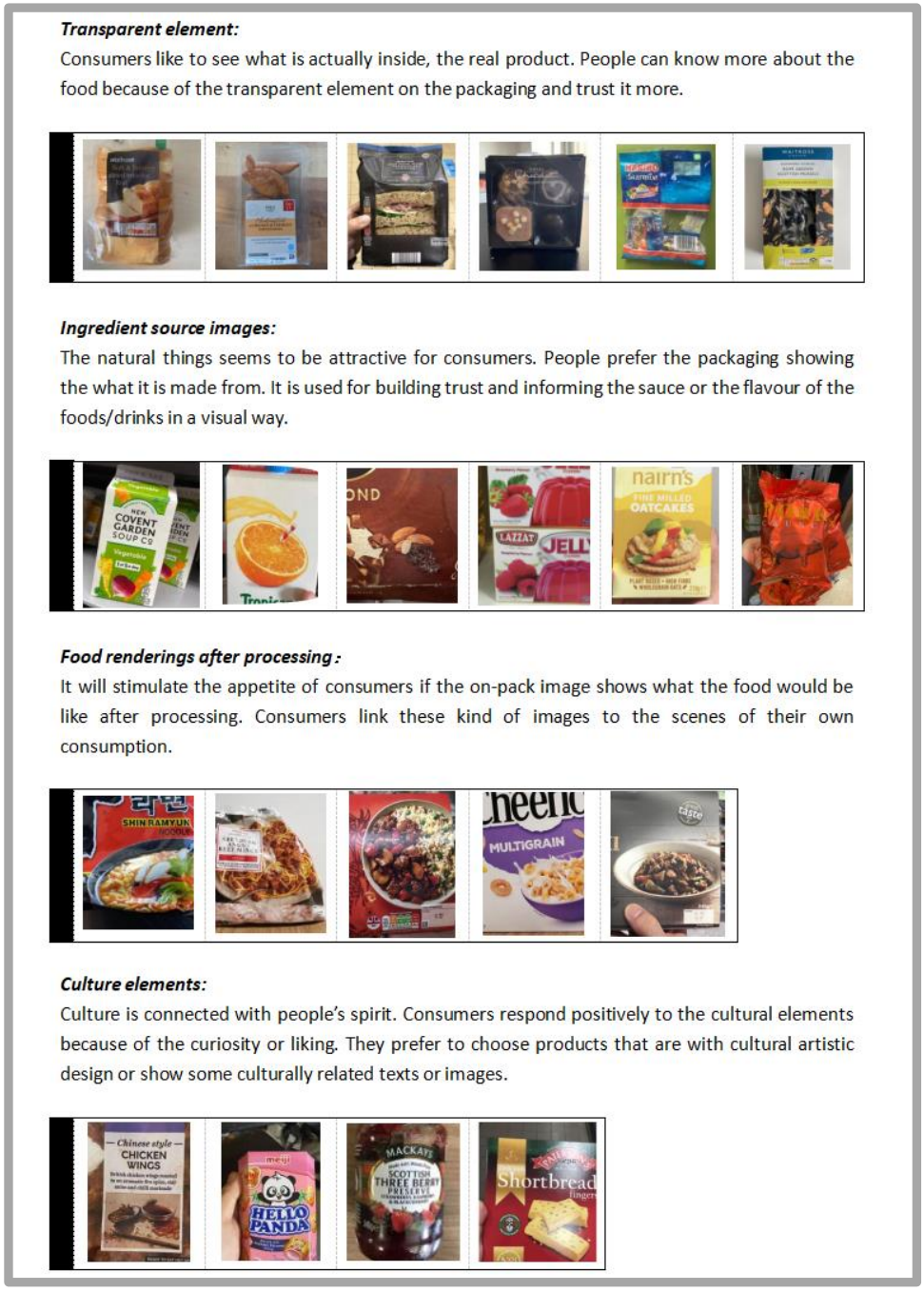


Figure 6.19 The salient packaging attributes from consumers' perspective.

Specifically, the appealing packaging attributes includes: transparent elements, ingredients images, food renderings after processed and cultural elements. Noticed impactful packaging attributes on food intake includes: single serving pack; packaging with reseal ability, nutrition labels or energy content numbers, partitioned packaging and transparent panels.

Figure 6.20 The packaging attributes facilitating portion control (single serving, small packs size, resealability and labelling).

Figure 6.21 The packaging attributes facilitating portion control (partitioning and transparency).

This section of the design tool included the image examples of specific packaging features and a brief text description to explain why they are attractive to consumers or why they can influence food intake. This section was designed to bring consumer insights to designers, making them understand how packaging design affect the attention and consumption from consumers perspectives.

- ***Inspiration- Target consumers***

Casteleyn et al. (2004) stressed the importance of identifying different target audiences and their requirements in web design. Conradie (2014) also emphasised the importance of leveraging sociocultural knowledge about the target audience for designing relevant educational materials. Therefore, the role of knowing the target audience in informing design decisions was revealed (Manero et al., 2016). It allows designers to adopt tailored design strategies that resonate with their

intended users (Jansen et al., 2020). User personas are a fundamental aspect of user-centred design, commonly used across disciplines to enhance designers' insights into diverse target audiences (Haldane et al., 2019). Thus, it can be used to highlight that such designs are not only relevant for individuals aiming to lose weight but can also benefit a broader population. Personas serve as fictional representations of target users and help designers comprehend and empathise with their audience throughout product development (Barambones et al., 2024). Compared to the empathy map or journey map which primarily focus on understanding user feelings and experiences (Kamińska et al., 2023), persona can provide a direct image of the target user and their features. Thus, this design tool created three representative consumer personas to represent diverse target consumers and address various healthy eating needs, thereby offering broader design directions. Figure 6.22 presents three personas of target consumers who may benefit from the health-oriented packaging design, including individuals who are overweight, in a sub-healthy state, and busy individuals seeking to stay fit.

Figure 6.22 The presentation of target consumers' personas.

In addition, as revealed in Chapter 4, customers possess varying attitudes towards food consumption. These attitudes categorise consumers into distinct groups, which are summarised and elaborated in Figure 6.23. Different strategies may be used in packaging design for different types of target consumers. Understanding users' genuine desires, needs, and pain points, as this can lead to the creation of meaningful designs and innovative solutions (Park et al., 2024). This material intended to highlight the significance of understanding the consumers.

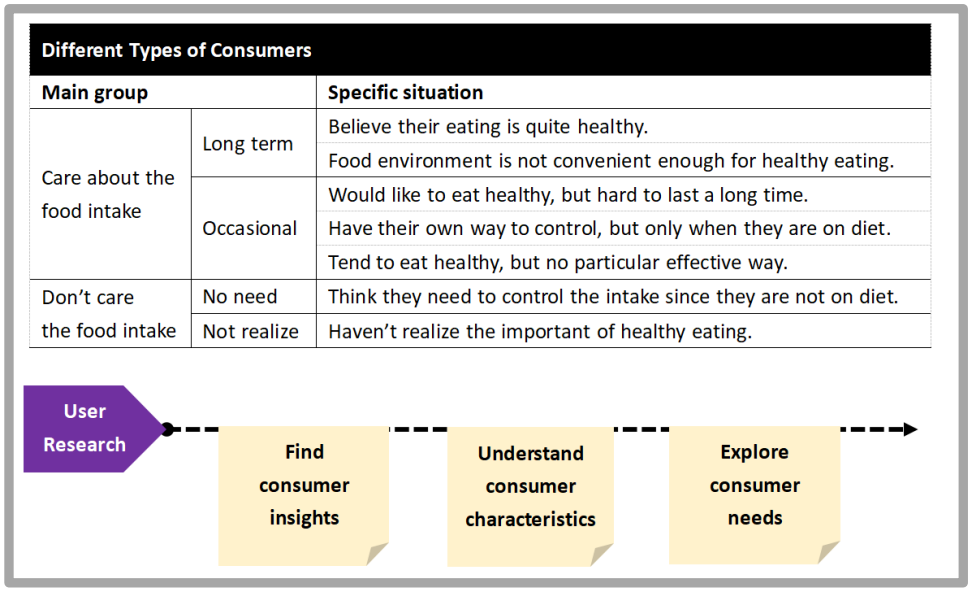


Figure 6.23 The presentation of various types of consumers.

Both sections aimed to help designers gain a general understanding of the diversity of target consumers, including their characteristics and attitudes toward food intake. In addition to providing insights, they encourage designers to conduct specific consumer research or create personas based on their target audience and tailor packaging designs accordingly.

- ***Inspiration- Design strategies***

Designers could benefit from an expanded understanding of creative thinking methods employed across various sectors to address unfamiliar challenges (Stacey and Eckert, 2010), highlighting the importance of integrating multiple design strategies to address complex design problems effectively. Furthermore, leveraging cognitive psychology theories can support innovative design approaches. Li et al.

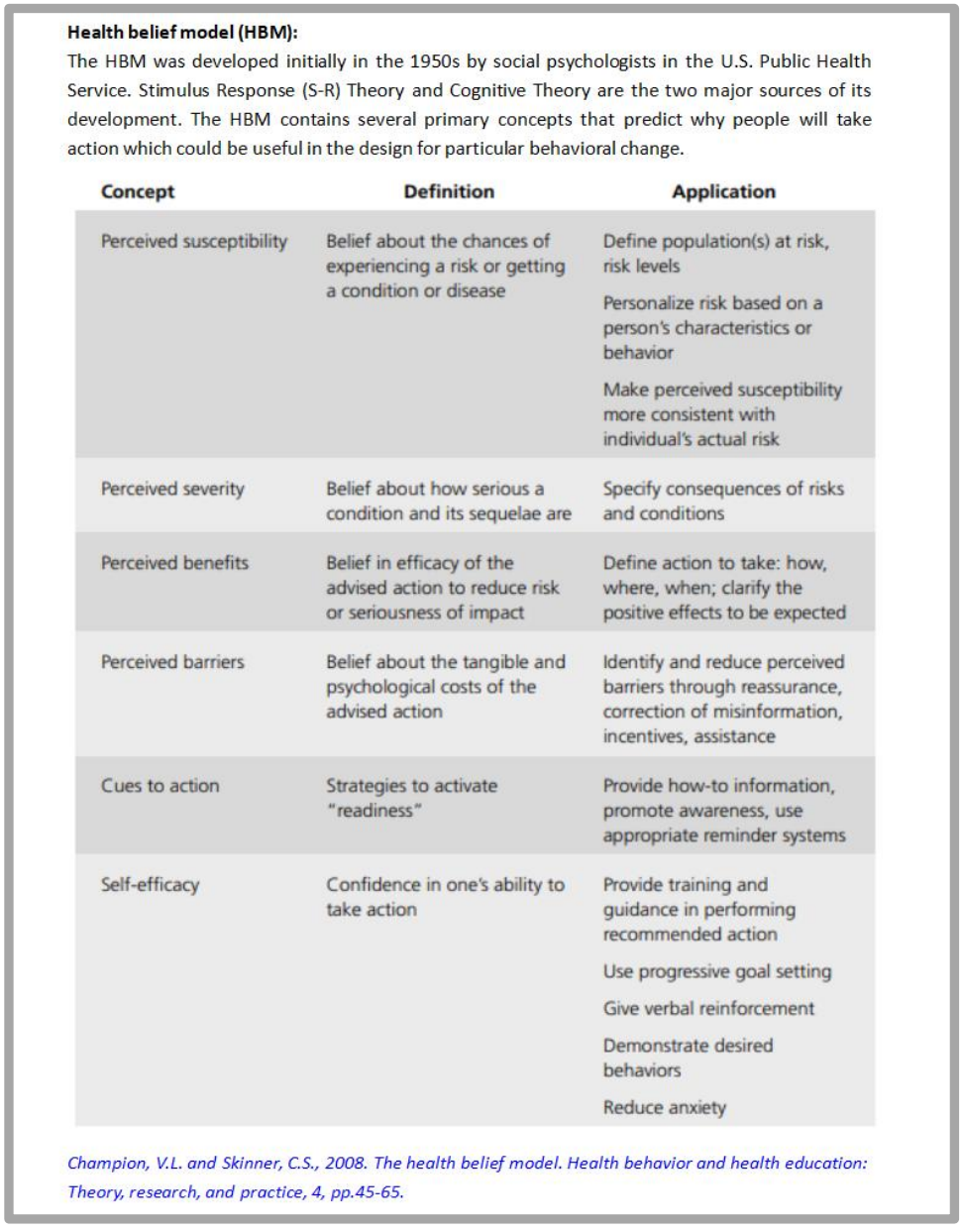
(2010) proposed a method based on cognitive psychology to categorise knowledge into explicit and tacit forms, aiding in knowledge transfer and creation in product design. Numerous studies have emphasised the significance of integrating behaviour change models and theories into the design process to develop interventions based on evidence-based practices (Merz and Steinherr, 2022, Agyei et al., 2024, Hors-Fraile et al., 2019). Webb et al. (2010) also demonstrated that interventions grounded in behavioural theories are more effective in promoting health behaviour change. For example, gamification and persuasive technology can be combined to incentivise energy-saving behaviours (Martin and Kwaku, 2019). The effectiveness of the warnings on the cigarette packaging is rooted in the HBM constructs (Jones et al., 2015), particularly perceived susceptibility and severity, as they make the risks of smoking more tangible to consumers. Thus, to achieve the packaging design purpose on healthy eating, this design tool explored relevant psychology theories and models to assist the expected dietary change.

These theories utilise psychological principles to elucidate how individuals respond to stimuli and how their behaviours can be altered. The design tool integrated Health Belief Model (HBM), the Theory of Theory of Reasoned Action/Theory of Planned Behaviour (TRA/TPB), and Persuasive Technology (PT) to provide theoretical inspiration to designers. In current research context, HBM can help designers understand the perceived barriers and benefits that influence consumers' decisions about healthy eating. TRA/TPB can be applied to encourage purchasing intention and intake change through influence the perception of the consumers on food packaging. PT provides an approach to use packaging as a communication tool to persuade consumers towards healthier choices and portion intake. More detailed description of these theory/model are introduced in the following sections.

Health Belief Model (HBM)

HBM is a widely used socio-psychological theoretical framework developed in the 1950s (Hochbaum, 1958) to explain the process of change in relation to health behaviour and encourage health-related behaviours. It focuses on beliefs and attitudes, positing that changes in beliefs and attitudes can lead to changes in

health preventive behaviours (Lyons et al., 2022). HBM comprises essential constructs including perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action and self-efficacy (Champion and Skinner, 2008), which collectively shape individuals' health-related decision-making and behaviours (Abd El Aziz et al., 2016, Shaahmadi et al., 2019).



Health belief model (HBM):

The HBM was developed initially in the 1950s by social psychologists in the U.S. Public Health Service. Stimulus Response (S-R) Theory and Cognitive Theory are the two major sources of its development. The HBM contains several primary concepts that predict why people will take action which could be useful in the design for particular behavioral change.

Concept	Definition	Application
Perceived susceptibility	Belief about the chances of experiencing a risk or getting a condition or disease	Define population(s) at risk, risk levels Personalize risk based on a person's characteristics or behavior Make perceived susceptibility more consistent with individual's actual risk
Perceived severity	Belief about how serious a condition and its sequelae are	Specify consequences of risks and conditions
Perceived benefits	Belief in efficacy of the advised action to reduce risk or seriousness of impact	Define action to take: how, where, when; clarify the positive effects to be expected
Perceived barriers	Belief about the tangible and psychological costs of the advised action	Identify and reduce perceived barriers through reassurance, correction of misinformation, incentives, assistance
Cues to action	Strategies to activate "readiness"	Provide how-to information, promote awareness, use appropriate reminder systems
Self-efficacy	Confidence in one's ability to take action	Provide training and guidance in performing recommended action Use progressive goal setting Give verbal reinforcement Demonstrate desired behaviors Reduce anxiety

Champion, V.L. and Skinner, C.S., 2008. The health belief model. Health behavior and health education: Theory, research, and practice, 4, pp.45-65.

Figure 6.24 The presentation of Health Belief Model.

Designers can benefit from the HBM in designing interventions and products that promote health behaviours by influencing individuals' beliefs, attitudes, and perceptions regarding the healthy eating or food packaging. For example, designers can tailor their creations to address perceived barriers and enhance perceived

benefits, thus encouraging the adoption of healthy behaviours (Mehta et al., 2014). Overall, the HBM provides a structured approach for designers to comprehend the psychological factors influencing health behaviours and to develop targeted packaging design strategies that resonate with individuals' beliefs and attitudes, ultimately fostering positive health behavioural outcomes. Figure 6.24 illustrates the six concepts of HBM together with their definitions and applications.

Theory of Reasoned Action/ Theory of Planned Behaviour (TRA/ TPB)

TRA was developed by and Fishbein in 1980 (Al-Suqri and Al-Kharusi, 2015), a valuable framework that designers can utilise in the DfBC. It is a psychological human behaviour model focuses on individuals' attitudes and subjective norms (Sheer, 2023). It serves as the foundation for understanding the determinants of behaviours (Wibowo and Indarti, 2020). TRA assumes that individuals are rational decision-makers who consider the consequences of their actions before deciding to engage in a behaviour. TRA was extended to the Theory of Planned Behaviour (TPB) (Hackman and Knowlden, 2014), which emphasises the role of perceived behavioural control in influencing intentions and behaviours (Hale et al., 2002).

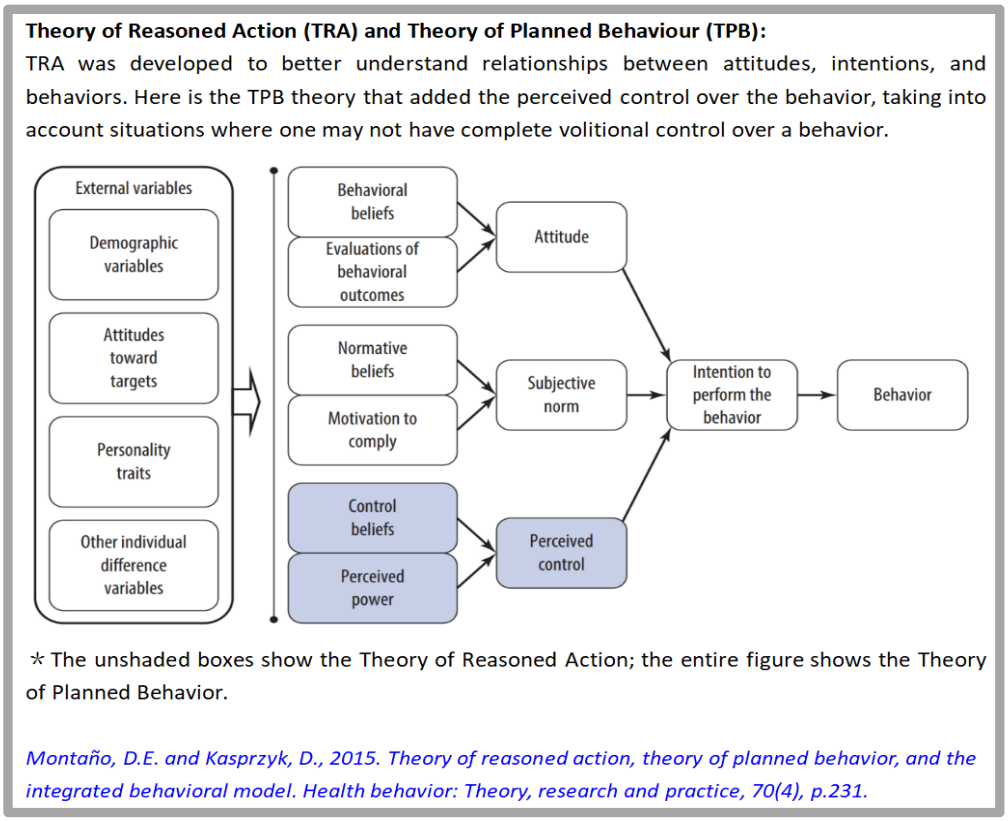


Figure 6.25 The presentation of TRA and TPB.

Designers can benefit from TRA and TPB by aligning their designs with users' preferences to enhance user acceptance (Torano and Kharie, 2023). Incorporating TRA and TPB into the design process can provide insights into users' perceived behavioural control, attitudes, and subjective norms, which collectively shape intentions and behaviours, making them essential tools for designers to develop more effective and user-friendly food packaging designs (Anderson and Lavallee, 2008). Figure 6.25 presents how the TRA and TPB frameworks were provided to designers to serve as theoretical guidance.

Persuasive Technology (PT)

The Persuasive Technology (PT) approach, grounded in psychology and behavioural science, is valuable for designers seeking to influence health behaviour change. For example, PT utilises interactive computing systems to modify people's attitudes and behaviours without coercion or deception (Gu and Mastaglio, 2009). Additionally, by integrating persuasive principles, health apps can serve as supportive tools to encourage and guide users towards desired behaviours (Geuens et al., 2016). Research has demonstrated that PT can improve nutrition in young children by addressing fussy eating behaviours (Winahyu et al., 2023), and encourage the selection of healthy and ecological food options (Volgger et al., 2022). The integration of PT in health behaviour changes design offers a structured approach to leveraging social influence, cultural nuances, and personalised strategies. Designers can use it to motivate consumers towards adopting appropriate food intake, thus, it was provided in design tool (see Figure 6.26).

Persuasive Technology (PT):

Persuasive technology (PT) is the general class of technologies that purposefully apply psychological principles of persuasion. It has been used in many dominions, including "Health Domain" (e.g., physical activity, eating, smoking). PT is an example of design intended to result in certain user behaviour.

Persuasive Strategy	Short Description
Reduction	Making a complex task simpler
Tunneling	Guided persuasion; giving control over to an expert
Tailoring	Customization; providing more relevant information to individuals
Suggestion	Intervene at the right time with a compelling suggestion
Self-monitoring	Automatically tracking desired behavior
Surveillance	Observing one's behavior publicly
Conditioning	Reinforcing target behavior

Orji, R. and Moffatt, K., 2018. Persuasive technology for health and wellness: State-of-the-art and emerging trends. Health informatics journal, 24(1), pp.66-91.

ORJI, R. & MANDRYK, R. L. 2014. Developing culturally relevant design guidelines for encouraging healthy eating behavior. International Journal of Human - Computer Studies, 72, 207-223

Figure 6.26 The presentation of Persuasive Technology (PT).

- *The development of packaging design strategies for healthy eating*

The previously mentioned models, theories, and technologies have certain areas of overlap, and all demonstrated their potential for accomplishing the desired change in eating behaviour. Although these frameworks have broad applicability, they do not establish a tangible connection with packaging design, food consumption and behaviour. Additionally, these theoretical frameworks may be unclear or too general for designers, and some themes may not be directly applicable to the healthy eating domain. Therefore, this tool generated design strategies, utilising TRA/TPB, which focus on user intention and planned behaviour as the foundation, while integrating other models (HBM and PT) to tailor design strategies for health-promoting food packaging. Figure 6.27 illustrates how the design strategies were developed, integrating overlapping themes to align with the healthy eating domain. To ensure readability for designers, the abstract theories have been translated into specific, actionable strategies with concise descriptions. Figure 6.28 illustrates how the generated design strategies were presented in design tool for designers.

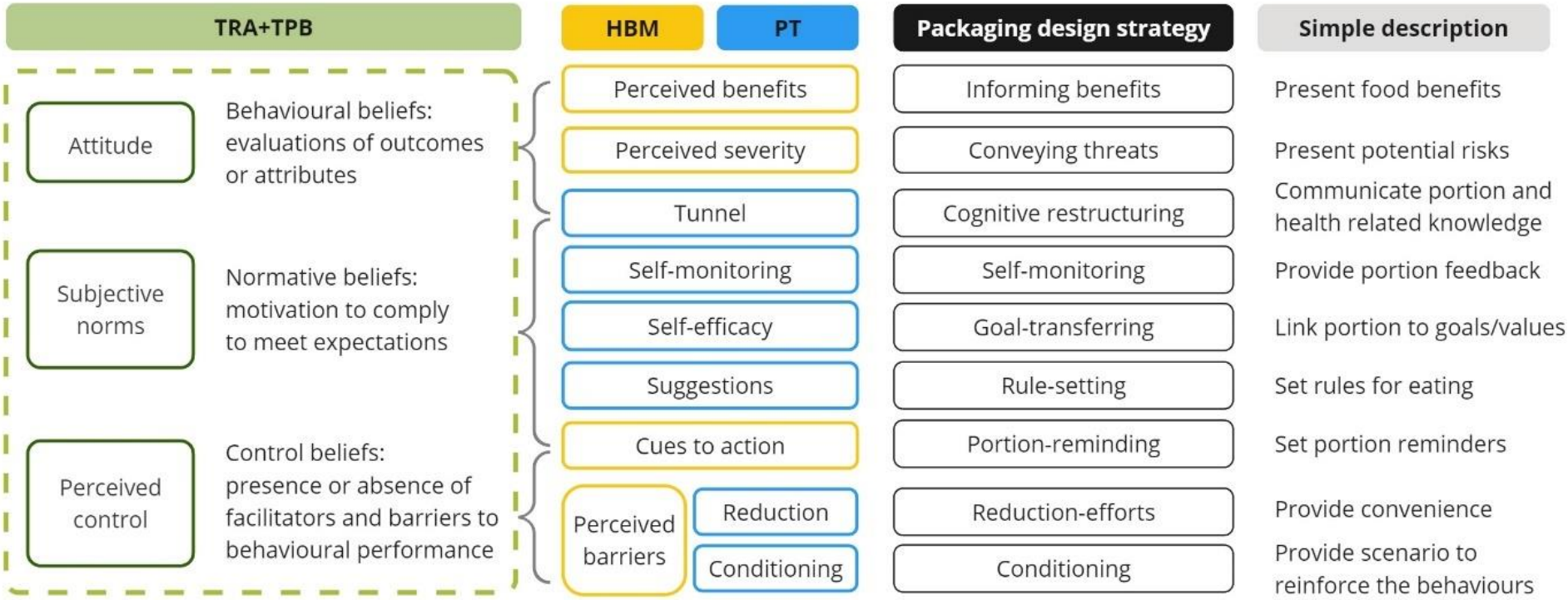


Figure 6.27 The illustration of the packaging design strategies development for healthy eating behaviours.

- **Main strategies for the packaging design for healthy eating**

Based on the model, theories or technology above, here is an attempt to provide designers with a set of packaging design strategies for promoting the health eating of consumers. It take the TRA as the start point to develop the design strategies from three main aspects.

DESIGN STRATEGY		SHORT DESCRIPTION
Attitude	Informing benefits	Presenting perceived health or related benefits.
	Conveying threats	Illustrating potential negative consequences./ Warning
	Cognitive restructuring	Communicating portion related information. Revealing unrealized knowledge/facts of healthy eating.
Subjective norms	Self - monitoring	Showing the consequence, providing real time feedback.
	Goal - transferring	Linking food portion to the life goals of consumers.
	Rule - setting	Making rules of portion intake for consumers.
	Reminding	Setting reminders for consumers to remind them about the portion size or food intake.
Perceived control	Reduction-efforts	Making the portion guide easy-to-understand. Simplifying the intended actions of consumers.
	Conditioning	Reinforcing the food intake behaviours of consumers.

Figure 6.28 Integrated packaging design strategies for healthy behaviour change

Furthermore, findings from prior studies in this research were consolidated, and practical tips for implementing the design strategies were provided. The factors identified in Chapter 4 that affect the impact of packaging features on food consumption include the characteristics of the food and the consumer. Meanwhile, eating habits, knowledge of portion sizes, acceptance of portion control, and eating occasions, which were also revealed in Chapter 5. To remind the designers to make a comprehensive consideration when applying these strategies, these factors were provided in the design tool, as illustrated in Figure 6.29.

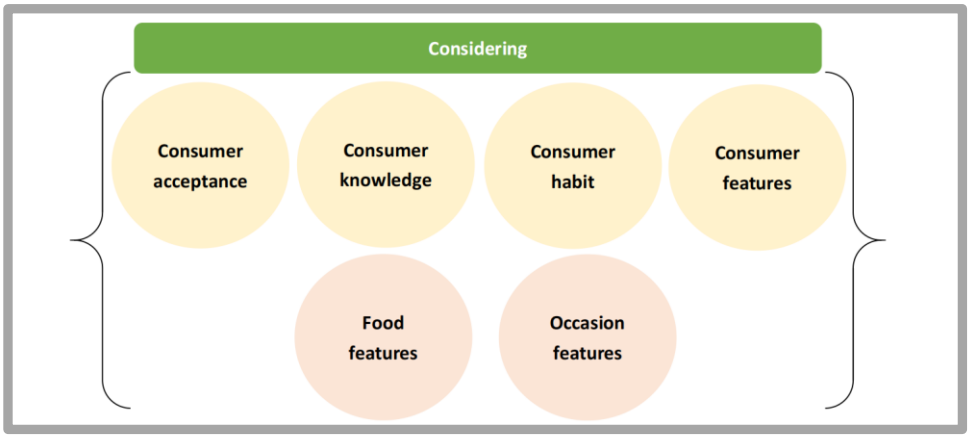


Figure 6.29 The presentation of the design strategies application tips.

- ***Inspiration- Design ideas from other designers***

In the design area, drawing inspiration from other designers' ideas is a common practice that can lead to innovative and creative outcomes. Research has shown that exposure to design exemplars can enhance creativity and inspire idea generation (Xu et al., 2021, Vasconcelos et al., 2017). For example, Lai (2007) highlighted the concept of 'idea hitchhiking' in the idea association process, where designers build upon each other's ideas to develop innovative concepts throughout the design process. In addition, searching for existing design examples is a common practice to find inspiration, as exposure to different ideas can stimulate designers' creativity and help overcome fixation (Hatıpoğlu and Yıldız, 2018). However, as reported by designers (see Section 6.3.2), there are few existing packaging design examples, since it remains a relatively new field of study. Thus, the current design tool provides some packaging design ideas to serve as references for designers and inspire creative design solutions. These design examples were from the professional designer participants who were required to create a new packaging design for promoting healthy eating. The slatches were collected and categorised based on the design features and intended impact on food intake.

A. Increase the attractiveness of the ND foods packaging (see Figure 6.30)

These designs presented a healthy living style through food packaging and highlighted the food features or benefits to attract consumers to encourage the consumption of healthier foods. Besides, some designs incorporated transparent elements in packaging to visually highlight the food's natural and healthy qualities.

B. Visualise the portion/energy (see Figure 6.31)

Some designs linked the portion to the other familiar stuffs in daily life or something that people care about. For example, energy content was associated with specific physical activities (e.g., running, cycling, or swimming) to increase awareness of energy consumption and portion sizes. Some risks to organs and changes in body shape were displayed on the packaging to draw people's attention to the potential consequences of over-consumption. The portion scale was also used as portion feedback to remind the portion intake.

These designs presented a kind of healthy living style through packaging and presented the food characteristics/benefits to attract more consumers to join healthy eating. In addition, some used transparent element in packaging, showing the ND food itself, to highlight its naturalness and healthiness of the food inside. *(informing the benefits / Goal - transferring)*

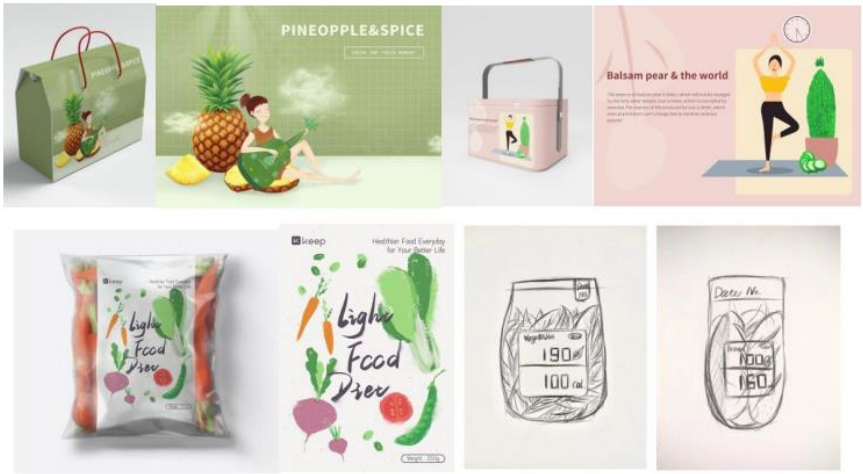


Figure 6.30 The presentation of the packaging design examples for encouraging the consumption of healthy food.

Some designers linked the portion to the things closer to the life or to some familiar stuff or something that people care about (e.g., body shape, organ, corresponding physical exercise) to draw people' attention to the consequences and potential harm of over-consumption. The portion scale is also used to remind consumers the portion intake. (Goal - transferring / Conveying threats / Reminding)

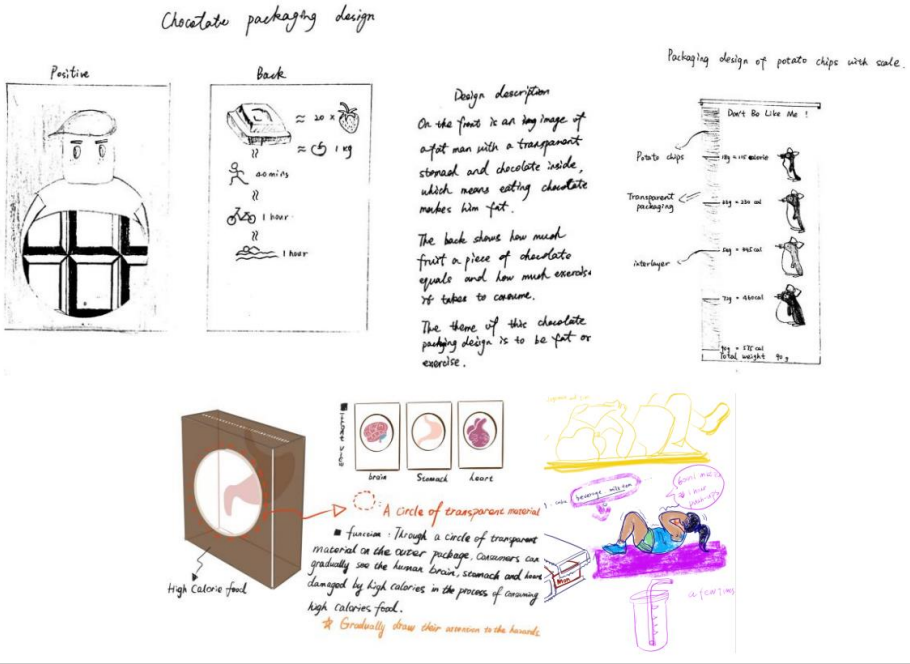


Figure 6.31 Design examples for portion control via visual features.

C. Physically partitioned (see Figure 6.32)

Some packaging designs divided the packaging into multiple small portions, providing appropriate portions for single servings or daily consumption to assist with portion control. In addition to partitioning, some fun elements were incorporated into the packaging design. For example, a random 'gift card' was included in the packaging, or the food packaging was designed as 'mystery boxes' to engage consumers and evoke positive emotions, thereby reducing negative feelings linked to portion restrictions.

Dividing the packaging into multiple small portions which provided appropriate portion for one serving or for one day is used in food packaging design to help with the portion control. Some designers also added the fun element to the packaging design, like adding random “gift card” or designing the packaging into a “mystery boxes” to try to bring more positive feelings from consumers rather than the negative feelings which may caused by portion restriction. *(Conditioning / Rule - setting)*

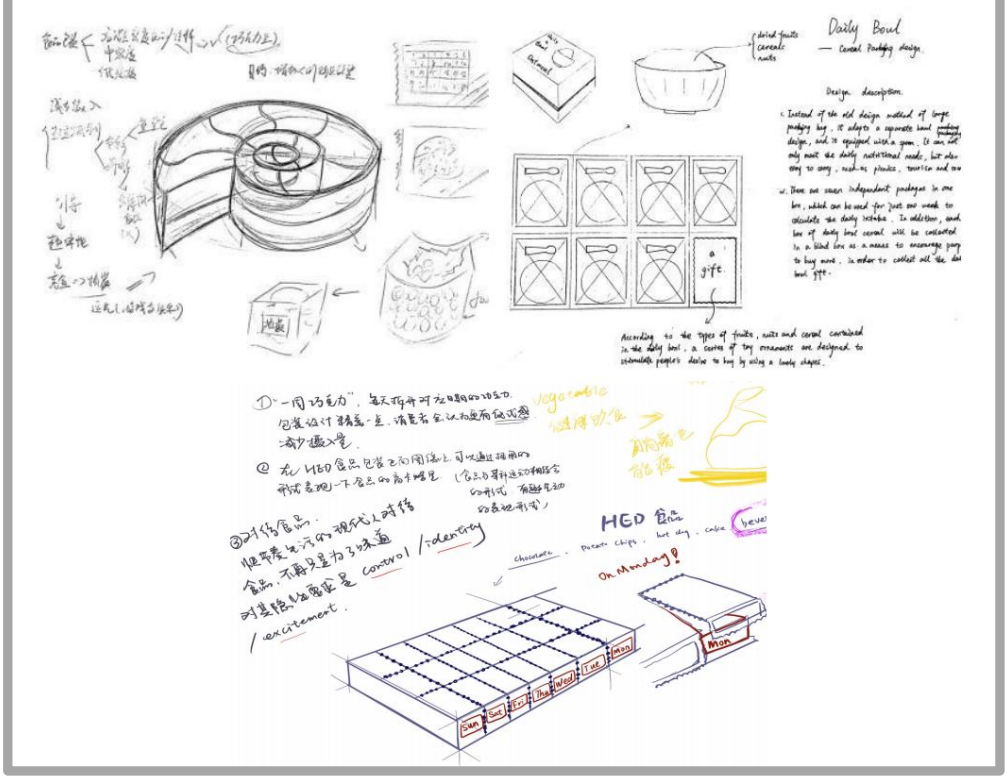


Figure 6.32 Design examples for portion control via structural features.

6.5.3 Design tool presentation

As reflected by designers, they prioritise design tools and supportive resources that are user-friendly, emphasising accessibility, simplicity, and visualisation (see section

6.3.3). The design tool developed by Aeni Zuhana Saidin (2015) serves as a strong example, as it organises persuasive design knowledge into actionable categories, enabling designers to apply these principles during the design process. The content is straightforward, combines text and visual elements, and is presented in PDF format for interactivity, while also being accessible on the web and as a standalone desktop application.

Research has shown that incorporating visual component significantly enhances consumers' understanding (Rose et al., 2011). The involvement of visual elements such as diagrams, icons, or infographics, enables designers to better apply the visual details to their concepts (Omwami et al., 2020). By integrating visual cues and collections of pictures, designers can gain useful insights and inspiration for their work (Zhang and Jin, 2022). Moreover, research on UI visual interface design emphasizes creating user-friendly interactions between individuals and software, enhancing usability and simplicity (Yue and Ying, 2023). These principles can also be applied to the presentation of the design tool materials to make it user friendly for designers by organising the content in an intuitive layout to reinforce the goal of usability and accessibility in the design process. These explain designers' preferences for simple and visual oriented materials. Thus, this design tool was designed to prioritise visual content to minimise cognitive load while enhancing user experience. Textual descriptions were included only when necessary to ensure the integrity of the content. For instance, text was provided when the content could not be fully conveyed through visual cues alone, combining text and visual elements to enhance explanations. Figure 6.33 presents a comprehensive overview of all design tool materials, categorised into information and inspiration sections.

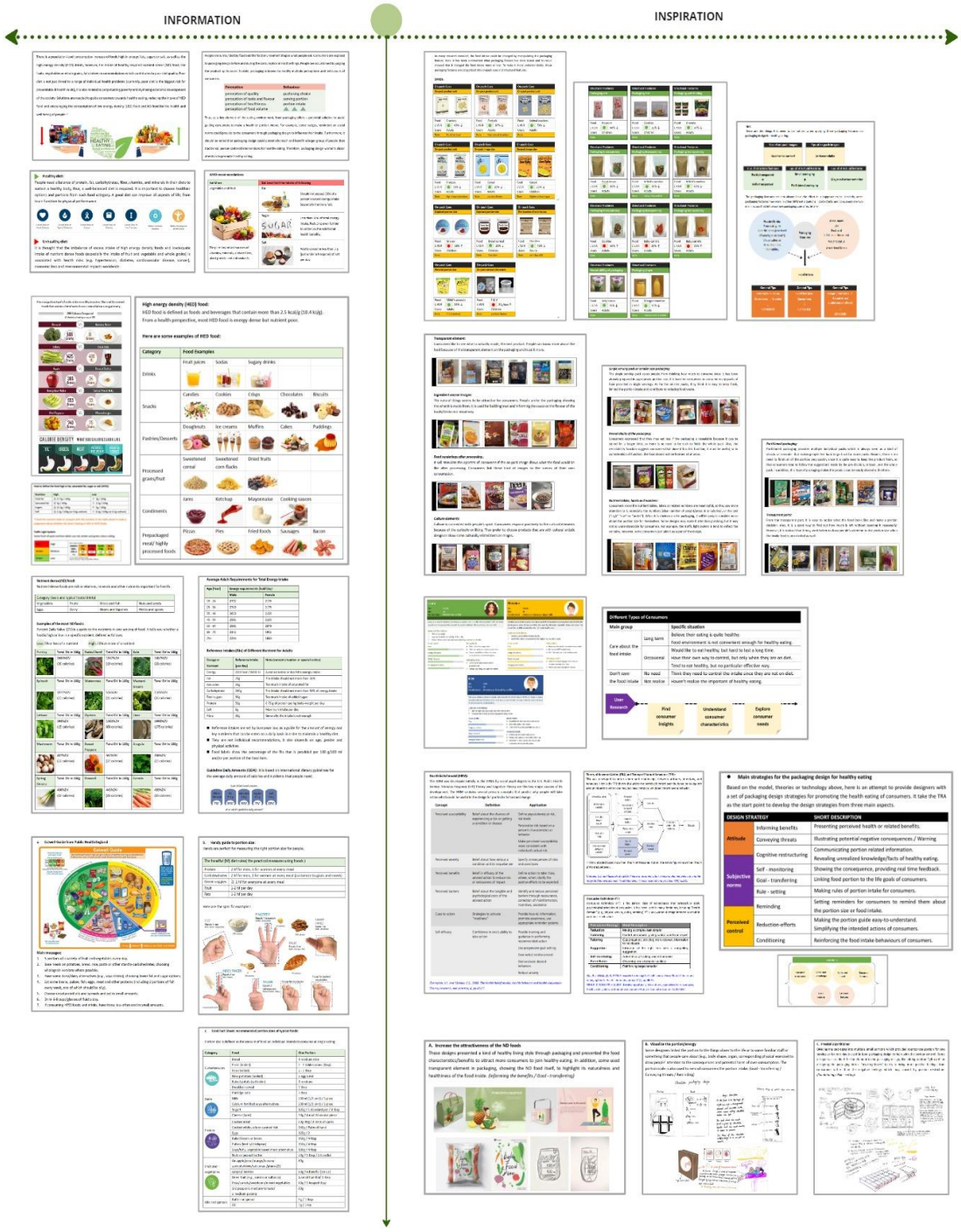


Figure 6.33 The presentation of all generated design tool support materials.

(Left: information content; Right: inspiration content)

Conclusion

Designers have an emerging role in using their expertise in packaging design to create supportive environments to contribute to healthy eating. Given this novel design problem, the results indicated that designers encounter several barriers ,

including lack of clear understanding of the design topic and lack of accessible useful materials to assist their design. To be specific, designers place significant emphasis on promoting healthy food while neglecting the impact of food packaging on portion control. Besides, there is a concern regarding market and consumer acceptance of portion-controlled packaging. Furthermore, designers struggle to obtain reliable resources and design examples to support the creation of innovative packaging designs, categorised into two key aspects, categorised into two aspects: information and inspiration.

The study on designer needs revealed an emerging demand for specialised design support that meets the specific requirements of food packaging with the goal of promoting healthy eating. Therefore, the identified demands were translated into design tool materials, introducing essential nutrition information to deepen understanding of the design topic and providing materials identified by designers to inspire packaging design. Specifically, the information section comprises an introduction to the background of the design issue, a concise explanation of general healthy eating knowledge, identification of food categories and specific food examples. It also provides an overview of energy content and portion sizes, as well as guidelines for intake requirements and portion sizes. The inspiration section includes the illustration of the impact of packaging features on food intake, the eye-catching attributes and the noticed portion control cues from consumers' perspective, target consumer types, psychology-based design strategies for achieving expected eating behaviours and the design examples from other designers. Moreover, the presentation of the materials follows the requirements proposed by designers that keep it concise and visualised. By embracing these supportive materials within the current design tool, designers can navigate unfamiliar design territories, foster creativity, and develop innovative packaging solutions to address this health-oriented packaging design challenge.

Chapter 7
DESIGN TOOL IMPROVEMENT WITH DESIGNERS

The initial version of the design tool materials developed in Chapter 6, was then tested with designers in this chapter for improvement. Two studies were conducted with student designers to test the usefulness of the design tool. The section 7.1 introduces the design tool testing study 1 (DS-II) and presents the improved version of the design tool (2.0) (PS-II). Then, the testing study 2 (DS-III) is introduced and discussed in section 7.2.

7.1 Testing design tool 1.0 with designers (TS1)

7.1.1 Method

In order to improve the current design tool materials, a qualitative study was conducted, driven by the need to gain deeper insights into designers' engagement with and interpretation of the design tool (Ekanem, 2019). Semi-structured interviews were applied to get feedback of the design tool materials during design practice of the student designers. Its structured design ensures that feedback focuses on insights into the design tool, while its flexible features facilitate in-depth reflections on experiences and opinions (Kallio et al., 2016), which is essential for capturing designers' perspectives on the tool. The testing study took place at the University of Leeds with student designers, aiming at testing (a) the clarity of the content and (b) the usefulness as a design tool.

(a) *Clarity of the content:* aimed at assessing that the content of the tool can be clearly understood by designers and the layout and format of the tool is appropriate.
(b) *Usefulness as a design tool:* aimed at testing the design tool in use and gathering feedback on the tool's usefulness in developing packaging concepts to promote healthy eating.

7.1.2 Participants and procedures

Overall, this study involved 12 postgraduate student designers for an 11-week course module on Packaging Design for Healthy Eating. They had freedom to choose among the design briefs provided in MA design programmes (design brief for this specific design topic is attached as Appendix 6.1). In the first semester in 2021, 4 student designers participated, and in the next semester in 2022, 8 students were recruited to this study. Participation in the study was entirely voluntary, with participants fully informed about the nature and purpose of the research prior to their involvement. They were introduced to this study, which involved course-related research and aimed to test a design tool intended to support packaging design for healthy eating. Table 7.1 provides the demographic information of the recruited student designers. Each participant was assigned an ID, for example, S1-D1-LG indicates it is from testing study 1, with the first designer identified by the initials LG.

Table 7.1 The demographic information of student designers.

ID	Gender	Age	Design background
S1-D1-LG	F	23	Graphic design
S1-D2-MY	F	25	Graphic design
S1-D3-NG	F	25	Product design
S1-D4-JX	F	26	Product design
S1-D5-BY	F	23	Graphic designer
S1-D6-YL	F	24	Product designer
S1-D7-YWZ	F	24	Design
S1-D8-EL	F	22	Design
S1-D9-FL	F	25	Visual design
S1-D10-JK	F	23	Design
S1-D11-YJ	M	24	Design
S1-D12-JYZ	F	23	Design

After obtaining the consent from the student designers, the study was conducted at the second week of the course after they were introduced to the design issue, and it was structured in the following steps.

1. *Quiz section:* a quick quiz test about food portion and energy was conducted with designers to increase their interest and engagement. The

specifics of the quiz and the justification for using it as an introductory activity will be explained in section 7.1.3 below.

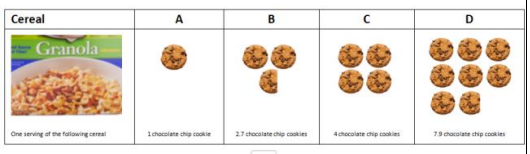
2. *Introduction to the design tool: next,* designers were introduced to the design tool as presented in section 6.5, which consists of an information section and an inspiration section. A brief overview of its components was provided.
3. *Packaging design idea generation with the support of design tool: then,* designers were provided with the design tool materials (PDF) and instructed to use them to support their development of packaging design ideas aimed at promoting healthy eating.
4. *Semi-structured interview for feedback:* at the fourth week of the courses when the initial design idea had been produced, designers were invited to an interview (attached as Appendix 6.2) to provide feedback on the content clarity and usefulness of the design tool.

7.1.3 Study materials

Quiz material

The quiz serves as an effective means of enhancing engagement and interest, especially in educational contexts, while fostering a deeper understanding of the subject matter. For example, quizzes are used as self-evaluation tools, allowing students to assess their understanding and identify areas for improvement (Ariana et al., 2016). Moreover, the interactive nature of quiz enhances student motivation and enjoyment (Pereira et al., 2022), which is particularly beneficial in maintaining student interest. In this design course setting, the quiz section may help increase their interest in using the design tool and developing a deeper understanding of its content. Thus, five representative quiz questions about food energy and food portions were sourced from healthy-eating websites, online magazines, and expert blogs, and were reviewed by Prof. Hetherington to ensure the quiz questions' accuracy and relevance (Trumbo et al., 2016). Then, they were presented to student designers (see Table 7.1 for the quiz details), aimed at raising their interests on food portion and reducing cognitive bias (Duerson et al., 1992).

Table 7.2 The illustration of the quiz, including the questions and answers.

Question	Answer
1. Orange juice vs cola： **The same glass of cola and orange juice, which one contains higher sugar?** 1. Cola 2. Orange juice 3. Nearly the same 	**Both are high in sugar：** Fruit juice and soda contain similar amounts of sugar. Both soda and 100% fruit juice pack around 140 - 150 calories and 30 –35 grams of sugar per cup (330 ml). However, soda is likely harmful to human health, regardless of the amount of consumption, whereas fruit juice may only increase the risk of disease when drunk in large amounts.   **Nutrition Facts** Serving Size 330 ml (330ml) Amount Per Serving Calories 139 — Calories from Fat 0 % Daily Values* Total Fat 0g — 0% Saturated Fat 0g — 0% Cholesterol - — Sodium 0mg — 0% Total Carbohydrate 35g — 12% Dietary Fiber 0g — 0% Sugars 35g Protein 0g Vitamin A - • Vitamin C - Calcium - • Iron - * Percent Daily Values are based on a 2000 calorie diet. Your daily values may be higher or lower depending on your calorie needs. **Nutrition Facts** Serving Size 330 ml Amount Per Serving Calories 156 — Calories from Fat 6 % Daily Values* Total Fat 0.69g — 1% Saturated Fat 0.083g — 0% Polyunsaturated Fat 0.138g Monounsaturated Fat 0.125g Cholesterol 0mg — 0% Sodium 3mg — 0% Potassium 692mg Total Carbohydrate 35.98g — 12% Dietary Fiber 0.7g — 3% Sugars 29.06g Protein 2.42g Vitamin A 14% • Vitamin C 288% Calcium 4% • Iron 4%
2. One serving of the following cereal has as much sugar as how many cookies?  Cereal — A — B — C — D Granola One serving of the following cereal — 1 chocolate chip cookie — 2.7 chocolate chip cookies — 4 chocolate chip cookies — 7.9 chocolate chip cookies	 7.9 chocolate chip cookies 13.6 chocolate chip cookies
3. Which of these contains the most calories? a) 100g of muesli b) 100g of cheese and tomato pizza c) 100g of standard crisps	Muesli contains 330kcal per 100g. Pizza contains 235kcal per 100g. Crisps contain 530kcal per 100g. 100g of crisps is almost four standard-size packets whereas 100g of pizza is almost one mouthful!
4. Which of these ISN'T a recommended portion size of protein? A Two medium size eggs B Four tablespoons of lentils C A tablespoon of peanut butter D A 10oz (300g) beef steak	A sensible portion size of meat is around 60g to 90g. This is about the size of a deck of cards.  
5. **You're trying to eat healthier during the day and reduce your snacking, so you buy a large bag of mixed nuts.** **But what's a sensible amount to have as a portion?** A Between 5 and 10 nuts. B A handful C Two handfuls D The whole bag, as long as it's under 100g	Nuts are a great choice for a healthy snack. But they can be high in fat, so keep your portion to a small handful (around 30g). 

Data collection material in the interview

The evaluation of the clarity and usefulness of design tools is a key focus in current research. The clarity of the content, which directly impacts user comprehension and application (Araújo et al., 2019) and the communication of the materials (Baur and Prue, 2014). The usability of design tools is another important aspect that

affects the user experience and the tool effectiveness (Baur and Prue, 2014, Bazafkan et al., 2019). To gain more specific insights from users, a semi-structured interview method was chosen, as many studies have used this approach for evaluating design tools (Dorta et al., 2008, Kurtoglu et al., 2009, Han et al., 2018). Besides, due to its inherent flexibility and depth of inquiry, semi-structured interview is suitable to gain feedback from student designers' perspective (see section 3.7.4). Three primary domains were featured in the interview: feedback of the quiz; clarity of the design tool content, usefulness as a design tool. Figure 7.1 presents the main interview questions.

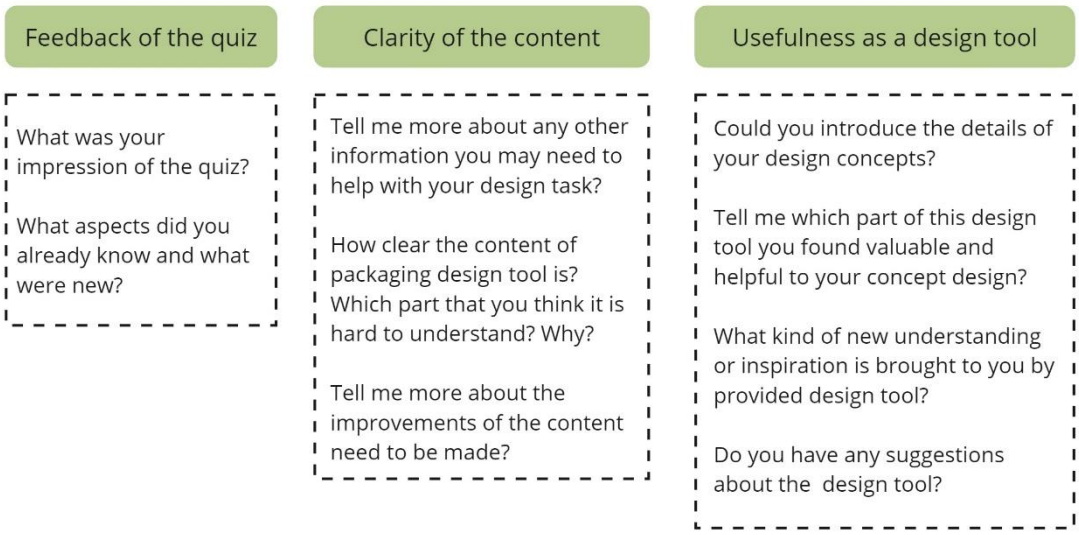


Figure 7.1 The illustration of interview questions with student designers.

7.1.4 Discussion of the results

7.1.4.1 Feedback of the quiz on food energy and portion

- *Interesting way to learn*

The quiz section before the introduction of the design tool got positive feedback from all student designers. They felt it was a fun way to help them gain a deeper understanding of food portions. Some designers suggested keeping this activity since it is a very interesting and useful learning approach.

> *"The quiz was interesting in that it helped us to understand that what we think is healthy food is not healthy, and to understand how to measure proper portion sizes in an everyday way." (S1-D4-JX)*

> *"The quiz was very fun and interesting! "I would suggest you keep the quiz*

activity in the future as it was very fun and a great way to learn!" (S1-D3-NG)

- *Surprised by the food facts – new knowledge*

Many designers were shocked by the fact of the food portion and energy. To be specific, the energy content of certain food is so much higher than they thought. It supports the findings from (Brindal et al., 2012), that consumers often make gross errors in estimating energy intake, suggesting a significant gap remains in consumer knowledge about energy content. Additionally, designers reported that most of the quiz content was new to them, making them aware of food facts they had not previously noticed.

> *"I was shocked to learn that some of the foods I thought were healthy were so high in calories" (S1-D9-FL)*

> *"It seemed like all the aspects were new to me and I hadn't paid attention to the energy of these foods before. Many of the foods I thought were not very high in sugar were much higher in sugar than I thought." (S1-D7-YWZ)*

- *Get inspired – more consideration on the food portion*

Through the quiz, designers not only have access to new information, but also become motivated and inspired. They discovered that many consumers may also possess misconceptions regarding food energy and portion sizes. In addition, they also recognised that there are alternative and innovative ways to measure or communicate food portion sizes.

> *"The quiz raised my interest, letting me realise that most consumers may misunderstand the energy and portion, including me." (S1-D12-JYZ)*

> *"I knew that juice and cereal (particularly sweet cereal) had a higher amount of sugar in them. However, I learned that you could use other methods to identify portion size. Such as, using our hands or other things around us like a deck of cards. This was very insightful and interesting." (S1-D3-NG)*

7.1.4.2 The clarity of the design tool content

- *General positive feedback of the content clarity*

The content of the design tool was considered as clear and easy to follow by designers. The feedback from designers was positive, with some expressing special appreciation for the visual aspects integrated with the text in the materials.

"I think each part of the packaging design tool is showed very clear and easy to understand" (S1-D8-EL)

"Overall, the information was presented very clearly and was easy to follow through. There was also a great use of visual elements" (S1-D3-NG)

- *Clearly purpose of each section is needed*

Despite receiving plenty of positive feedback, some designers reported difficulties due to the large volume of information and content provided by the design tool. They suggested that it would be easier to follow if the purpose of each section of the design tool is provided. It can be explained by extraneous cognitive load theory (Skulmowski and Xu, 2022), which arises from the way information is presented rather than the content itself, can further complicate the designers' experience with tool. Thus, to enhance comprehension of the tool's information, prominent headings or divisions should be incorporated.

"The information is clear, but the intention of each section is less clear and needs to be appreciated. Would like to see the aim added to the headings" (S1-D1-LG)

"It is very logical and clear. There are many materials in this tool, very comprehensive, but it will be great to tell the purpose of each section, let us follow the content with purpose." (S1-D12-JYZ)

- *Prefer more straightforward design strategies*

The design strategies were challenging for some designers to understand. While designers found the strategies interesting and useful, they struggled to grasp the social-psychology theories to some extent. They expressed the preference for a more straightforward or detailed explanation of the design strategies and requested additional design directions.

"However, one section which I found quite difficult to understand at first was the different models and theories. I would prefer it if you could include a few simpler explanations on the model or theory for me to understand it better. Other than that, everything else seems to be great and was very helpful." (S1-D3-NG)

"The design strategies are very interesting, but any more strategies could be provided? Any specific barriers of overeating?" (S1-D12-JYZ)

7.1.4.3 The usefulness of the design tool

- *General positive feedback of the usefulness as design tool*

The designers also provided positive feedback regarding the usefulness of the tool. The information offered by the design tool was deemed to be exhaustive and thorough, encompassing all necessary related content for current design issue. Besides, the content helped designers better understand the design topic and proved valuable for conceptualising packaging designs.

> *"I got most information I need from the tool already." (S1-D12-JYZ)*
>
> *"I think the design tool is good enough to help the designers in creating a nice packaging design solution for promote healthy eating." (S1-D8-EL)*
>
> *"Let me better understand how food packaging can correctly guide consumers to eat healthily" (S1-D6-YL)*

- *Assist to deep understanding of the design background*

According to designers, the design tool made the design issue very clear and reasonable. They had a better understanding about the background information, for example, they know much more about the relationship of the food portion and nutrition as well as the packaging design impacts on consumers.

> *"I particularly found the introduction part where discussed and highlighted key information on healthy eating and its usefulness in detail useful as it clarified what our research task was, which was very clear." (S1-D3-NG)*
>
> *"Packaging not only has a visual impact on the consumer, but also has a wide range of different angles and uses different means to influence the consumer psychologically" (S1-D9-FL)*
>
> *"I think it was the 'Food categories (HED, ND)' section that helped me the most with my design. It made me realise the difference in the energy of food." (S1-D7-YWZ)*

- *New insights gained from the design tool*

The design tool content was reported to bring new insights into design. Specifically, designers learned that there are multiple ways to measure food portions, offering new perspectives on presenting food portions. Besides, the nutrition information and food categories provided more details which could be used as references in their packaging design.

"The portion guide (mainly the part of hand measuring) is valuable that brought me the ideas of using some simple and daily materials to be the portioning tool in my design." (S1-D8-EL)

"I found the image of using hand to guide portion size very useful as I was not aware of this information before. Also, the table which includes the portion sizes of different types of foods was valuable as it gave me an insight into how different types of food have different methods to measure portion size. I will take this information in consideration when designing packaging." (S1-D3-NG)

- *Deriving inspiration from the design tool*

Furthermore, designers reported that they were inspired by design tool. For example, the cards, which present the impact of packaging features on food intake, highlight packaging elements previously overlooked by designers, offering expanded design possibilities. This demonstrated the usefulness of integrating research findings into design practice, commonly referred to as evidence-based design (Stichler, 2016), bridging the gap between research and design practice, particularly when findings represent new knowledge for designers.

The design strategies were also reported to help designers understand how packaging design can influence behaviour change. They assist designers in navigating complex problem spaces and enhancing creative output (Yilmaz et al., 2010) by theoretically guiding packaging design. It showed the value of integrating design strategies to solving design problem, allowing designers to explore ideas that may not be immediately apparent (Valjak and Bojčetić, 2019).

"I found in your Design Tool document that packaging is divided into visual elements and structural elements, which in turn are divided into different types. There are elements I haven't found before, such as serving size food picture. This document has given me a lot of inspiration." (S1-D1-LG)

"The impact of packaging features, get to know many features could be influential on intake, inspired me a lot." (S1-D12-JYZ)

"The design strategies let me know more ways to guide the expected behaviour outcome." (S1-D12-JYZ)

- *Seeking resources references and more design examples*

Alongside the positive feedback on the usefulness of the design tool, designers expressed some other expectations. For instance, they require access to the original sources referenced in the design tool to better comprehend specific areas

of interest. As highlighted by Yakar et al. (2020), access to primary resources is foster deeper understanding and creative synthesis. Besides, more design examples were also requested. Research has shown that examples are a cornerstone of creative practice (Herring et al., 2009) and that exposure to diverse perspectives and ideas can significantly enhance the creative process (Sun et al., 2015).

> *"It is better to see the original source of the content, maybe I will go to explore more details where I am interested." (S1-D12-JYZ)*

> *"It would be nice to have more design examples" (S1-D9-FL)*

7.1.5 Improvement considerations and design tool 2.0.

In summary, the positive comments received from student designers confirmed the clarity of the design tool material and its usefulness as a design tool. However, some issues and expectations regarding the design tool were identified. Table 7.2 presents a design tool improvement framework, summarising the identified issues and the main changes required.

Table 7.3 The improvement framework of the design tool.

Issues and suggestions	Main changes in version 2.0
Not clear about the intention of each section	Distinguishing the purpose of different sections of the content and present them to guide designers in the use of design tool.
Difficulty in understanding the design strategies	Giving more detailed description to explain the design strategies; providing more straightforward design strategies (gained from consumers) to make it is easy to understand.
The need of the content sources	The inclusion of resource references in each section facilitates designers' access to the original data or source.
Keeping the quiz section in the design tool	Integration of the quiz into the design tool to interest and motivate designers for the exploration of the design tool.

The summarised purpose was added to each section to reduce the cognitive load of designers (Sweller, 1988), thereby enhancing the usability of the tool. Besides, the question format was used to inform the designers about the purpose of each section since the questioning serves as a pivotal mechanism for stimulating

engagement, critical thinking, and deeper exploration of subjects (Braund and Lelliott, 2017, Tofade et al., 2013). Figure 7.2 illustrates two examples of the purpose added to each section of the tool's content in a question format. Additionally, the content was streamlined based on its purpose.

Figure 7.2 The illustration of the added purpose of each section of design tool.

Furthermore, more detailed descriptions were included to enhance the clarity of the design strategies. In addition, insights gained from the consumer study in Chapter 5 and the designer study in Chapter 6, which are not addressed by current food packaging design strategies, were integrated into the design strategies to offer additional design directions and maximise inspiration for designers.

Research indicated that many human actions are influenced by emotional cues and habitual patterns, which often operate outside of conscious awareness (Jackson, 2014). Idea is further reinforced by research indicating that emotional responses can be triggered by environmental stimuli, which subsequently guide decision-making (Bechara et al., 2000, Smith and Lazarus, 1990). It was shown that emotions like guilt and pride influence consumers' sustainable consumption choices, shaped by ethical beliefs (Wang and Wu, 2016), suggesting that emotions can serve as a strong motivator for consumer behaviour change. Besides, both food inside and the packaging were found significantly raise the emotion response of consumers, such as pleasantness, and thereby impact their choices (Gutjar et al., 2015). Thus, emotional prompts can be integrated into packaging cues to encourage consumers to make choices and decisions that align with their health beliefs. Furthermore, some design ideas from designers aimed at influencing intake behaviour by evoking feelings of guilt or interest in consumers (see Section 6.5.2.2, design examples) were summarised as examples under the 'Emotion' design strategy.

For behaviours that are to be performed more often like eating behaviour that may be under habitual control (Montano and Kasprzyk, 2015), a degree of automaticity

influences behaviour, making it more difficult to change. Under habitual control, intention becomes less important in determining behavioural performance (Triandis, 1979). In addition, consumers showed habitual careless on the portion recommendations. One way to change this habitual inattention to serving size recommendations is by enhancing portion size awareness using visual cues on packaging (Tal et al., 2017). Furthermore, as the HED food is typical visually competitive, making the healthy options hard to be noticed. An important strategy outlined in Chapter 5 (see Section 5.2.2.1) is using design to enhance the appeal of packaging for healthier (LED or ND) foods. It aims to attract consumers and show them there are other alternative, lower energy density more nutrient dense options in the market to support sustainable behaviour change. Thus, two themes: raising awareness and providing alternatives were summarised as "Habit" design strategy.

Table 7.4 New version of packaging design strategies.

DESIGN STRATEGY		DESCRIPTION
Attitude	Informing benefits	Presenting the positive effects to be expected. (e.g., perceived health or related benefits for consumers)
	Conveying threats	Illustrating potential negative consequences of eating too much food items inside the packaging. (e.g., potential disease risk)
	Cognitive restructuring	Revealing unrealised knowledge/facts of healthy eating. (e.g., the healthiness of food, the nutrient recommendation)
Subjective norms	Self - monitoring	Showing the portion intake, providing real time feedback. (e.g., transparent panel, scale, measuring tool)
	Goal - transferring	Linking food portion to the life goals of consumers. (e.g., Fitness, vitality and healthy eating)
	Rule - setting	Making rules of portion intake for consumers. (e.g., informational, structural)
	Portion - reminding	Setting structural or visual reminders for consumers to stop them from overconsumption. (e.g., individual pack, independent energy content)
Perceived control	Reduction - efforts	Making the portion guide clear to see and easy-to-understand. Simplifying the intended actions of consumers (convenience).
	Conditioning	Reinforcing the portion control behaviours of consumers. (structural, interactive, narrative or combine with other social media activities)

Emotion	Guilt - inspiration	Stimulating guilt about overeating (Linking the energy or sugar or fat content to typical HED food or equal exercise)
	Arousing interest	Appealing to enjoy the food/consumption (e.g., fun, game)
Habit	Raising awareness	Reminding consumers to notice their portion intake or their eating habit. (e.g., healthy prompts, unit number, warning signs)
	Providing alternatives	Showing the other options to catalyse the new behaviour. (e.g., increasing the attractiveness of the healthier food packaging)

As for the need for original source of the content, the references were provided in the design tool. For example, many sources of the food and nutrition were provided for retrieval (see Figure 7.3). The quiz section was kept as part of the design tool and was illustrated with images for better understanding. Figure 7.4 presents an example of the illustrated quiz question. In addition, more design concepts from student designers were added to the design tool.

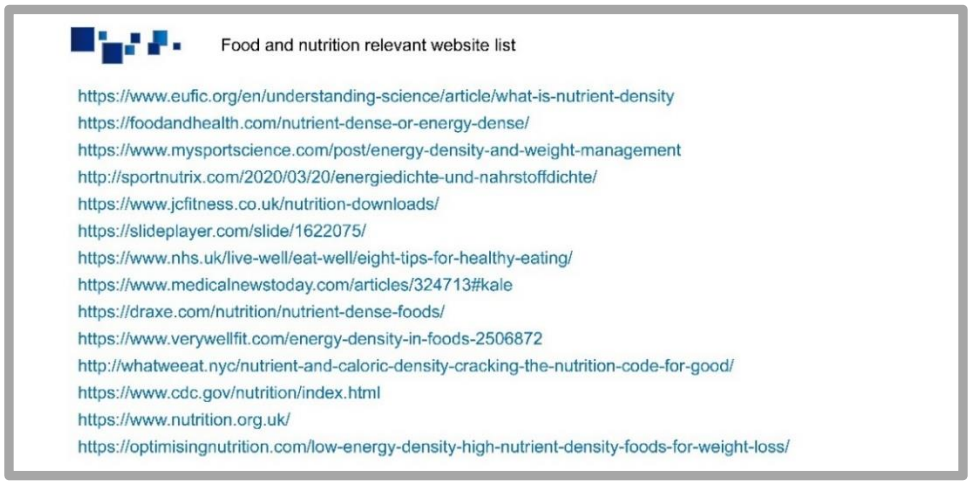


Figure 7.3 The presentation of provided sources of the food and nutrition content.

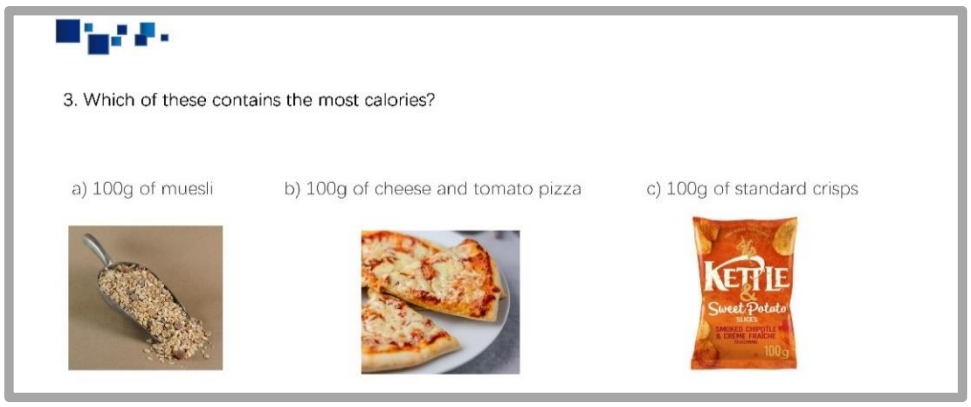


Figure 7.4 The presentation of using image to illustrate the quiz options.

To summarise, the design tool content and its presentation were refined based on issues and suggestions raised by designer participants. Figure 7.5 presents the overview of design tool version 2.0, which were used for further testing with student designers in the following section 7.2.

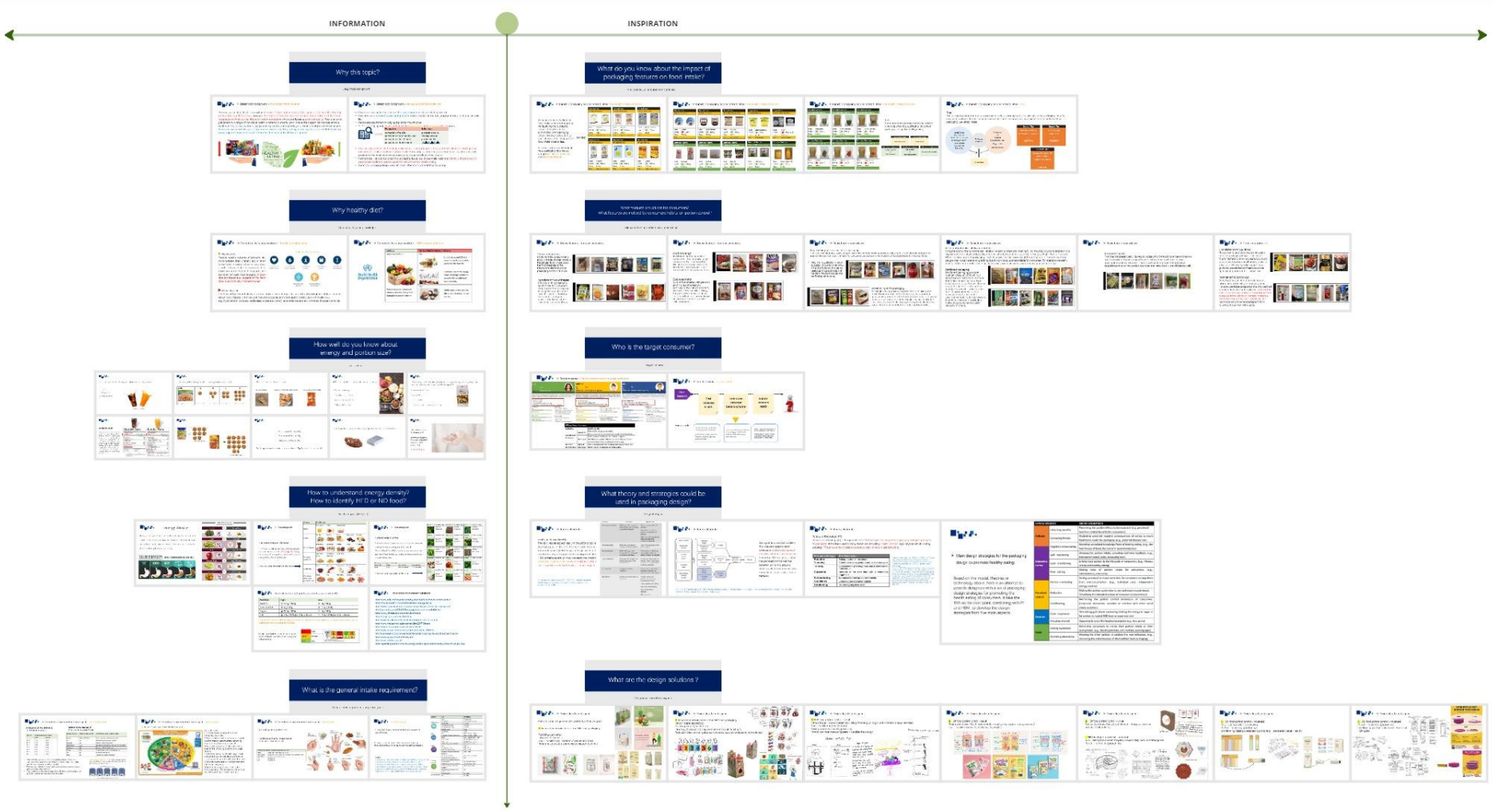


Figure 7.5 The overview of the design tool presentation

7.2 Testing design tool 2.0 with designers (TS2)

7.2.1 Methods

To further test version 2.0 of the improved design tool, additional measurements were conducted to gain a comprehensive understanding of its effectiveness. The integration of qualitative and quantitative data enhanced the validity and credibility of research findings (Galanti et al., 2020). Specifically, a diverse range of input was gathered in this study, including the (1) pre and post testing of the creative self-efficacy, knowledge gaining and usefulness, as well as the using experience (2) exploring how designers used and influenced by the design tool via design log and design flow test (3) gathering the feedback on the design tool content clarity and usefulness the through interview.

(1) Creative self-efficacy, knowledge gaining, usefulness and using experience

Creative self-efficacy has been shown to positively impact creative performance (Walumbwa et al., 2018). Three-item measure of creative self-efficacy by Tierney and Farmer (2002) was adopted. The scale is widely used in research (Chen and Zhang, 2019, Gu et al., 2017). Items were adapted based on the current design problem, including, 'I have confidence in my ability to solve problems creatively for this project.', 'I feel that I am good at coming up with novel ideas for this project.' and 'I am confident in developing creative design solutions (s) with current or similar design topics.'. Besides, the process of knowledge acquisition in design contexts is critical for enhancing innovation and product development. Current design tool provides many aspects of new knowledge for designers. Thus, the testing of knowledge acquisition experience is another aspect of ensuring the effectiveness of design tool. To be specific, three main aspects of knowledge gaining were tested, including the healthy eating related knowledge, the impact of packaging features on food intake and the design strategies for healthy eating. Besides, the usefulness of gained knowledge in design idea generation was also measured. overall user experience, including usage, usefulness, and applicability of the design tool, was tested using the same scale as Rexfelt and Selvefors (2021) in evaluating their design tool. All above aspects, including creativity self-efficacy, knowledge acquisition and tool using experience, were tested using seven Likert

scale questions (the detail of the survey is shown in Appendix 7). By calculating these measures, changes in designers' perceptions, as well as the tool's perceived effectiveness and satisfaction, can be better understood. All scale data was analysed with descriptive statistics to show the trends and changes. T-test (the alpha value of 0.05 for t-tests) was used to define whether a significant change occurred between the pre- and post-conditions.

(2) How designers used and were influenced by the design tool—through design logs and a design flow scale test.

Design was described as a dynamic process, requiring continuous reflection and adaptation (Daly et al., 2012). Thus, understanding how these tools shape the design process is necessary for both educators and practitioners in the field, especially for this interdisciplinary designer task (Saadi and Yang, 2023). Therefore, the design log and design flow scale were used for tracking design activities and the status of designers. Design log serves as a comprehensive record of design decisions, actions taken, and difficulties or confusions encountered during the design process, aiding in managing changes and preventing repeated issues (Kinneging et al., 2020). While design flow scales provide a structured approach to assess the status of designers. The Flow questionnaire was adapted to current study base on the questionnaire from Csikszentmihalyi and Larson (1987) incorporating 12 flow-related questions from Mayers (1978), which was expanded into Design Flow and used as a approach to test the design tool by Dorta et al. (2008). The questionnaire asks the participants to evaluate the twelve dimensions of the design flow using a 10-point scale. The design log template and the design flow questionnaire are provided in Appendix 8. Through thematic analysis (TA) of design logs, the designers' design stages and key activities were identified. A descriptive statistics analysis of the designers' design flow was conducted to explore the dynamics and trends. In combination with the comments on the design tool, this further analysis examined the tool's value during the design process.

(3) The content clarity and usefulness as a design tool

Following the same procedure outlined in section 7.1, specific feedback from designers about the design tool version 2.0 was obtained in current testing study, focusing on the clarity of the content and the usefulness of it as a design tool. The

qualitative feedback from designers was analysed using the TA method to explore their perceptions of the tool's content, usefulness, and other valuable insights.

7.2.2 Participants and procedures

Nine student designers from a MA design programme in 2023 were recruited to this study to test the design tool version 2.0. They were free to choose any design brief, and their participation in this study was voluntary. Table 7.5 provides the demographic information of recruited student designers. Each participant was assigned an ID, for example, S2-D1-DWH indicates it is from testing study 2, with the first designer identified by the initials DWH.

Table 7.5 The demographic information of student designers.

ID	Gender	Age	Design background
S2-D1-DWH	F	24	Graphic design, visual design
S2-D2-DYG	M	26	Brand design, graphic design
S2-D3-SNS	F	28	Visual design
S2-D4-THW	F	25	Graphic design
S2-D5-YWZ	F	25	Graphic design
S2-D6-YBP	M	26	Packaging design, visual design, logo design
S2-D7-KY	F	25	Visual design
S2-D8-QJS	F	24	Product design, graphic design
S2-D9-YWX	M	24	Graphic design

The study process consists of three main stages, including (1) pre tool introduction, (2) during the design project research and (3) post design. The specific procedures are introduced as following:

(1) At the end of the week one, a questionnaire was sent to student designers to test the pre-creativity and pre-knowledge acquisition. Then, the student designers were introduced to the new version of design tool at the beginning of the week two. Student designers were not given instructions about where to start, and how to use the tool, but instead were encouraged to use the tool in a flexible way in their design process. (2) A design log template and a questionnaire (including the design flow scale questions and other free comments) were provided to the student designers. They were required to complete the provided design log and

questionnaire weekly, from weeks three to eight. (3) At the end of week eight, a questionnaire was sent to participants, including the same questions from stage one, to assess post-creativity and post-knowledge acquisition. Besides, more questions were asked regarding the tool using experience in the questionnaire. Afterwards, all involved designers were invited to provide detailed feedback on the clarity of the tool's content and the usefulness of the design tool through interviews. The Figure 7.6 illustrates the timeline and the main tasks for designers in this study.

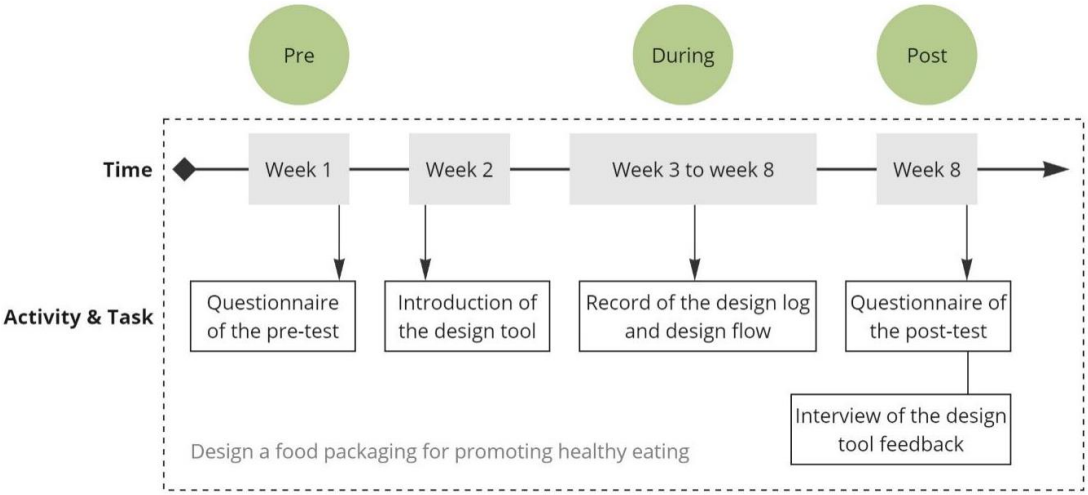


Figure 7.6 The illustration of the study procedure and timeline.

7.2.3 Results and discussion

7.2.3.1 Related creativity and knowledge improvement

Creativity self-efficacy

As a class overall, most of the students' self-assessments of the creativity efficacy showed increasing tendency between the comparison of the three post and pre creativity test questions. Figure 7.7 presents the Likert score results comparison of the pre and post creativity test. The mean of the pre group is 14.33 with a standard deviation (SD) of 2.18. The mean of the post group is 14.67 with a SD of 2.12. It indicates that there was an improvement trend of the creativity efficacy with the impact of the design tool. However, the all the T test of each questions showed no statistic significant differences.

Figure 7.7 The illustration of the scale results of the pre and post creativity test.

(CQ1 means the creativity test question 1, same with the CQ2 and CQ3)

Gaining knowledge of the general healthy eating

The gaining healthy eating knowledge result suggests a modest increase in the post group. Specifically, the post group's mean (5.19) is slightly higher than the pre group's (4.48), with SD of 0.85 and 0.78, respectively. Therefore, despite the observed increase in the mean values, the difference between the pre and post groups is not statistically significant. However, as illustrated in Figure 7.8, an increase in the post group can be observed.

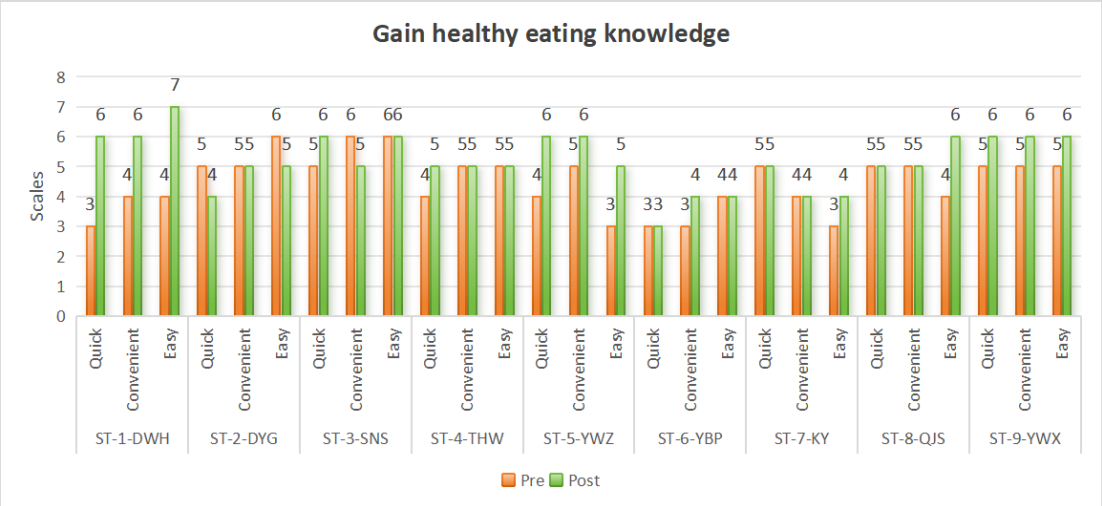


Figure 7.8 The illustration of the scale results of the pre and post knowledges gaining about the general healthy eating knowledges.

Gaining knowledge of the packaging impacts on food intake

The post group's mean (5.22) is higher than the pre group's mean (4.44), indicating an improvement in the knowledge gained on the packaging impacts as shown in

Figure 7.9. However, the t-test result suggests that while there is a trend towards an increase in the post group, the difference is not significant. While, when individually looking at the convenience of gaining this knowledge, the p-value is 0.04, implies an observed significant increase. This demonstrates that the information provided by the design tool regarding the impact of packaging on food intake greatly supports designers by allowing them to acquire relevant knowledge with minimal effort.

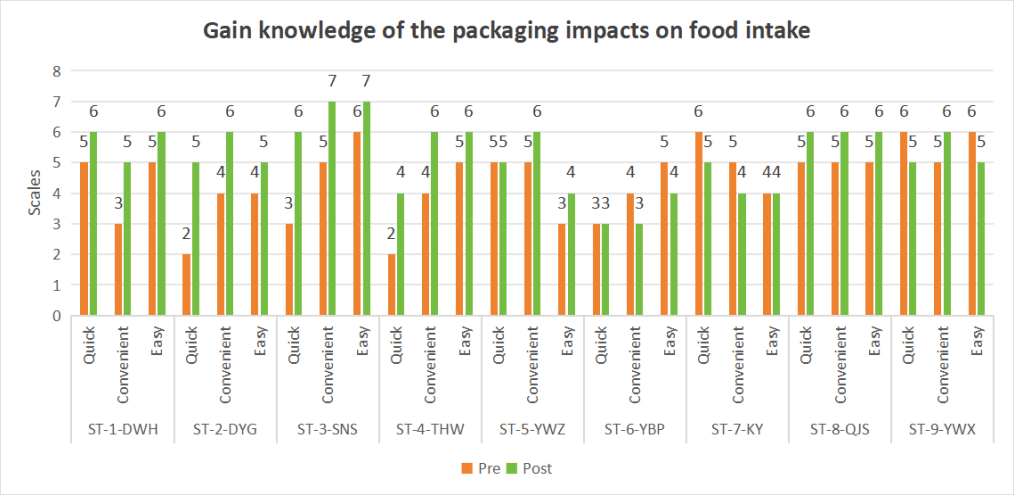


Figure 7.9 The illustration of the scale results of the pre and post knowledges gaining about the knowledge of the packaging impact on food intake.

Synthesising knowledge regarding the packaging design strategies for promoting healthy eating

The post group's mean (5.33) is higher than the pre group's mean (4.11) with p-value of 0.049, indicating a significant improvement in the synthesis of the knowledge of the packaging design strategies for healthy eating, as shown in Figure 7.10. More specifically, the easiness of synthesizing the useful packaging deign strategies contributed to the significant difference between the post and pre groups. The results (mean: post 5.67 > pre 4.22; p value: 0.038) report a significant improvement, suggesting the design tool facilitates designers' access to relevant packaging design strategies for application in design idea generation.

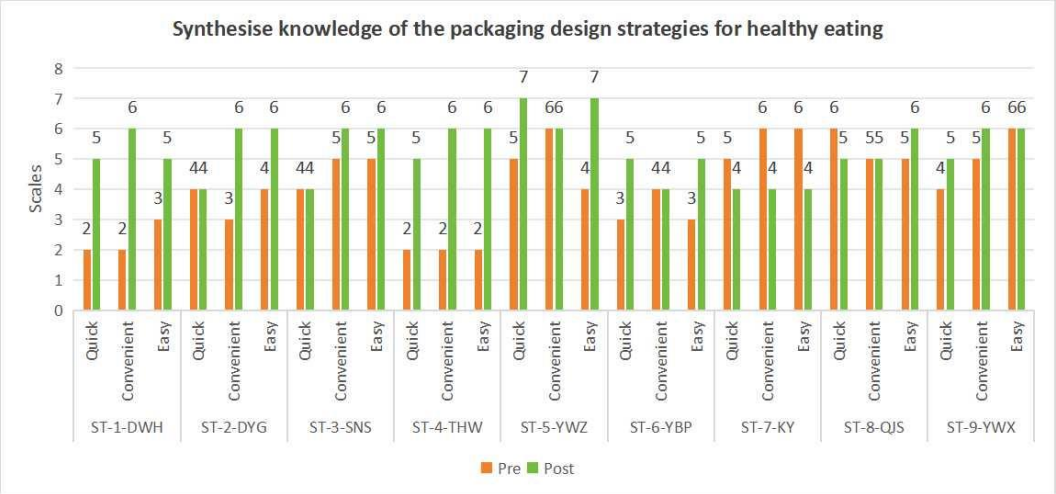


Figure 7.10 The illustration of the scale results of the pre and post knowledges synthesising about the knowledge of the packaging design strategies.

Gained knowledge resulted in packaging design idea generation

Figure 7.11 shows the application of gained relevant knowledge among designers. The mean score of the post group is notably higher than that of the Pre group (5.11 > 4.39) with p-value in 0.026, indicating a significant improvement of the knowledge application in design. To be more precisely, this significant difference is brought by the scores of the new insights from gained knowledge (post: Mean 5.22; SD 0.67; pre: Mean 4.22; SD 1.20, p value: 0.028). These results suggest that the knowledge gained from the design tool provided designers with more novel insights to their design solutions.

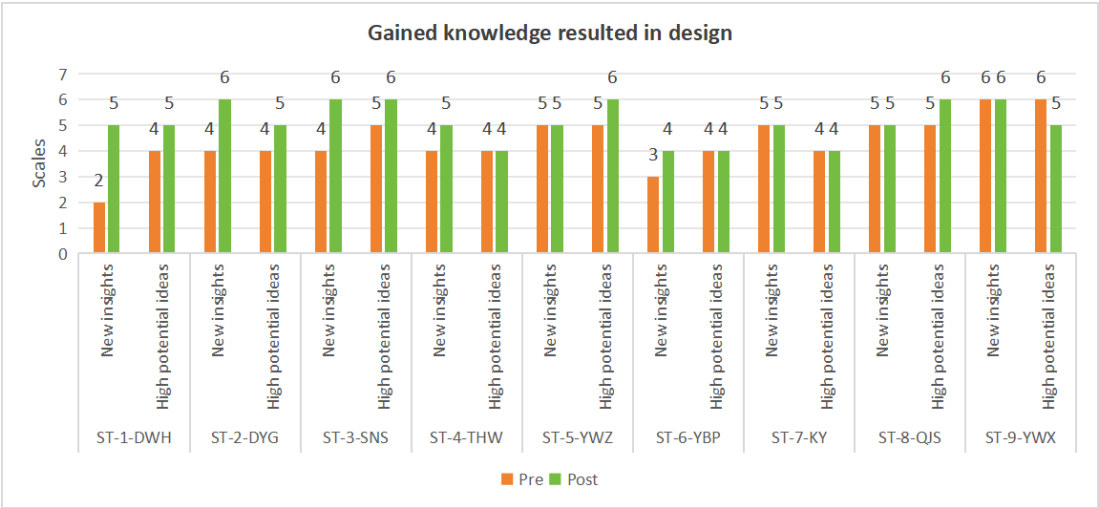


Figure 7.11 The illustration of the scale results of the pre and post the gained knowledge resulted in design idea generation.

In summary, there was an increase trend of the creativity efficacy, but not significant. As for the knowledge gaining from the design tool, results showed that it brought significant convenience the access the impact of the packaging features on food intake. Besides, it significantly simplifies the synthesis of design strategy knowledge. Furthermore, the knowledge provided by the design tool brought more new insights into their design idea generation.

7.2.3.2 Tool using experience: usage, usefulness and applicability

Designer participants rated various aspects of overall tool using experience on a Likert scale from 1 to 7, with 1 indicating the most negative response and 7 indicating the most positive response (see Table 7.6). The consistently high median scores (5 and above) across categories suggest that the tool is effective and well-regarded by designer users. The generally positive feedback received across all aspects, including the tools' usage, usefulness, and applicability to show the potential of the design tool.

Table 7.6 Overview of the survey data regarding the design tool using experience.

Survey Questions Likert Scales 1-7	Median (N = 9)	Min - Max
Using the tool was:		
1: Boring — 7: Fun	5	4 - 6
1: Time-consuming and effort — 7: Quick and convenient	5	4 - 7
1: Uninstructive — 7: Instructive	5	4 - 7
1: Uninspiring — 7: Inspiring	6	4 - 6
Using the tool resulted in:		
1: Known insights and ideas — 7: New insights and ideas	6	5 - 7
1: Insights and ideas with no potential — 7: Insights and ideas with high potential	6	5 - 6
Using the tool in my everyday work would be:		
1: Irrelevant — 7: Rewarding	5	5 - 6
1: Difficult — 7: Easy	6	4 - 6

Tool usage

The tool was perceived as moderately fun, with a median score of 5 (range: 4–6), indicating that most participants found the tool enjoyable to use. In terms of efficiency, the tool was rated as "quick and convenient" (median = 5, range: 4–7), reflecting a balanced perspective with some variability in the responses. However, in general, users reflected that the tool saved their time and improved their design efficiency. Besides, the tool was also seen as instructive, with a median score of 5 (range: 4–7), showing that users generally found the tool educational. The inspirational value of the tool received a slightly higher median score of 6 (range: 4–6), suggesting that the tool has a positive impact on creativity and inspiration, which is also consisted with the previous results in section 7.2.3.1.

Usefulness in design insights

When asked about the insights gained from using the tool, designers rated it with a median score of 6 (range: 5–7), indicating it generated new and valuable insights. Furthermore, the potential of the ideas generated was also rated highly, with a median score of 6 (range: 5–6), suggesting that the tool is effective in providing insights on the packaging design for healthy eating.

General applicability

The tool's relevance in everyday work was given a median score of 5 (range: 5–6), indicating that users found it moderately rewarding to use in their daily tasks. It is reasonable since they were currently working on the project with same design topic. Besides, the ease of using the tool scored a higher median of 6 (range: 4–6), indicating that designers found it easy to integrate into their design work.

In summary, the survey data of the tool using experience indicated that the tool was well-received by designers. They found it enjoyable, educational, and useful to use in the design practice, both in terms of generating new insights and integrating it into relevant design work.

7.2.3.3 Design log and design flow

7.2.3.3.1 Design log reflection

The records from the design logs were summarised into key activity and progress, as well as the key concerns in a weekly base. Figure 7.12 provides the visualisation of the design process over a six-week period from the introduction of the tool to designers until they developed the final packaging design solutions, highlighting both progress and challenges experienced by student designers (yellow notes represent completed tasks, while red notes indicate concerns or issues encountered) and the comments (grey label) and scores on the design tool (at the bottom line of the figure) in varied phases.

Distribution of task progression and issues

The design log from designers reflected a comprehensive design journey from ideation to implementation. To be specific, the design progression started from early-stage conceptual development, consumer research, data collection, and analysis, to later stages such as data-driven refinement, design finalization and user testing. Except that, some specific concerns were identified during the process. For instance, concerns were raised in week 4 and week 7 regarding the application of design strategies, data collection, data analysis and concept presenting. These phases may represent turning points in the design process where complex decisions related to data and strategic design choices were most prominent. While, during the week 5 to week 6, the progression indicated that the designer focused on design refinement and detail works with relatively fewer challenges.

Feedback on the design tool application during the design process

Designers were required to score the acquisition of new information and inspiration weekly and to provide free comments if they have used the design tool during the week. Specifically, the scores (median and min-max) displayed at the bottom of the Figure 7.13 presents how the designer perceived the design tool application in their design work each week. The free comments on the design tool are presented in the grey section, capturing the designer's opinions on the tool at different design stages. To understand the overarching themes and the reasons

behind the designer’s reflections, analysis was conducted by combining comments, scores, and design timeline.

The new information scores ranged from 6.5 to 8, these scores reflected the steady intake of new knowledge throughout the design process. Notably, week 5 and week 8 show higher scores for new information, suggesting that in these stages (focused on data analysis and refinement of design concepts), design tool provided designer with fresh insights and new knowledge. While, as for the inspiration scores, with values fluctuating between 6 and 9, most stage showed 7, suggesting that designer consistently drew inspiration throughout the process. Notably, W4 had highest inspiration scores, likely due to the ideation work occurring during these periods. The detailed results which combined with the free comments on design tool are presented and discussed in the following section. The value of the design tool in varied design stages were summarised as follows:

- *Knowledge support and shaping the design approach at the early stage*

In week 3, the designer’s evaluation focuses on theoretical frameworks such as HBM, TRA, and other design strategies, particularly noting the tools' impact on understanding packaging features and health/behavioural awareness of consumers. Designer highlighted the importance of these tools in providing theoretical grounding for early-stage conceptual development and research development. As discussed by previous researchers, at the early stages of the design process, theoretical knowledge and strategies are important for shaping the design approach (Meinel et al., 2011, von Thienen et al., 2023). The new information score of 6.5 indicates the designer is absorbing new knowledge, though inspiration is relatively lower (6.0), reflecting their ongoing exploration within these theoretical frameworks. In week 4, designers remarked that background design knowledge helps in understanding the entire design process, which facilitates progress through each stage. This suggested that the focus shifts from theory to practical application, particularly in setting design objectives and managing research on consumer features. At this stage, designer is beginning to apply packaging design strategies and planning to conduct consumer research, with the design tools' practical utility becoming more critical. The new information score

7.0 and inspiration score 7.5 indicated that the design tool effectively provides both new knowledges and creative stimulus during this phase.

- *Providing data-driven insights and refinement details*

In week 5, the designers noted that the tool offers inspiration and direction, especially when paired with consumer preferences and needs data, providing a clear guide for design drafts and conceptual sketches. This reflects how data-driven insights inform design decisions and inspire further creative development, which is consisted with the finding by Eisenhardt and Zbaracki (1992). In this phase, the primary role of the tool is to provide data-driven design guidance. By integrating consumer feedback, the tool assisted the designer in making informed design choices. The new information score (8.0) increased compared with previous weeks and reached the maximum score across all weeks, while the inspiration score (7.0) was slightly lower than week 4 but remained higher than week 3, indicating the tool effectively fosters insight and creativity. Furthermore, by week 6, the design process focused on refining details, especially based on consumer input. Designers mentioned that the tool assisted effectively in achieving design goals at this stage. It is particularly helpful in the refinement of design details, application of consumer data, and responding to feedback. The new information score of 7.0 and the inspiration score of 7.0 suggest the tool continues to provide important insights and to stimulate creative at this stage.

- *Support the design refinement at the final stage*

At this stage, designers were focused on feedback analysis and final concept refinement. Designers' feedback in week 7 highlighted that the tool is instrumental in collecting and analysing consumer feedback, which was important to refine the design direction. The new information score of 7.0 and inspiration score of 7.0 suggest that, as designers gather valuable insights from feedback, the tool remains essential for sustaining creative momentum as the design approaches its final stages. By the final week 8, designers were focused on the presentation and visualisation of the design concepts. The new information score of 8.0 and inspiration score of 7.0 reflect the tools' continued ability to provide fresh insights and stimulate creativity, even in the final stages of the project. The higher score of

new information implied that designers may go back to the theoretical knowledge provided in the tool to support their design ideas.

In summary, the evaluations of the design tool reveal their varied roles throughout the design process. Specifically, in the earlier weeks, the focus was on acquiring new theoretical knowledge and strategies, as well as applying it to conceptual design, which resulted in higher new information scores, particularly in week 4 and week 5. As the project progresses, the tool supported the practical application of this knowledge, with increasing inspiration scores in week 5 and week 6, as the designer refined and adjusted designs based on data and feedback. By week 7 and week 8, the tool was primarily providing support to further rational the design ideas, where the balance of new information and inspiration remains high, indicating the tool remains essential for both insights and creative output even as the project concludes. The corresponding scores for new information and inspiration reflect the designer’s journey from theoretical exploration through to practical application, demonstrating the tools' continued relevance and utility across the design project.

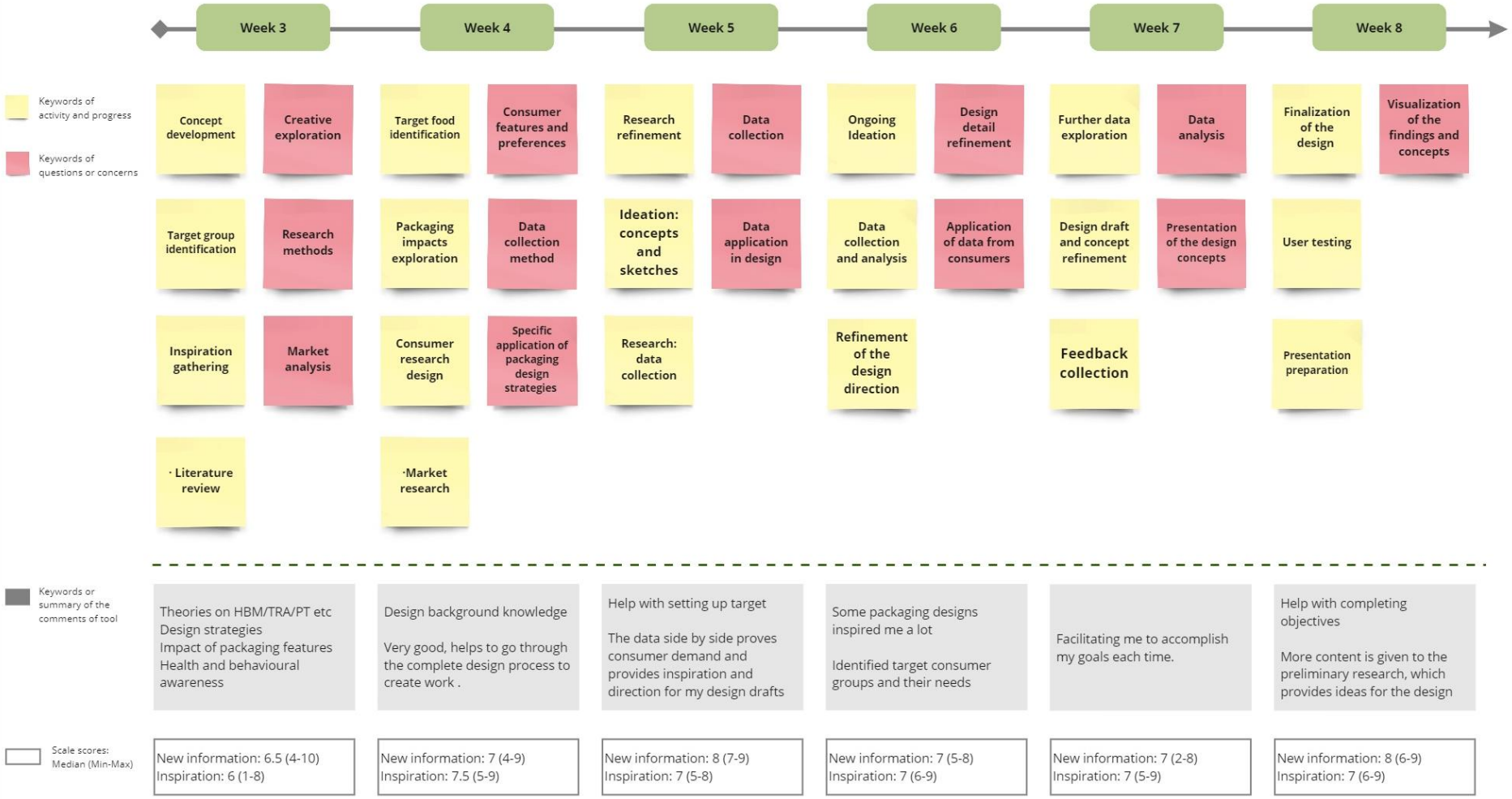


Figure 7.12 The illustration of the key activity reflected in design log and the median values for the design tool as well as the free comments.

7.2.3.3.2 Design flow reflection

The mean value of each question of the design flow in varied weeks were calculated, concerning the twelve questions with 1 presenting totally disagree and 10 indicating totally agree. In general, participants gave high ratings to the positive questions (7 questions) and the stabled relatively low ratings to the negative questions (5 questions). As shown in the Figure 7.13, the options involved (A), task clarity (C), self-efficacy (E)**,** altered sense of time (k) showed consistent high rating and rising trend during the design process. Besides, the Figure 7.14 presented the rating values of the negative questions. It can be observed that the existing of the negative status of designers such as anxiety (B), boredom (G) and the effort to focus (H), but the rating all maintained stable and low ratings throughout the process. These results of the scale values will be discussed as follows:

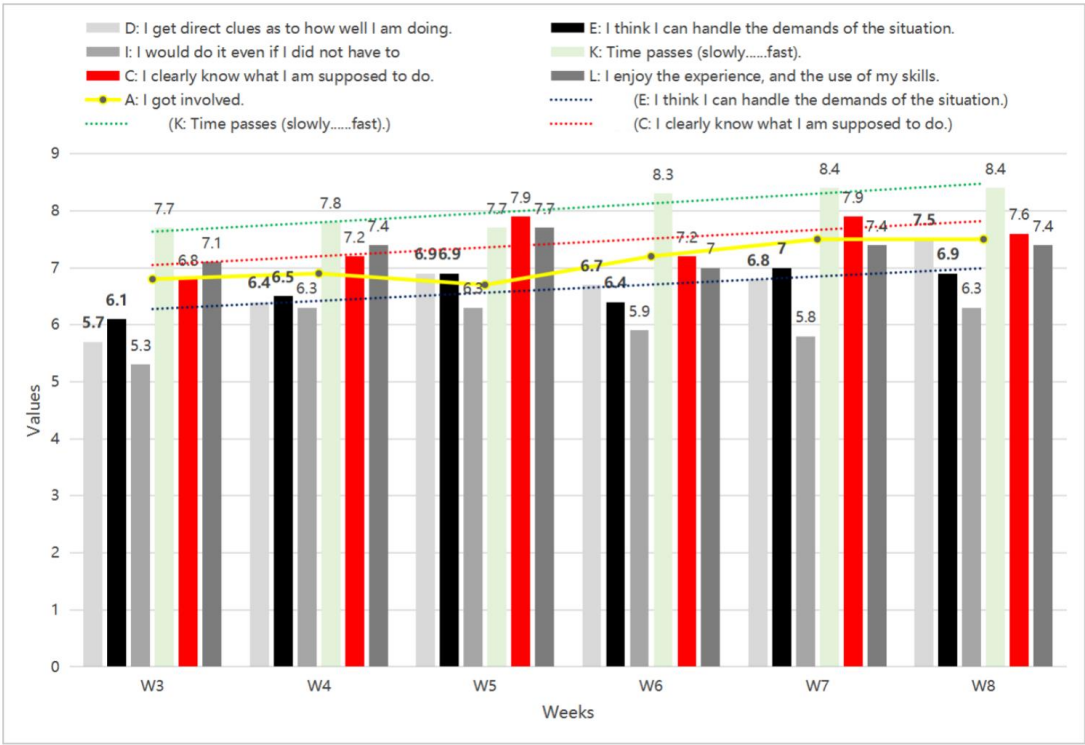


Figure 7.13 The chart of the mean values of the positive question in design flow during week 3 to week 8 with some trendline of the key aspects.

The trend for involvement (A) stays relatively steady from W3 to W5 but begins to increase towards week 7 and afterwards. The involvement peaking after a few weeks as they find solutions of the design tasks. Similarly, the task clarity (C) remains fairly consistent and high rating value since week 3, staying above a score

of 7, with peak in week 5 and minor fluctuations throughout the weeks. Designers' self-efficacy (E) is stable around 6 but shows an increase from week 3 to week 5 and stabilizes slightly below 7 towards the end. High self-efficacy is often associated with better problem-solving and higher productivity (Stajkovic and Luthans, 1998), indicating that designers felt empowered to perform well in this context. Furthermore, time perception (K) increases consistently from week 3, peaking around week 7, indicating that time was perceived as passing more quickly as the research progressed. It is a potential sign of flow or deep engagement and immersion in the tasks. The enjoyment levels (L) remained high throughout the process, showing that designers generally found the design experience rewarding and meaningful, which is important for sustaining motivation and creativity (Amabile and Pratt, 2016).

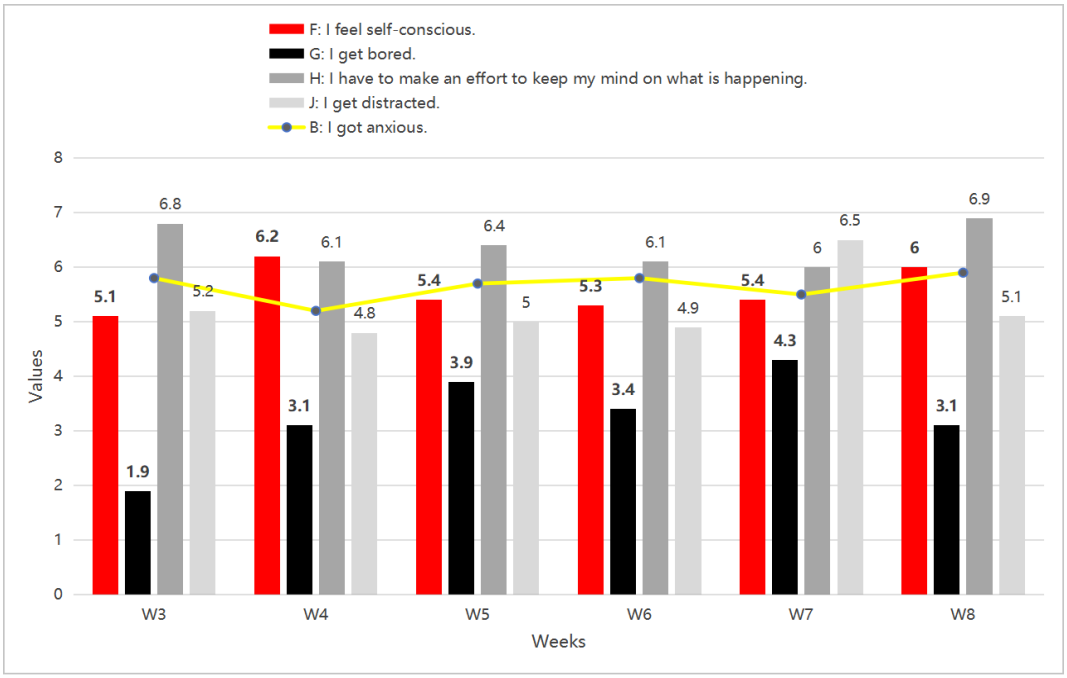


Figure 7.14 The chart of the mean values of the negative question in design flow during the design practice from week 3 to week 8.

The anxiety levels (B) of designers initially decreases after W3 and remained relatively stable around 5 throughout the process, without significant fluctuations. The relatively low and stable anxiety scores imply that there is no high level of stress or uncertainty. The boredom level (G) kept low rating across the entire process but showed a slight increase around week 5, towards the later weeks of

the design. The low rating indicates that this design topic remained the interest of designers, it is a quite interesting design topic, the upward trend may be due to a lack of new challenges or new insights in later weeks to keep the interest of designers. The focus level (H) shows minor fluctuations, with a decrease from week 3 to week 4, before raising to week 8. It is also noticeable that focus level (H) is the only options that were rated higher than 5 in all weeks, which may be explained by the relatively long-term design process, where designers may lose this high level of focus (Sweller, 1988).

To make it clear to see the correlation between the design flow and the design tool influence. A descriptive comparation of the rating of design tool (information usefulness and design tool inspiration) and the designer flow was conducted. A summary is presented as follows:

- *Raising needs at the early and the end of design stage for information*

The peak in week 5 was also shown in early rating results of the new information from the tool aligns with higher task clarity (C) and self-efficacy (E), suggesting that access to new information from the tool may have supported them understanding the design objectives and enhanced their confidence in handling tasks. The increasing boredom observed in the later weeks (week 6-week 8) could be connected to a reduced influx of truly novel information during those weeks, as the score for new information levelled off. In addition, the slight dip in week 6 and week 7, when designers reported an increased need to make effort to stay focused (H), could indicate that new information may not have been as prominent need during those weeks. But its return to a higher level in week 8 could be due to the design idea justification need to gain more information from the tool at the end of the design process.

- *Inspiration of the design tool: stable but effective throughout the entire process*

While the level of inspiration did not fluctuate dramatically, it remained consistently high, suggesting that designers felt inspired throughout the process and the design tools provided sufficient stimuli for creativity and idea generation. The peak in inspiration in week 4 coincides with a notable decrease in anxiety (B), indicating that designers got inspired from the design tool and felt more confident

in doing the design task. Besides, the stable involvement (A) and enjoyment (L) ratings suggest a link between the perceived inspiration of the tools and designers' willingness to participate actively. Designers reported a slight increase in the effort required to stay focused (H) around week 5 to week 6, which aligns with a plateau in inspiration. This indicates that maintaining or increasing the inspirational impact might help alleviate cognitive fatigue in the middle phases of the design process.

In brief, design research process presents a generally positive and stable experience. High levels of engagement, task clarity, self-efficacy, and enjoyment were maintained throughout, while negative emotions such as anxiety and distraction were low, even as other factors such as boredom and distraction emerged in the later weeks. When considering the design tool alongside the design flow, new information from the design tool was considered most valuable at the early and final stages, enhancing task clarity and self-efficacy. Despite a dip in focus and increased boredom in the middle stages, the demand for new information resurfaced toward the end due to the need for design justification. The tool was believed consistently to inspire designers, especially fostering engagement and reducing anxiety in the middle stage of the design.

7.2.3.4 Interview feedback on the design tool

The overall feedback of the packaging design tool by designers was positive. Users noted that its content is clear, well-structured, relatively easy to understand and well received by designers.

> *"I thought it was very informative and very instructive." (S2-D6-YBP)*

> *"Very informative and covered some knowledge that was new to me; Nice structure. There is a clear and general outline at the beginning and then a detailed discussion one by one. The content is progressive." (S2-D4-THW)*

The tool was also seen as effectively assist in developing design concepts. For example, some mentioned that the tool helped them organise their thoughts, design objectives and the identification of the design focus. In addition, the interactive content (quiz content) broke some previous perceptions on food portion, fostering deeper thinking about the design topic. The new insights and

design strategies brought inspiration to the design. The consumer case studies, and the design examples provided in the design tool made theoretical concepts easier to understand and to be applied in their design practice.

- *Thoughts organising*

  "The main design strategies are very helpful for me. Because it gives me the direction to collect data or research, and also let me know how to conduct qualitative analysis." (S2-D6-YBP)

  "Guided identification of design research topics and planning of objectives." (S2-D7-KY)

  "Let me focus the design on the functionality of the packaging." (S2-D7-KY)

- *Quiz rewarding for deeper thinking*

  "There is interactive content, which increases participation and prompts students to think about the topic. I really enjoyed the case shows at the end, which were lively, interesting and helpful in understanding the theory." (S2-D4-THW)

  "The quiz section was very rewarding for me as the answers to some of the questions broke down many of my previous perceptions." (S2-D2-DYG)

- *Design idea inspiration*

  "The sections on design strategies and case studies were especially valuable in shaping my design concepts; The content provided helped me understand the importance of considering behavioural psychology and visual communication in packaging design for healthy eating. It inspires me to deliver persuasive techniques and effective messages into my designs." (S2-D3-SNS)

  "The final section of the case show. The cases were more inspiring than the theoretical part and helped me to see how far we needed to go." (S2-D4-THW)

The design tool was considered well-developed, with sufficient clear and useful content. No further improvements are required. ("I found the design tool to be very well developed and detailed, and a great help to us."; "I personally don't think there is anything that needs to be improved."). However, some limitations and expectations were also reported. For example, the large amount of text slowed down reading makes it hard when users want to return to a particular point. An extraction of the content and the standard the hierarchical of headings were suggested by designers. This can be solved if the design tool is transited into a web-based version. With navigation and a hierarchical directory, users will be able to

locate content more quickly and directly access the interface with the desired information. Some designers preferred more packaging design examples as references. While there are few packaging cases under this topic and so far, all the relevant and useful packaging cases collected have been presented in the design tool for reference. Furthermore, some content expectations emerged, like specific information about the product ingredients, behavioural tendency of the target consumer group and data feedback related to specific food or packaging, as well as data analysis methods. However, current design tool only targets to provide general information and inspiration support. Thus, designers are required to conduct their own research based on their specific target food and consumer group if they need to.

Chapter summary

This chapter aimed to improve the design tool for packaging design to promote healthy eating, through two studies involving student designers. Study 1 tested the design tool initial materials (design tool 1.0) with 12 designers. The positive comments received confirms the clarity of the design tool and its usefulness as a design tool. The feedback also revealed some improvements:

1) adding heading question for each section
2) more straightforward and detailed packaging design strategies
3) presenting the resource references of the material or data
4) integrating the quiz to the design tool

The design tool 1.0 thus, improved accordingly into design tool 2.0.

Study 2 expanded the investigation by evaluating version 2.0 of the design tool using multiple measures. As shown above, there is an increase trend in creativity self-efficacy of designers. The results also demonstrated more convenient to gaining the knowledge of the packaging impacts on food intake and easier of gaining the packaging design strategies for healthy eating with the content provided by the design tool. Besides, the designers reflected their tool using experience as enjoyable, educational and useful. Furthermore, the results of the design log and the comments of the tool revealed that the design tool serves

multiple roles throughout the design process, including the knowledge support and shaping the design approach at the early stage, providing data-driven and method structural guidance at the middle stage, supporting the design refinement at the final stage. In addition, the design flow characterised by high levels of engagement, task clarity, self-efficacy, and enjoyment, with low levels of negative emotions such as anxiety. While boredom and distraction emerged in the mid-stage, the need for new information was particularly significant in the early and final stages, enhancing task clarity and self-efficacy. Throughout the process, the design tool consistently inspired designers, fostering engagement and reducing anxiety. There was positive feedback for its clear, well-structured content on the design tool, which helped designers in organising thoughts and developing concepts. Specifically, the interactive section was appreciated for fostering deeper thinking, the design strategies inspired designers and the design example making theoretical ideas easier to apply. Some limitations included difficulty navigating large amounts of text, leading to suggestions for a web-based version. Designers also expressed a desire for more specific packaging examples and consumer data, though the tool primarily offers general insights.

This chapter not only validates the usefulness of the design tool and identifies areas for improvement, but also explores the tool's varying roles at different stages of the design and its relationship to the designers' emotional and cognitive design status. Building on these findings, the next chapter presents the transition of the design tool into a web-based prototype (Version 3.0) and tests its practicality with professional designers. In addition to validating the usefulness of this form of design tool, the next chapter also explores its potential value and limitations in real-world applications, from the perspective of professional designers.

Chapter 8
EVALUATION OF THE DESIGN TOOL

This chapter presents the new format of the design tool: web-based prototype (design tool 3.0) and the evaluation of it with professional designers. The evaluation procedures and the feedback are described in detail as follows.

8.1 The web-based prototype

Developing the design tool into a web-based prototype provides immediate accessibility across various platforms, including desktop, tablet, and mobile devices (Al-Kodmany, 2003), which facilitates broader user engagement. In addition, web-based prototype allows multiple users or stakeholders to interact with the tool simultaneously, regardless of their location (Toukola and Ahola, 2022). The design tool 2.0 was transited into a web-based prototype (design tool 3.0) via the Figma platform, making the design tool more accessible for broader designers.

The web-based prototype underwent minor modifications from design tool 2.0 to adapt it to the web format. It is divided into three main sections: Home (to introduce the design background), Information (to provide essential food and nutrition information), and Inspiration (to offers solid data, strategies and examples to inspire designers), as shown in Figure 8.1, with an introduction of the website purpose on the top of the homepage.

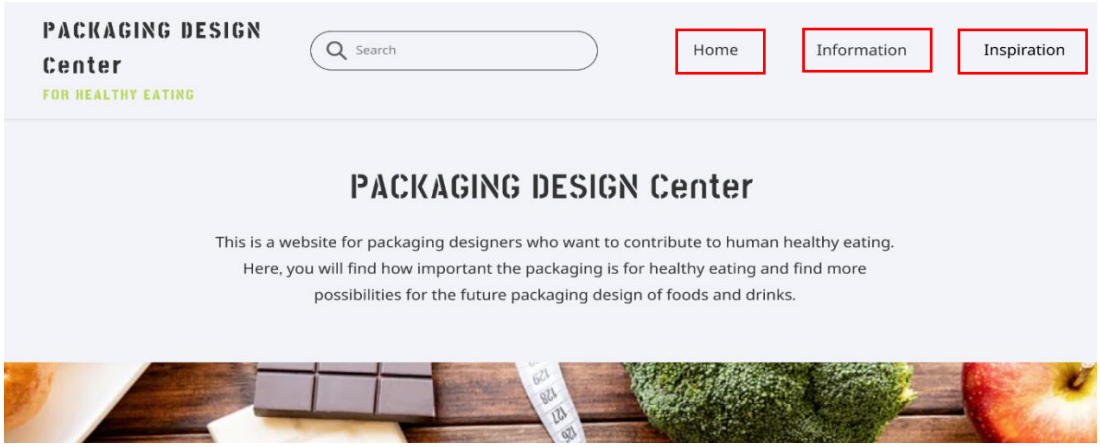


Figure 8.1 The display of the menu bar of the website prototype.

(the main menu of the web is highlighted by a red box)

The quiz section was arranged in the beginning to engage the user, so that when designers access the design tool, they would be immediately presented with some portion-related tests (see details in Figure 8.2). The goal of it is to spark user curiosity and encourage further exploration of the design tool.

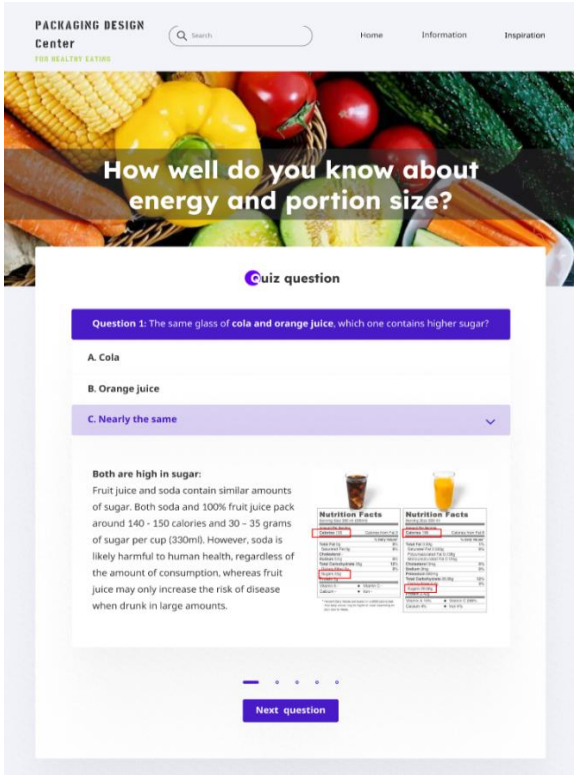


Figure 8.2 The homepage illustration, with the quiz presented at the beginning.

Additionally, each secondary menu was accompanied by corresponding images to match its content to ensure that designers can intuitively understand the theme of each section when they open the page (see Figure 8.3).

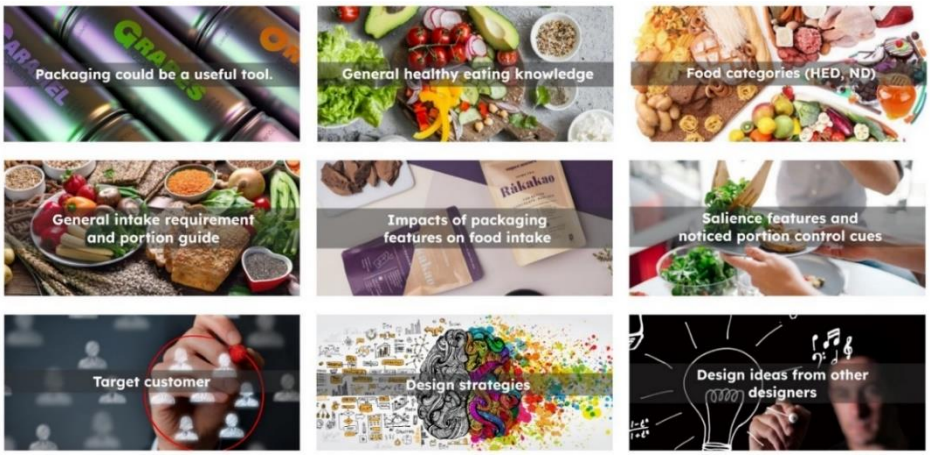


Figure 8.3 The illustration of the main background image of each section.

More visual elements were added as required by designers, for example, some icons were added to let designers quickly grasp the benefits through the visual icons, without relying on text (see Figure 8.4).

Figure 8.4 The examples of the visual icons added in the web-based prototype.

The overall style of the website prototype remained consistent with the content of the previously tested tool. Minor adjustments were made in some areas due to layout and visual considerations. Figure 8.5 shows the webpage layout for the information section, while Figure 8.6 presents the content and design of the inspiration section. The complete website content can be viewed through the following link: https://www.figma.com/proto/yCt81PjBS5TpJ8OmbePoIh/Design-Tool-(Copy)?node-id=0-1&t=bmMxcIN6XBnYLgYN-1

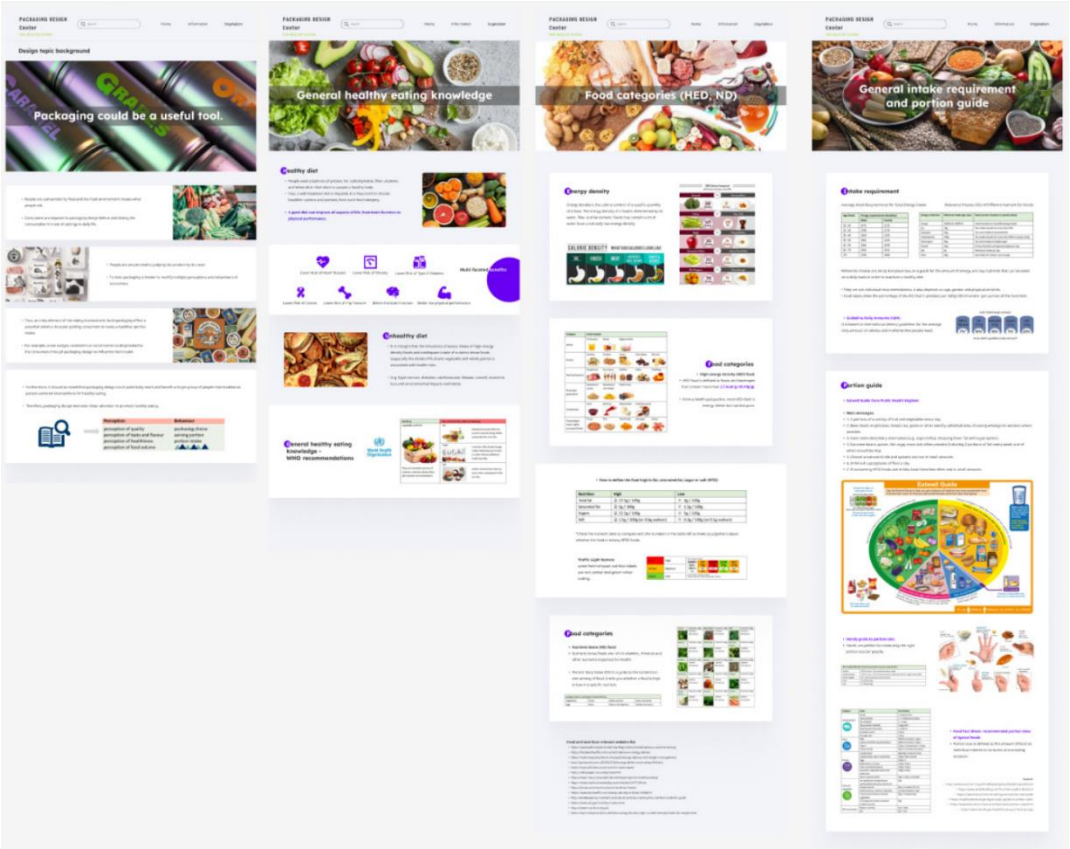


Figure 8.5 The illustration of the information section of the web-based prototype.

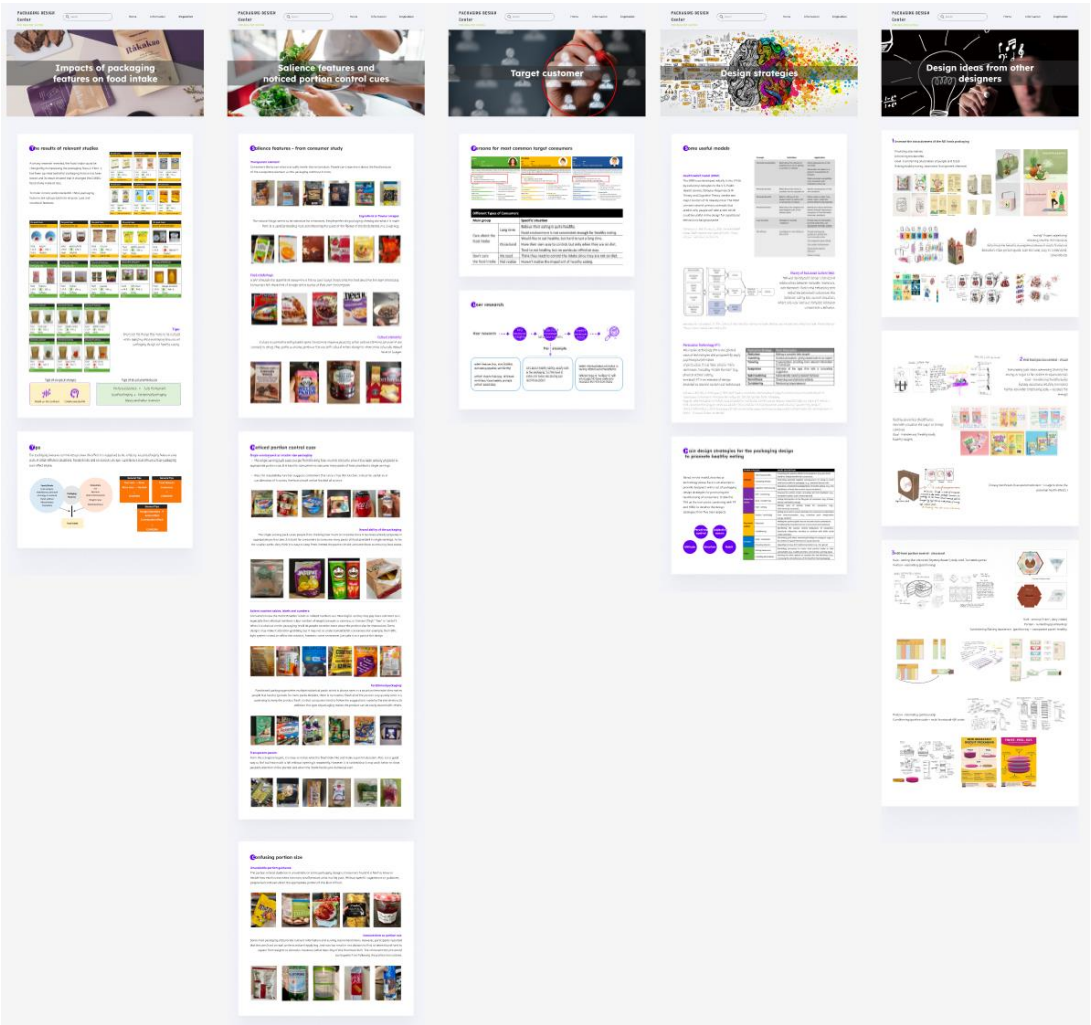


Figure 8.6 The illustration of the inspiration section of the web-based prototype.

8.2 Evaluation of the design tool version 3.0

8.2.1 Method

To assess the usefulness and value of the web-based prototype for designers and the field, interviews were conducted with professional designers. Professional designers can offer valuable insights into the tool's functionality, usability, and relevance within real-world workflows (Cross, 2004, Zdanowska and Taylor, 2022). Besides, professional designers are equipped to provide contextual feedback and often have a clear understanding of industry standards and client expectations, which make the evaluation more practical and applicable (Nelson and Stolterman, 2014). The interviews focused on four key aspects (see Appendix 9): understanding

of the design topic (Mavros et al., 2022), specific descriptions of the tool's usefulness (Camere et al., 2018), reflections on the tool's value (Mavros et al., 2022), and the support needed for the implementation of packaging ideas. A thematic analysis was conducted to identify key themes emerging from the interview data and to address questions related to four key aspects.

8.2.2 Participants and study procedures

Eight professional designers were recruited to the study to evaluate the design tool 3.0 (web-based prototype). They were recruited through personal contact and snowball sampling methods, with the sample size informed by similar design tool evaluation studies (Haritaipan et al., 2019, Dorta et al., 2008). They were first informed about the purpose of the study and the main tasks they were required to complete, and the signed consent forms were collected. Basic demographic information was also collected, including design expertise, years of design experience, and current position, to capture participants' backgrounds (see Table 8.1). The diverse design expertise enhanced the study's reliability by accounting for multiple perspectives and mitigating biases (Wakelin et al., 2023). A unique ID was assigned to each participant. For example, PD_01_10 indicates a professional designer, first in interview order, with 10 years of design experience.

Table 8.1 The profile of the participants (professional designers).

ID	Design expertise	Year of experience	Current position
PD_01_10	Brand communication design	10	Cultural and tourism product designer
PD_02_02	Industrial design	2	User experience designer (UX design)
PD_03_12	Illustration design, visual design	12	Independent designer
PD_04_08	Visual presentation, packaging brand design, character design	8	CEO of the independent design studio, illustration designer, brand designer
PD_05_06	Graphic design, packaging design	6	Graphic designer
PD_06_06	Product design, 3D designer	6	3D designer
PD_07_06	Product design	6	Automotive product designer
PD_08_05	Decoration design, packaging Design	5	Product manager

The designers were invited to participate in an interview lasting approximately one hour. Its structure was informed by the study conducted by (Ho, 2019). At the beginning of the interview, the link of the design tool prototype was provided to designers so that participants had the chance to pre-test the design tool to make sure it is functional. It was followed by a 15-minute introduction of the design tool to ensure participants understood the tool and its intended function. Then, a design task was delivered: the design goal is a food packaging that could help with the healthy eating (either help with reduce the consumption of high energy density food or encourage the consumption of lower energy density food, like fruit and vegetables). They can access and review the details of the design tool at any time to assist them in their design process within 15 minutes, focusing on assessing its quick impression and immediate usability. Their design ideas could be clearly described by sketches and/or written words and, also to generate as many ideas as possible. They were allowed to ask any questions or give comments during the tool introduction and its use. After that, they were asked about their packaging design ideas and feedback on the provided design tool. Figure 8.7 presents the procedure of this design tool evaluation study.

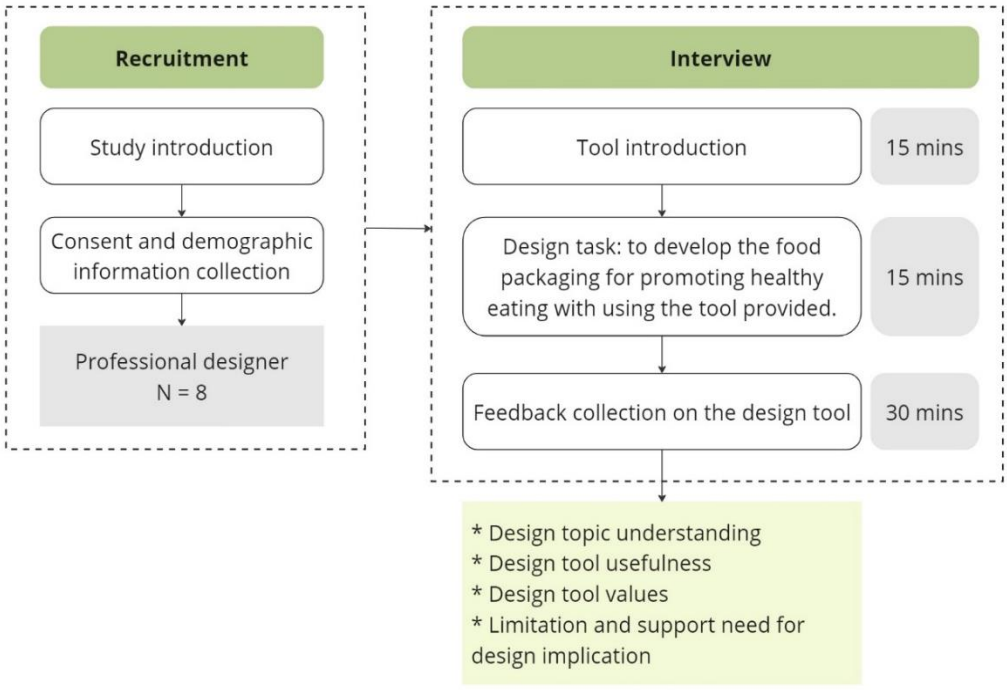


Figure 8.7 The illustration of the design tool evaluation study procedures.

8.3 Results

8.3.1 Understanding of the packaging design for healthy eating

Recognised the impact of packaging on food intake

Designers provided feedback that, compared to before using the design tool, they gained a deeper understanding of the importance of food packaging and its impact on portion sizes. For example, some designers were previously unaware of how much influence packaging could have, but now recognise its potential and the numerous design opportunities it offers to promote healthy eating. Overall, designers had a clearer understanding of the significance of the packaging design for healthy eating.

> *"Realising that packaging is important—it's not just a container." (PD_03_12)*

> *"I have gained knowledge about healthy eating and clarified the significance of design. Previously, I only considered small packaging as a way to prevent waste, but I had not thought about its impact on portion control." (PD_04_08)*

Acknowledged diverse food choice

Designers becalmed aware of broad food-related objectives. They focused not only on healthy foods as primary design targets but also emphasised portion control for less healthy options, such as popular snacks, ultra-processed foods, and beverages. In addition, some foods, such as frozen foods, are often misunderstood by consumers, highlighting the value of using packaging to communicate their health benefits.

> *"For those who love to eat, want to lose fat, but struggle to control their consumption, packaging could be designed for the snacks they enjoy." (PD_01_10)*

> *"Some frozen foods are actually healthy, but due to people's stereotypes, they are perceived as unhealthy. The health benefits and value of these foods have not been effectively communicated." (PD_04_08)*

Identified broad range target audience.

From the perspective of professional designers, there are several audiences that could benefit from food packaging designed to promote healthy eating, which can be grouped into three main categories. First, it provides helpful guidance for health-conscious individuals who prioritise a healthy diet, such as fitness

enthusiasts or those aiming to lose weight. Second, it benefits people with certain health issues, such as those who are in sub-healthy or elderly people, helping them to improve their health through dietary changes to some extent. Finally, it can have a broader impact on the general public, such as parents, children, busy professionals and students, gradually fostering healthier eating habits.

> *"Some sub-healthy individuals may experience positive changes to some extent. (PD_01_10)*
>
> *"Many types of consumers. For example, those who are relatively lazy and don't want to search online, health-conscious fitness people, or busy young people, college students, and parents—all these groups rely on packaging to get more direct health or nutritional information." (PD_03_12)*
>
> *"I believe the entire society could benefit from this, as it could genuinely help transform the eating habits of those with unhealthy diets into healthier ones." (PD_06_06)*

8.3.2 Usefulness of the design tool

8.3.2.1 Information perspective

It was reflected that the homepage quiz can guide designers to explore relevant information more deeply. Designers reported that this design topic focuses on health and covers a wide range of areas, while they can accumulate substantial insights directly from this tool ("*allowing easy access to a wealth of accumulated knowledge. (PD_07_06)*"). Some participants noted that the information integration significantly saved them time and effort, preventing them from wasting time on disorganised information collection (*"allowing designers to focus on creativity and informed decision-making without spending excessive time on searching (PD_05_06)"*). The tool also helps clarify aspects of the design topic that were previously unclear, such as the relationship between food energy and portion size, through intuitive and summarised presentations. Additionally, participants pointed out that the information is comprehensive and widely applicable, making it suitable various food companies and food products.

> *"It is particularly helpful when entering the website interface, as there are some small quizzes in front of you that guide you through the tasks. After answering, it encourages me to further look into the relevant information and*

background." (PD_08_05)

"It's helpful because designers can't know everything. The information available online is often quite disorganised, so if there is a website like this design tool, it would save a lot of time and effort during the design process. Particularly, the comparison between foods with the same energy content but different portion sizes in the food categories is very intuitive. What I didn't understand before is now much clearer." (PD_03_12)

"The information is very comprehensive, and it can be applied to any product. Its target audience is very broad, allowing users to choose any product, such as chocolate. By using the design strategies you provide, I can filter and select the best approach. In fact, it can be applicable to any company." (PD_07_06)

8.3.2.1 Inspiration perspective

Designers reported gaining new perspectives from the tool, seeing greater possibilities for packaging design. It helped them break away from their previous focus of packaging design, broadening their perspectives. For example, the focus was primarily on packaging text or packaging shape, but they began considering the impacts of other packaging elements, such as structural features, after engaging with the design tool. Participants found that packaging could influence behaviour beyond basic functions (*"This tool also highlights how it can impact the user's psychology and behaviour, which is very inspiring (PD_05_06)"*). To be specific, they pointed out that they knew resealing and partitioning are not only effective in preventing waste but also can also regulate consumer eating portion.

"Before seeing this, I thought packaging design depended on the content, specifically the text. However, now I believe that the form of the packaging and its guidance—how the packaging itself directs consumers—is actually more important. I haven't come across packaging that, through its structure alone, can guide consumers to better understand health. That's why I initially thought only text was can convey health-related information." (PD_01_10)

"New design perspective, Through the website's design strategy, attention was drawn to creatively using negative information to help consumers recognise the importance of healthy eating." (PD_02_02)

Some designers were also inspired to approach the design problem by considering the preferences and characteristics of the target consumers. Furthermore, the provided design strategies were well summarised and served as excellent starting

points, helping designers establish clear goals and directions on specific packaging solutions. Overall, the feedback from designers suggests that the tool offers various insights that can inspire designers and can be directly applied or adapted to new packaging designs.

> *"It's definitely inspiring, and the content is very detailed. The impact of reseal ability on food consumption was kind of eye-opening for me. Previously, I only considered its convenience for storage, but now I understand its connection to consumption, which is truly thought-provoking." (PD_02_02)*

> *"With summarised theoretical research reports, you can focus on specific points and design accordingly." (PD_04_08)*

> *"The models, references, and case studies are quite helpful. The design strategy provides directions to try, which gives us a solid foundation and clear starting points in the design process." (PD_06_06)*

8.3.3 Benefits to the field

8.3.3.1 Application

- *For ideation or information support*

Participants reported that this tool greatly improved their design efficiency, and they would revisit and use the tool. They mainly rely on the tool to explore new ideas when lacking design inspiration. Additionally, when faced with too many ideas and uncertainty about suitability, they turn to the tool for reference to help narrow down their options. They would also use it after developing initial ideas, to find specific information (e.g., the impact of packaging features, portion guidance) that supports their concepts or to add more details to their designs.

> *"When I already have some initial ideas in mind, I would return to the tool to find specific information to support my concepts or to seek new, more concrete design inspiration." (PD_02_02)*

> *"When I have no design idea, I would return to this tool for new ideas. Similarly, when I have too many ideas and find it hard to choose, the tool can help refine and solidify my concepts." (PD_08_05)*

- *For idea communication*

Designers also highlighted the tool's role in facilitating communication as it serves as a valuable resource for communicating concepts and refining strategies in

collaborative environments. Specifically, it was seen as a convenient tool for discussion with other members of the design team to exchange and explore concrete design ideas. Additionally, it could support the presentation of design concepts, whether for showcasing ideas to clients or enabling clients to present their design requirements through the website. Designers also mentioned that in companies with clear departmental divisions, this tool would be especially useful for the design planning department. It can clarify design contexts and streamline task communication with the execution team.

> *"I would tend to use the tool when conducting project research, discussing plans with colleagues or project stakeholders, or explaining my design ideas to them. It serves as a useful resource for facilitating these discussions and clarifying concepts." (PD_03_12)*
>
> *"If I were working on a design project related to this theme, I would definitely use the relevant information to showcase my design ideas to others. It's highly supportive and educational, primarily serving as a tool for design communication." (PD_04_08)*
>
> *"The design planning department would likely prefer this tool, as it provides a solid foundation for assigning design tasks to the design execution team. It helps streamline the process and ensures that the planning team can clearly communicate objectives and strategies." (PD_07_06)*

8.3.3.2 Values for designers and design field

- *For designers*

This design tool was believed to offer valuable insights and resources for both novice and experienced designers. It was regarded as a versatile resource suitable for addressing complex design tasks across different levels of expertise. For novice designers, the tool offers valuable background, guidance and provides essential design strategies that can be applied directly to their projects, facilitating more informed decision-making for design (*"For beginners, the provided design strategies, can be highly useful and may be applied in designs. They might also use these strategies to compare and summarise different design proposals for clients or companies to choose from.(PD_03_12)"*). For experienced designers, they may find the basic content less necessary but benefit significantly from design strategies and the presentation of more design examples (*"Experienced designers are more likely*

to benefit from a large, easily searchable design case library (PD_06_06).”). For them, the tool serves more as a supplementary resource, offering new perspectives and additional inspiration to enhance their pre-existing knowledge.

> *“The tool primarily serves as a source of inspiration, likely offering more significant help to beginners. For experienced designers in the field, it might function more as a supplemental resource, providing additional information and insights to enhance their existing knowledge.” (PD_08_05)*

> *“Whether for novices or experienced designers, this tool provides new directions. When designing food packaging to promote health, designers can approach the task from different angles and theoretical perspectives, offering a broader and more informed approach to their work.” (PD_04_08)*

- *For the design field*

In this field, participants acknowledged that few designers have focused on this aspect of packaging design and that it remains an unfamiliar area for most designers. Food packaging design often prioritises visual appeal. This design tool effectively introduces this emerging design topic, while highlighting its connection to consumer health. Some designers emphasised the importance of more designers using this tool to better understand the link between packaging design and consumer health, and to recognise its significance.

> *“For the design industry, this approach is quite innovative—few people are doing or even familiar with this type of design. The tool conveys a new design topic that is clearly reflected in the content. By exploring the various categories on the site, users can grasp the design concepts and messages being communicated.” (PD_01_10)*

> *“Currently, many packaging designers focus on visual appeal, with few paying attentions to how packaging impacts consumer health. It’s important to raise awareness among more designers about this issue, helping understand the broader influence and potential of packaging beyond aesthetics.” (PD_02_02)*

8.3.4 Challenges and the support needed for packaging design implementation

8.3.4.1 Commercial barriers

Designers expressed concerns about the challenges of convincing companies to adopt health-oriented packaging due to commercial interests. Therefore, a clear demand for health-oriented food packaging must be established at the company

level to drive its development. Given this is a new design area, many factors , such as cost implications, market acceptance, sustainability and environmental impact as well as company values, should be considered. For successful implementation, both the food company and the design firm need to align their values with a focus on consumer health to effectively implement the design.

> *"Clients or companies may not place much emphasis on the health-related significance and functionality of the design, which could lead to them not choosing this type of design proposal." (PD_03_12)*

> *"First, the company must have a relevant need and establish a clear design focus. Then, with that focus in mind, designers can use the design website to proceed with the design process." (PD_07_06)*

> *"Support at the company level is essential, as this field is quite new and requires consideration from many different aspects." (PD_08_05)*

8.3.4.2 Marketing promotion

To achieve the desired impact of packaging and benefit the wider public, market promotion of food packaging design is crucial, given the uncertainties present in the market. Additionally, the display environment of the product was identified as influencing the effectiveness of packaging. For example, products positioned at eye level or in well-lit areas tend to receive more attention, which increases their likelihood of purchase (Sunaga et al., 2016). Thus, how it is placed in supermarkets also needs to be considered. Designers also mentioned the need for long-term market feedback to further develop packaging design in this field. However, obtaining relevant feedback data at an individual level is challenging, highlighting the need for higher-level support. Specifically, government support and policy incentives are important to encourage healthier packaging solutions.

> *"Marketing and promotion need to keep up to ensure the design gains traction and resonates with consumers." (PD_07_06)*

> *"For the packaging to be successfully implemented, it requires a marketing campaign. How to promote it and whether it can help consumers intuitively perceive the product's characteristics are key considerations." (PD_05_06)*

> *"In terms of the market, there are many uncertainties related to marketing strategy and promotion. Packaging display environment: The placement of packaging in a supermarket can also have an impact. Visual capture plays a significant role." (PD_08_05)*

In summary, designers highlighted the challenges of convincing companies to adopt health-oriented packaging and the need for a health-oriented packaging design demand from the company level. Besides, market promotion and product placement are important to determine the effectiveness of packaging. This challenges the traditional emphasis on immediate profitability at the expense of long-term health benefits (Nirino et al., 2020). Thus, government support and policy incentives are necessary, including tax incentives for companies adopting health-promoting packaging and stricter regulations on marketing practices.

8.3.5 Further improvement suggestions for the design tool

Homepage design

Designers emphasised the need to highlight that the tool is specifically designed for designers and should directly appeal to them. For example, on the homepage, present the main modules in a clear and visual way so that designers could immediately understand the tool's offerings.

> *"The content should be arranged in a way that allows designers to instantly recognise that it's tailored for them. The structure needs to be clear and direct, making it easy for them to see its relevance to their work at first glance." (PD_05_06)*

> *"The content is very valuable and useful, but the homepage should directly attract designers. Having parallel modules on the interface allows designers to choose the content they are most interested in." (PD_07_06)*

Content hierarchy

In addition, designers suggested that the most inspiring parts, such as creative and inspirational content should be presented directly. They recommended further refining and distinguishing content based on its importance, placing it under different levels of menus to cater to designers with varying needs for content depth. Specifically, designers proposed the tool could be image-driven, with text explanations and principles offered at the next level. If users are interested in exploring further, they can click it for more details. Mariani et al. (2018) also highlighted the effectiveness of visual posts in driving user engagement and interaction. The overall aim is to reduce or rearrange the use of text, ideally

communicating through visuals only. However, it also comes with challenges, including the potential for miscommunication and cultural differences in symbol interpretation (Tucker et al., 2023). Thus, a balanced visuals with minimal but effective text, where necessary, could be most helpful. Some even proposed to add animations to the tool for enhanced clarity and engagement.

> *"Lead with conclusions, allowing designers to choose the topic they're interested in, and then provide the detailed text afterward." (PD_07_06)*

> *"Placing "Inspiration" at the centre as the main focus of the design tool makes sense. Designers might not find the "Information" section as important or engaging, as their primary interest may lie in the creative and inspirational aspects." (PD_06_06)*

> *"Currently, everything is organised within parallel second-level menus. I believe more detailed and in-depth content could be placed in third- or fourth-level menus, allowing those who want to dive deeper to click through for additional information. If possible, adding animations would make it even better." (PD_02_02)*

More functions

Designers expressed additional expectations for the design tool, including functional features (e.g., sharing, searching) and interactive features (e.g., discussion forums, design practice tool). First, they hoped the tool can include a sharing function, allowing the meaningful content to be quickly spread within the design community. Additionally, the sharing function can improve the observability of the tool's benefits, as potential users can see the successful applications of the tool through shared content, which can motivate broader adoption (Dearing and Cox, 2018). Searching function was also mentioned to quickly locate relevant information. Besides, an interactive feature was expected, such as a discussion forum where designers can discus and exchange design ideas. Some designers even suggested expanding the tool to include practical design functions specifically for packaging, enabling design practice directly within the platform.

> *"The content is highly professional, and the resources are valuable. However, these materials need better dissemination. It would be helpful to have sharing features so that more designers can access and benefit from them." (PD_02_02)*

> *"I think this tool is really great, and the resources are comprehensive. It would be even better if there were a feature for leaving comments, interacting, and*

exchanging ideas with others." (PD_05_06)

"More practical design execution features, such as drag-and-drop element combinations, effect displays, and so on. These functionalities would make the tool more helpful for actual design practice." (PD_01_10)

8.4 Discussion

This study gathered feedback from professional designers after their engagement with the tool. Drawing on their own work experience and industry insights, the designers offered insights on both the tool and the design topic from various angles: impact of the design tool on designers, applicability and implement of the health-oriented packaging design and design tool values for designer, design practice and design field.

The impact of the design tool on designers

This study indicated that the design tool provides designers with new insights into this design topic, which is a key factor in driving design innovation (Verganti, 2009). To be specific, it challenges preconceived notions about food packaging's impact on consumers and encouraged designers to recognise its evolving role in promoting consumer health. Additionally, it helps designers acknowledge diverse target foods, broadening their focus beyond improving the packaging of healthy foods (e.g., light meals, salads) and recognising that other food types also offer opportunities for improvement and innovation to promote healthier eating habits. This impact creates opportunities for creative design, allowing exploration of new possibilities in packaging to promote consumer health and well-being. The comprehensive content provided by the tool enhances designers' efficiency, reducing the time spent searching for unorganised information. Additionally, the design tool offered designers new perspectives, enabling them to gain a fresh understanding of certain packaging features and their impacts on food intake. This further proved the tool's usefulness on assisting designer to solve the design problem since it facilitates a deeper understanding of the characteristics of the design target (Buchanan, 2010). The tool significantly inspired designers, expanding their creative thinking and serving as a source of design inspiration.

Views on the design topic and its implementation

After recognising the importance of food packaging, designers realised that health-promoting packaging designs could benefit a wide range of people. For example, the food packaging could guide individuals with health-conscious, those with existing health issues and broader general consumers towards heathier food intake, contributing to their health. For individuals with busy schedules and limited time for cooking, packaged food may become their primary food source. Therefore, health-oriented food packaging can significantly influence their eating habits towards healthier choices. Different consumer groups may have varied characteristics and needs, but all can experience positive health effects from such packaging designs, especially when the packaging is tailored to meet the specific needs of the target consumers.

Although designers recognised the general benefits of health-promoting packaging design for consumers, they also highlighted potential challenges at the company level as they may prioritise short-term profits over long-term health benefits (Vogel, 2007). Convincing design companies to focus on this field requires a commitment to social responsibility for public health and a value-driven design approach. As Tang et al.'s research demonstrates, food packaging products designed for portion control are appreciated by consumers, who are willing to pay more for such products, making them profitable for businesses (Tang et al., 2022), which provides support to persuade stakeholders. Besides, government relevant support could contribute the adoption for health-oriented packaging design. For instance, the "Public Health Responsibility Deal" in the UK between the government and food companies outcomes voluntary commitments to reduce salt, sugar, and calorie content in food products (Knai et al., 2018). Furthermore, during the design implementation phase, particularly when entering the market, effective promotion is critical for ensuring the design withstands market challenges and achieve its purpose of influencing food intake.

The value of the tool

Designers mentioned that the tool is beneficial for designers at all levels of design experience, although the focus of needs may differ between novice and

experienced designers. That novice designers may found the design background information, existing design examples more useful (Deininger et al., 2017), while experienced designers may focus on inspiration materials. While both groups can find content that meets their specific needs within the design tool. From a practical application perspective, this design tool, tailored for health-oriented food packaging, provides significant value by fostering creativity and offering inspiration for designers working on this topic. At the same time, it serves as a collection of relevant information and knowledge, providing design background information, food portion and energy knowledge, packaging research results and tailored theoretical guidance for design ideas. As a result, the design tool was considered highly suitable for design communication, especially when presenting design concepts to others or communicating ideas within a team. For the design field, the value of this tool lies in breaking the limitations of focusing on the visual appeal of food packaging. It encourages designers to view food packaging from broader perspectives (e.g., long-term health benefits, social responsibility) to better support consumer and public health.

Chapter summary

This chapter presented the web-based prototype (design tool 3.0) and described the evaluation of it with eight professional designers. Designers developed a deep understanding of the design topic by renewing their perception of the impact of packaging on food intake, identifying a broad audience that could benefit from health-oriented packaging, and recognising various food choices with the help of the design tool. The design tool was reported to provide designers with valuable new insights, helping them explore new perspectives on packaging design. Besides, the well-summarised design strategies provided a solid foundation for setting clear goals and design directions, supporting creative and targeted solutions. The design tool enhanced design efficiency by simplifying access to comprehensive and well-organised content, while also facilitating the communication of design ideas. It was seen as a valuable resource for both novice and experienced designers, offering tailored strategies, new insights, and a deeper understanding of the relationship between food packaging design and consumer food intake. However, designers

pointed out that potential obstacles may arise when specific packaging designs are implemented in the market, such as commercial barrier and the marketing promotion strategies.

Regarding improvements to the tool, no issues were raised with the content itself. However, suggestions were proposed on how to better present the content in a web-based format, including improvements to the hierarchy and the addition of functional and interactive features. The usefulness, value, and application of the design tool are further discussed in Chapter 9, alongside previous main findings and relevant literature, with recommendations for tool improvements outlined in Chapter 10 as directions for future work.

Chapter 9
DISCUSSION

This chapter aimed to provide a synthesis of the main findings from Chapters 4-8, discussing the main themes in relation to current literature and theory. The conflicts of healthy eating, the feasibility of using food packaging design to nudge healthy eating, contributions to DfBC, and the value of the design tool are discussed. Further insights from the iterative development of the design tool, along with subsequent improvements, are presented, as well as suggestions for future improvements and further research.

9.1 Recap of main findings

The first aim of this research was to gain a deep understanding the impacts of packaging attributes on consumers intake, achieved through a systematic review (Chapter 4) and photo-elicitation study (Chapter 5). Then, the challenges and needs of designers were elaborated through interviews which then informed the development of a design tool, tailored to support designers in creating food packaging that promotes healthy eating (Chapter 6). The design tool underwent two rounds of testing with student designers. Based on the analysis of feedback from these tests, improvements were made, leading to the development of version 2.0 of the design tool (Chapter 7). Finally, design tool 2.0 was further developed into a web-based prototype and was evaluated with professional designers (Chapter 8). The key findings from each chapter in this thesis are summarised in the following sections and in Figure 9.1.

9.1.1 Chapter 4: Systematic review of existing experimental evidence about the impact of packaging features on food intake.

To understand the role of packaging in influencing how much is eaten within a single snack or meal, a systematic review (Chu et al., 2021) was undertaken. The review revealed 40 experimental studies from 23 identified research articles examining the effects of manipulated packaging features on food intake. Of these

studies, 36 reported significant effects of various packaging elements on consumption, mainly clustering into visual and structural features. Some of these short term studies provided initial evidence that these packaging interventions could have longer term impacts on food intake. Furthermore, the review highlighted the importance of considering both consumer characteristics such as sex and dietary restraint status and food-related attributes, such as snacks or meal items as these factors modified the effectiveness of packaging impacts on consumer food intake.

9.1.2 Chapter 5: Collection consumers insights about the impact of food packaging in their real life.

An exploratory study with consumers, using a participant driven photo-elicitation (PDPE) approach, investigated consumer insights based on packaging they had purchased. It revealed the confusion around portion sizes when portion information was unavailable on the food packaging or where it was difficult to interpret. The study highlighted attention-grabbing elements, such as building trust, stimulating appetite, and aligning with self-identity. Structural segmentation of packaging, on-pack health prompts and portion reminders enhance portion awareness was found to influence the portion decision (Chu et al., 2022). Consumers relied on packaging for portion decisions, especially structural features. However, the health prompts on packaging such as indicating low sugar, fat or energy cues may inadvertently serve as permissive eating cues. Despite these cues, consumers often ignored or resisted on-pack textual serving size recommendations, with individual circumstances and emotional responses contributing to the difficulty in applying portion control. From the results it appears that consumers value autonomy, convenience, and healthiness when making portion decisions (Chu et al., 2024b). To address these complexities, incorporating consumers' suggestions, several design recommendations were proposed to better support portion control without compromising these values.

9.1.3 Chapter 6: Identifying the challenges faced by designers, and subsequently developing a design tool to offer appropriate support.

A design task-led interview explored the challenges designers face when designing food packaging to promote healthy eating (Chu et al., 2024a). There was a limited understanding of the evolving role of packaging in influencing consumer behaviour, particularly in portion control. Another main challenge was the difficulty in gathering useful materials to assist their design idea generation, such as data on food and healthy eating, solid insights into packaging impacts, theoretical design guidance. Concerns about the conflicts between business interests and public health goals were also reported. To address the challenges, a design tool was developed, structured around the needs and expectations of designers. The content of the tool included essential information such as background on the design topic, general knowledge about healthy eating, food categories, portion sizes, and intake requirements. It also offered inspiration by presenting experimental findings on the effects of packaging features on food intake, highlighting salient elements and the features can facilitate portion control. The tool further provides insights into target consumers, tailored food packaging design strategies, and design examples, contributing to the development of the initial design tool materials (Design tool 1.0).

9.1.4 Chapter 7: Two rounds of testing and feedback-driven improvements of the design tool.

Two studies were conducted with student designers to test the designer tool. In the first testing study (TS1), conducted over one week, the design tool's content clarity and usefulness were confirmed by users. Participants reported that the tool helped them gain a deeper understanding of the design background and provided new insights and inspiration for their packaging design idea. Based on this initial feedback, improvements were made, leading to the development of design tool 2.0. In the second testing study (TS2), which spanned six weeks, users found that the tool facilitated convenient access to relevant knowledge and made it easier to synthesize information on design strategies. This knowledge gain from design tool contributed to the new insights for design. The overall experience of using the tool

was described as enjoyable, educational, and highly useful. Varied values in different stages of the design process were revealed based on the design log and the comments on the design tool. An interview at the end further confirmed the tool's usefulness in fostering deeper thinking about the design topic, and helping users organise ideas and draw inspiration for their designs.

9.1.5 Chapter 8: Evaluation of the web-based prototype with professional designers.

The transition of design tool 2.0 into a web-based prototype (Design tool 3.0) allowed for its evaluation with professional designers. The results demonstrated the tool's usefulness in several key areas. It clarified the unfamiliar or unclear aspects of the designers on the design topic, enabling designers to deeply understand the design context. Additionally, the tool improved design efficiency by integrating essential resources, providing new insights, and sparking innovation. Many designers also recognised the tool's potential as a valuable communication tool with others to rational their design ideas. However, some challenges were reported in the implementation of packaging design, particularly regarding aligning with company values and marketing strategies. To enhance the tool’s effectiveness, further improvements were suggested, including refining the content hierarchy, adding additional functions to the design tool to support more diverse needs or interests of designers.

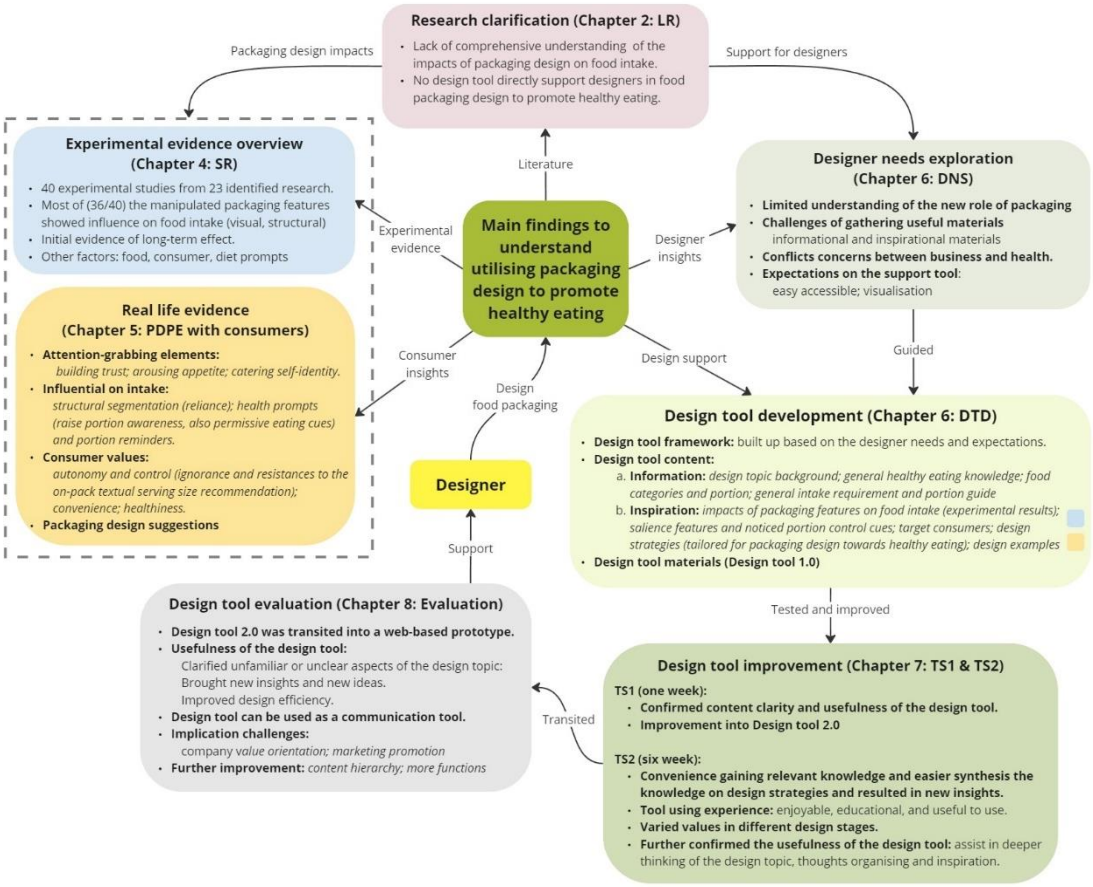


Figure 9.1 An overview of the main findings from each chapter, illustrating their connections to one another and relevance to the research topic. .

9.2 Conflicting perceptions of healthy eating

9.2.1 Healthiness perception vs actual healthiness

As revealed in Chapter 5, some health-related prompts, such as independent energy content, traffic light label, can make consumers pay more attention to the portion size by motiving the health consciousness. While, some health-related claims, such as “low calorie”, “low sugar”, “high in protein”, can alter the healthiness perception and portion size to eat (Benson et al., 2018), was also seen as a permissive cue for overeating (see section 5.3.4). Besides, these health-related claims can lead to a phenomenon known as the "health halo" effect (Chandon, 2013), inflating the perceived health benefits of a product beyond its actual nutritional value and leading to misleading food choices and overconsumption, even if these claims fail to accurately reflect the product's overall nutritional quality. These attractive package labels can lead consumers to form healthy overall

impressions of the product, overshadowing less healthy components. For example, study showed that although the presence of a traffic light warning label increased perceived sugar and calorie content, it did not counteract the effect of the effect of “Protein bar” on perceived healthfulness (Fernan et al., 2018).

This conflict between perceived and actual healthiness becomes particularly apparent in relation to consumers' varying levels of health consciousness. While less health-conscious individuals are more likely to accept positive cognitive bias (Mai and Hoffmann, 2015), often consuming more of a product perceived as healthy. In addition, environmental factors, such as the presence of diet-related prompts, can exacerbate these effects. Chapter 4 showed such prompt (informing the energy information) can modify the impact of some packaging features, such as packaging presence, partitioning, packaging shape and packaging size, on food intake. This raises ethical considerations about the healthy claims and other packaging features can affect the healthiness perception (see section 2.3.2.1) in reinforcing unhealthy consumption pattern. Therefore, the food packaging design should be more transparent, especially when highlighting health benefits on the packaging either by words or graphics.

9.2.2 Portion control vs resistance

Some reviewed packaging visual cues and structural cues showed ability in portion control (Chapter 4). Visual cues include displaying fewer product units or providing a smaller on pack food image which may act as a “nudge” on the package. As for structural features, the smaller size of packaging, its partitioning, and resealability all showed significant effects in reducing intake, particularly for HED foods. These structural features were also reported by consumers that help with portion control in their real life (Chapter 5) and pointed out these features meet the autonomy control and convenience values of consumers. Transparency of packaging was found to influence food intake, but the effect is varied by food type, colour, attractiveness and size (see section 4.2.4.2). Consumers also mentioned the influence of packaging transparency and explained that a transparent window

allows them to see the remaining contents, helping them monitor their intake (see section 5.2.3.1).

However, the results showed that the serving size recommendation (SSR) on the packaging did not capture consumers' attention, nor did it guide them toward the recommended portion intake. It is supported by Faulkner et al. (2012), the actual food intake often exceeds the recommended portion which may due to the misinterpretation or ignorance of the SSR by consumers. Chapter 4 further revealed the resist attitude towards following these on-pack textual SSR which could be another explanation to its ineffectiveness (see section 5.3.2). Designers also showed the concerns on the responses of the consumers to packaging designed for portion control (see section 6.3.1.2). While the pictorial portion suggestions were reported to be effective in guiding food intake (see section 4.2.4.1), highlighting the value of visually presenting SSR on packaging. The consumer values revealed in Chapter 4 explained why certain packaging elements support portion control, whereas others have minimal or no impact. These findings provide design insights for visually communicating portion size, coupled with structural features, to nudge consumers toward portion control while preserving their sense of control and convenience.

9.2.3 Health vs business

As discussed by Spencer (2018), the role of designers in addressing interdisciplinary and complex social issues is increasingly recognised, yet it demands collaboration and coordinated efforts from multiple stakeholders. Designers expressed their concerns about the conflicts between business and health (see section 6.3.2). Specifically, designers, particularly professionals, perceived a conflict between packaging appeal and the impact of portion control. This implies that packaging designs intended to promote portion control of HED foods could adversely affect product sales and profitability. This conflict concern was raised by designers before the design tool development (see section 6.3.1.2). The designers who reviewed the design tool also raised conflicts between food companies and health benefits (see section 8.3.4.1), particularly in relation to food company values. Specifically, first,

food companies need to establish clear design requirements to enable designers to develop packaging aligned with specific design goals. This implies that food companies must take on greater social responsibility and prioritise consumer health as a primary design objective. The concern is reasonable, as food companies, based on practical experience, often face ambivalence between pursuing profit and maintaining a reputation for health responsibility (Tempels et al., 2017).

A comparison of designers in these two studies revealed shared concerns about the conflict between business and health; however, their main reasons differed. Designers without access to the design tool were concerned that portion control and packaging appeal could not be achieved simultaneously, whereas designers who reviewed the tool viewed the conflict from a different perspective. On one hand, it showed that the design tool eased designers' concerns by illustrating various ways packaging can be used to control portions. On the other hand, it highlights an ongoing tension between business goals and consumer health that designers continue to face.

Even though Tang et al. (2022), as mentioned in Chapter 1, revealed that consumers are willing to pay more for products that aid in portion control of HED foods, further investigation is needed to gather more data which could help food companies view it as an opportunity rather than a conflict to their business. Besides, designers need to adopt creative approaches to achieve a balance between promoting public health and meeting profitability demands in packaging design. Additionally, food companies should consider effective strategies to promote their products and address fierce market competition (Spiegler, 2016). In addition, support from relevant institutions, organizations, and government is essential. Promotion, advertising, funding, and relevant policies are needed to ensure that health-oriented packaging designs effectively reach and benefit a wider audience. Such support can help drive innovation in packaging design that aligns with public health objectives, sustainability principles, and market demands, enhancing its accessibility and impact.

9.3 Feasibility of nudging for dietary behavioural change through packaging design

Design for behaviour change is concerned with how design can facilitate positive behavioural changes. As shown above, packaging design can utilise subtle, non-intrusive design modifications to guide consumers toward healthier choices while preserving their freedom of choice. This aligns well with the principles of Nudge Theory (NT), which suggests that small environmental changes can effectively guide people's choices without forcing them (Thaler, 2008), highlighting the role of environmental cues. Besides, nudge interventions on dietary behaviours were reviewed by Arno and Thomas (2016) as measured by frequency of healthy choices or by overall intake, the results of which suggested that NT strategies provide an effective approach in encouraging healthier eating behaviours. The interventions included various labelling schemes, accessibility of different food options, and reductions in the size of food portions, packaging or containers. As showed above, packaging is perceived and functions as one type of nudge. Based on the findings of the exploratory studies in this research, the feasibility of using food packaging as a key intervention tool to promote healthier behaviour is discussed through the following key aspects:

- *Choice architecture and behavioural change*

The core of nudge theory lies in modifying the choice architecture that small modifications in the way choices are presented to individuals can significantly influence their decisions (Quigley, 2013). In the context of healthy eating, the nudge makes healthier or more beneficial options more appealing or easier to choose. Packaging design as it is often the first interface between a consumer and the product, is ideal for implementing these nudges. For example, making the packaging of healthier options (LED or ND foods) more appealing by applying the attention-grabbing elements (see section 5.2.2) or subtle changes in visual cues, structural features that were revealed as effective (see section 4.2.4), can gently steer consumers toward healthier portion choices. However, the food features (e.g., attractiveness and palatability) (see section 4.3.2.1), consumer emotional feelings and social context may lead the preference of HED foods, thereby constraining the effectiveness of packaging.

- *Liberty preservation and portion control*

Many nudges target automatic cognitive processes (Congiu and Moscati, 2022), encouraging individuals to make healthier or more desirable choices without taking perceived freedom away. It is consisted with the findings in Chapter 5 that consumers value the autonomy control when making portion decisions (see section 5.5.5.1). Portion control could be one of the outcomes of the application of nudge through food packaging. For instance, packaging that comes in smaller, pre-portioned sizes naturally limits how much a person consumes at once, serving as a built-in nudge, signalling the consumer to stop after one serving. It helps consumers automatically regulate their intake without consciously measurement or restrictions. Similarly, resealable packaging was reported make multiple servings easier and optional (see section 5.5.1.1). The nudging effect can be achieved by making healthier portion decisions easier and more convenient. Moreover, the health prompts (see section 5.2.3) could be applied on packaging as motivational triggers to stimulate autonomous behavioural change in healthy eating.

- *Possibility of long-term behavioural change*

While nudge theory is effective in encouraging immediate behaviour change, its impact can be reinforced through repeated exposure. The desired behaviours can be reinforced even after the nudges are removed (van Rookhuijzen et al., 2023). Some design efforts aimed at promoting healthy eating, such as mHealth (see section 2.2.2.2), face limitations in maintaining long-term user engagement. However, since food packaging is a daily and passive point of engagement for consumers, long-term engagement can be anticipated. Initial evidence suggests packaging can have a long-term effect (see section 4.3.1). For example, repeated exposure to such packaging, such as single-serving packaging, can lead to long-term behavioural changes in consumers. Over time, this can contribute to healthier eating habits as portion sizes become standardised in consumers' minds, establishing portion norms (Robinson et al., 2019). Other packaging attributes have yet to be tested for long-term impacts, but they may also support consumers in internalising healthier habits due to frequent interactions with food packaging. There is more likely that the initial nudge from the packaging helps to build a long-term behavioural change that is sustained even outside the specific food packaging

context, but further investigations are needed. However, Yokokawa et al. (2019) argued that consumer perceptions of packaging, such as expiration dates, can undermine the intended benefits of packaging. Moreover, the effectiveness of packaging in altering consumer behaviour is contingent upon its integration into familiar routines or their eating habit. The above demonstrates the opportunity to leverage packaging to achieve sustainable behaviour change, though several challenges remain.

- *Cost-practical and broader audience*

Nudge is often seen as a cost-effectiveness method for promoting desirable behaviours (Murayama et al., 2023), since it usually involves simple environmental or contextual changes rather than large-scale interventions. Thus, packaging design can used as a low-cost intervention tool, nudging for healthier eating behaviour. To be specific, the changes on packaging size, adjusting or adding visual cues, or modifying the on-pack claims are relatively low-cost that can have a significant impact on consumer behaviour. One of the limitations of existing efforts made for healthy eating is hard to reach broader population (see section 2.2.1). Food packaging, however, due to its nature in food marketing, making them practical and scalable for widespread implementation to reach broader audience. Designers also believed that using packaging to guide consumer dietary behaviour could benefit a broader audience because of its wide accessibility (see section 8.3.1). However, it is essential to make sure that the packaging design can be implemented and mass-produced for reaching broader populations.

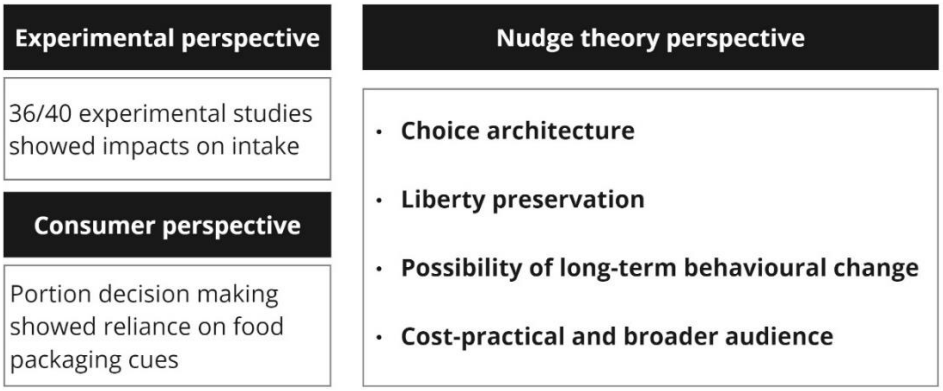


Figure 9.2 The feasibility of using food packaging to guide food intake.

In conclusion, this research demonstrates that food packaging design serves as an effective intervention tool for promoting healthy eating, based on evidence gathered from multiple studies and perspectives (see Figure 9.2). From an experimental data standpoint, it confirmed that design changes in numerous packaging features can influence food intake. From the perspective of real consumer experiences, it identified the elements that influence intake and highlighted the reliance on food packaging cues when making portion size decisions. Additionally, from the lens of nudge theory, the applicability and potentials of food packaging in encouraging healthier eating behaviours were analysed. Although sustaining dietary behaviour change through packaging alone presents challenges, its benefits and potentials make it worthy of greater attention.

9.4 Design tool tailored to assist designers to design the packaging for healthy eating

9.4.1 User-centred design tool development

Boradkar (2010) discussed that if design problems pose a unique set of challenges, designers need a unique set of tools to assist the problem-solving design. Thus, this design tool was developed using a user-centred design approach (Mao et al., 2005), specifically tailored to address users' challenges and needs, resulting in a tool that supports designers in overcoming these challenges.

Challenge - Lack of design background information

One of the primary challenges is dealing with low-quality, poorly summarised, and inconsistent relevant information outputs related to healthy eating and food nutrition as well as limited relevant information that can be effectively incorporated into packaging design (see section 6.3.2). Designers, therefore, struggle to find reliable, standardised information to help them have a deep understand of the design issue and its significance.

- As emphasised by Maturana (2014), design purpose and significance are important for a design task and the design performance. To address this challenge, information on healthy eating, food energy, portion sizes, intake standards, and portion guides was provided. With this summarised

background information, designers can gain a deeper understanding of the design topic and enhance their design efficiency. The information is as concise as possible and illustrated with images or icons to make it friendly to designers (see section 6.5.2.1).

Challenge - Lack of evidence support

Some designers expressed familiarity with packaging design but not with its purpose of promoting healthy eating. Their unfamiliarity with this emerging role of packaging raised concerns about its impact on food intake, highlighting a lack of supporting evidence. Similarly, in mHealth applications design, the lack of evidence demonstrating its impact was also reported as one of the main challenges (Pagliari, 2007). Understanding which specific design elements affect consumer intake requires extensive searching and reading, a process that designers reported as time-consuming and difficult to grasp (see section 6.4.2). Furthermore, there is little practical design and evaluation research being conducted, which often makes consumer insights difficult to obtain.

- To provide more evidence of the impact of packaging on food intake, the experimental results of the SR study were presented in the form of digital cards (see section 6.5.2.2), providing a clear comparison of changes in packaging elements and their effects on food intake. Besides, based on the findings of the review, several tips for applying these packaging elements were provided, such as considering the characteristics of the target food and audience. Moreover, the evidence from consumer perspective were provided. The packaging images provided by consumers were summarised and presented with a short description to explain why it is working for attention-grabbing or portion control. Moreover, three consumer personas were proposed based on the different needs of consumers (Brangier and Bornet, 2011) on healthy eating as the representations of the target audience. It was designed to encourage designers to consider broader audience (Lanius et al., 2020), rather than focusing on the obese population to further inspire designers for more design possibilities.

Challenge - Lack of guidance and deign examples

Moreover, the need for interdisciplinary knowledge brings more opportunities but also complicates the design further (Andrawes et al., 2021). In this research, the interdisciplinary nature of this design topic requires designers to incorporate insights from dietary guidelines, food energy, and portion sizes, along with psychological factors that influence consumer intake. The application of certain design theories and models serves as guidance to help achieve design goals in promoting healthy behaviour (see section 2.2.2.2). However, when it comes to packaging design aimed at encouraging healthy eating behaviours, designers still lack specific guidance. In addition, as this is a relatively new area of focus, there is limited prior design work that can serve as a foundation, leaving designers to experiment without sufficient reference points.

- To provide more theoretical guidance, three psychology theory that usually used in the design for health, including the Health Belief Model (HBM), Theory of Reasoned Action/Theory of Planned Behaviour (TRA/TPB) and Persuasive Technology (PT), were presented through diagrams, descriptions, and references (see section 6.5.2.2). Design strategies are needed to guide a specific design area (Kane et al., 2018). To make it tailored for food packaging design, several design strategies were proposed by combining these three theories and adapting them to current packaging design problem. A more detailed description was added next to each theoretical strategy to make it easier to understand (see section 7.1.5). Packaging design examples were collected and categorised from concepts generated by designers during the design task in design development phase and the design tool improvement phases. Besides the illustration, a brief note was provided to indicate which design strategy the example aligns with, aiming to inspire designers.
- Additionally, a quiz section comprising five questions related to food energy and portion sizes was implemented at the beginning of the tool's introduction. This was designed to spark designers' motivation to further explore the relevant information provided by the tool. According to feedback from student designers who participated in the test, this section was regarded as an engaging method for acquiring new knowledge (see section 7.1.4.1). The

correct options challenged their preconceptions, prompting their deeper reflection on the design subject. This also reinforced the idea that learning from mistakes can be highly effective (Yerushalmi and Polingher, 2006). Due to the positive feedback from all designers regarding the quiz, its content and format were integrated into the design tool (see section 7.1.5).

The tool expectations were summarised into two aspects: (1) easily understand and visual-oriented content; (2) convenient and unrestricted availability tool format (see section 6.3.3).

- Two main formats of the design tool are cards and a digital platform (see section 2.4.2.6). The current web-based format of the design tool was selected to present diverse information while meeting designers' needs for convenience and unrestricted access. Thus, the ultimate aim was to create a web-based design tool. However, during testing phases, the tool was initially presented in PDF format. This format evolving process is similar with the colour tool prototype developed by Won (2021), which is initially presented in PDF format in content testing phase, targeting to an interactive website.

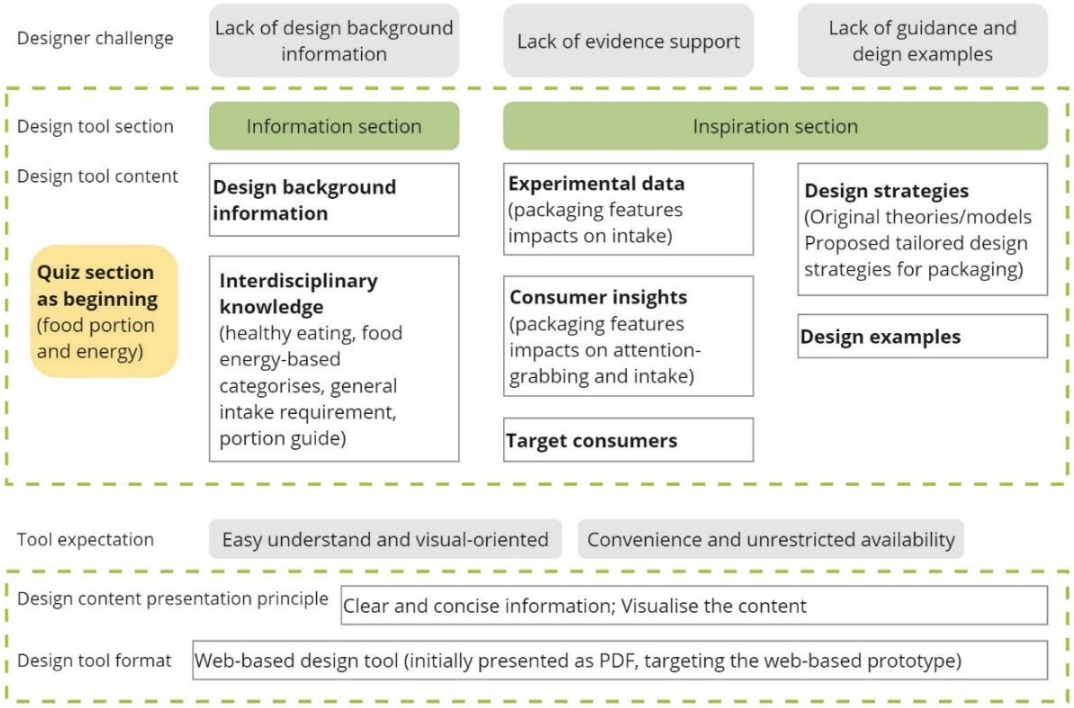


Figure 9.3 An illustration of the user-centred design tool development, along with the structure and main content of the tool.

In summary, the design tool was designed tailored to the challenges faced by designers. There are two main sections: the informational section provides designers with background information and interdisciplinary knowledge, while the inspirational section offers data from experiments and user perspective, along with targeted design strategies and design examples. It also seamlessly integrates a quiz section to spark interest and motivate designers to further explore the tool. Figure 9.3 summarises the process of user-centred design tool development.

9.4.2 Design tool usefulness

Based on the feedback of two round test with student designers (Chapter 7) and evaluation with professional designers (Chapter 8), the tool's clear and well-structured content was praised. The tool was perceived as enjoyable, efficient, and educational, reflecting a favourable reception by designer users (see section 7.2.3.2). Besides, the tool fostered high levels of engagement, task clarity, and self-efficacy of designers (see section 7.2.3.3.2). Its usefulness for designers was demonstrated in assisting designers utilising packaging design to promote healthy eating in the following aspects.

Deep understanding of the design topic – recognising the role of food packaging

The design tool was noted to offer comprehensive coverage of the design issue, helping designers navigate complex design topic with greater ease and understanding. Besides the knowledge on food and nutrition, the design tool significantly enhanced designers' understanding of food packaging and its broader implications. Specifically, prior to accessing the tool, many designers had limited awareness of how food packaging could influence consumer eating behaviours, particularly food intake (see section 6.3.1). After reviewing the tool, they recognised the potential of packaging design as a powerful tool for promoting healthier eating behaviours, highlighting new design opportunities for both healthy and HED foods (see sections 7.1.4.1 and 8.3.1). This awareness encouraged designers to think beyond traditional packaging functions and design focuses, prompting them to consider public health as part of food packaging design goals.

New design insights and inspiration – acknowledged new design directions

The tool was not just informative but also brought new insights to designers. For instance, designers reflected that learning about different methods to measure and present food portions offered new perspectives they had not previously considered for packaging design (see section 7.1.4.3). Besides, the tool inspired design by presenting the impacts of various packaging attributes in an easily digestible format that designers did not previously consider as influencing intake (see section 7.1.4.3 and section 8.3.2.1). For example, resealing and partitioning, which not only facilitate the food waste reduction but also help consumers regulate their food intake. These new perceptions of these features expanded the design possibilities by revealing new ways packaging can influence food intake and consumer behaviour. Furthermore, the tool not only provide deign examples as references, but also equipped designers with tailored theoretical strategies, offering new and actionable directions to designers (see section 7.2.3.4 and section 8.3.2.1). These insights proved the inspirational effectiveness of the design tool. Varied content was identified as inspirational sources which further support the argument by Petre et al. (2006) that gathering inspiration sources is essential for guiding designers' activities and fostering new ideas.

Efficient improvement - resource integration and keep design focus

Designers emphasised that the design tool saved them time and effort for accessing relevant information. The tool provided a streamlined, well-organised platform for exploring relevant design considerations, saving designers from spending time collecting disorganised information. This efficiency also allowed them to focus on creative solutions rather than getting lost in information overload (see section 8.3.2). The statistic results also support the efficiency, especially on the convenience of gaining knowledge of the packaging features' impact on food intake (see section 7.2.3.1). Furthermore, the ease of synthesising useful packaging design strategies improved significantly after engaging with the design tool (see section 7.2.3.1). Besides, the theoretical model itself was also seen as a approach to increase the design efficiency (Dormans, 2012). The design tool can be seen as a one-stop solution that saves both time and effort. This efficiency improvement of the design tool may benefit novice designers more since they tend to go to search

for stimuli from further domains intuitively without reflection (Gonçalves et al., 2016), thus, keeping them in an appropriate deign focus.

In summary, the design tool proved instrumental in enhancing designers' comprehension of the design topic, particularly in highlighting the role of food packaging in promoting healthy eating. It encourages innovation beyond traditional packaging functions, catering to diverse food target and consumer needs. It also provides new insights and inspiration by linking packaging design with consumer behaviour and offering actionable strategies for guiding health-oriented packaging design. It saves designers time while broadening their creative perspectives by delivering organised, intuitive, and comprehensive content, keeping designers focus on design solution. The above demonstrates that the design tool is effective, as it addressed the challenges faced by designers and successfully met its intended design objectives.

9.4.3 Design tool improvement considerations

Although general positive feedback on the final web-based prototype, designers gave some suggestions for improvement in three main aspects (see section 8.3.5). (1) Homepage Clarity: designers highlighted that the first impression of the design tool should clearly communicate that it is specifically intended for designers. (2) Content hierarchy: the content provided by the tool can be further categorised based on the designers' needs and levels of interest. Further improvement can achieve these two aspects by organising and prioritizing the content, thereby the display of the homepage can be simplified and more direct for designers. This allows users to quickly find areas of interest and enables them to decide whether to explore the content further based on their needs. To achieve this, a further investigation may be needed to prioritise the content through Delphi study (McPherson et al., 2018). These suggestions emphasise the importance of user-specific targeting and content hierarchy of the presentation of the tool content. The designers as the users of this study, offered suggestions from their own perspectives. It highlights that since the tool may have a wide range of users, different users may have varying focus areas, suggesting that different versions of the tool could be developed to cater to specific target users in the future. (3)

Additional functions: designers proposed additional functions that they would like to see in future versions of the design tool. The search function and sharing function are needed, they are considered in the design tool, however, it cannot be implemented at the moment, as the tool is still in its prototype stage. Designers also mentioned the expectation for an interaction feature to facilitate discussions and idea exchanges among users. Some even proposed expanding the tool's capabilities by adding practical design functions, allowing users to directly conduct design practice on this web-platform. These functional suggestions were insightful, but more specific web development technologies are required to implement these functions, thus, collaboration may be required with experts in relevant fields, along with cooperation from multiple parties, to successfully implement these features.

9.5 Considerations on contribution to design for behaviour change and its application values

9.5.1 Contribution to design for behaviour change

Providing interdisciplinary approach to address health eating challenges

This research contributes to the field of DfBC by integrating interdisciplinary knowledge, actionable insights and theoretical strategies to position packaging design as a tool for influencing eating behaviours. It emphasises the importance of collaboration across disciplines, drawing from packaging design, nutrition, psychology, and public health to develop a holistic approach to addressing dietary challenges. This tool combined behavioural theories, including Health Belief Model (HBM), Theory of Planned Behaviour (TPB), and Persuasive Technology (PT), to create a theory-based design strategies for influencing eating behaviour. Unlike existing approaches that focus primarily on psychological models (see section 2.4.2.5), this study demonstrates how these principles can be translated into packaging design strategies, empowering designers to develop design solutions that subtly nudge consumers towards healthier eating behaviours. By merging evidence-based information with behavioural theories, this study demonstrates how design methods can effectively tackle real-world issues, such as unhealthy eating patterns. While the focus is on packaging design for healthy eating, the

findings and methodologies offer insights applicable to other behaviour change contexts. It reinforces the importance of supporting designers in their work to influence behavioural outcomes. This research offers a flexible tool that supports designers while establishing a foundation for broader applications in behaviour-focused design, extending its impact within the field of DfBC.

Designer's power and support needed for target healthier behaviour

Designers possess a unique power and advantage in influencing healthier behaviours through their ability to shape visual, structural, and interactive elements of packaging that directly impact consumer perceptions and behavioural decisions. Current research highlights the role of designers on positive change through equipping them with the knowledge and resources needed to address complex social challenges. Specifically,

However, designers also face limitations when addressing health-related behavioural challenges. Beyond the support offered by this design tool, achieving widespread impact requires broader, multi-sector collaboration that extends beyond the scope of designers, including industry adoption and policy interventions. For example, financial incentives and tax benefits could encourage food companies to prioritise health-focused packaging (Mozaffarian et al., 2018, Acton et al., 2019), aligning with trends in consumer health awareness. Additionally, government regulations that ensure transparency and accuracy in health claims on packaging are essential for fostering a healthier food environment (Ares et al., 2022). Moreover, education and public awareness play a critical role in supporting behavioural change. Similarly, consumer education campaigns can improve health literacy, empowering individuals to interpret health cues on packaging effectively (Xie et al., 2022). Coupled with public media campaigns and such strategies reinforce the nudges embedded in packaging designs (Wakefield et al., 2010), ensuring sustained behavioural impact.

9.5.2 Design tool values in design process

The design tools were tested both in short-term and long-term duration. The short-term testing (one week) (see section 7.1) provided immediate insights into the

usability and intuitive functionality of the design tool, allowing participants to explore key features of it. Besides, short-term evaluation (see section 8.2) can also facilitate the identification of usability problems that may hinder user engagement (Lewis, 2014). The long-term testing revealed how the design tool functioned across different design stages (see section 7.2).

As recorded in designers' logs (see section 7.2.3.3.1), the progression of the designers in current project aligned closely with the Double Diamond process of design, which includes four key phases: discover, define, develop, and deliver as reviewed (see section 2.4.1). Figure 6.3 presents the main values of the design tool in different design process. The following section further discussed the specific role the tool plays at various stages of the design process.

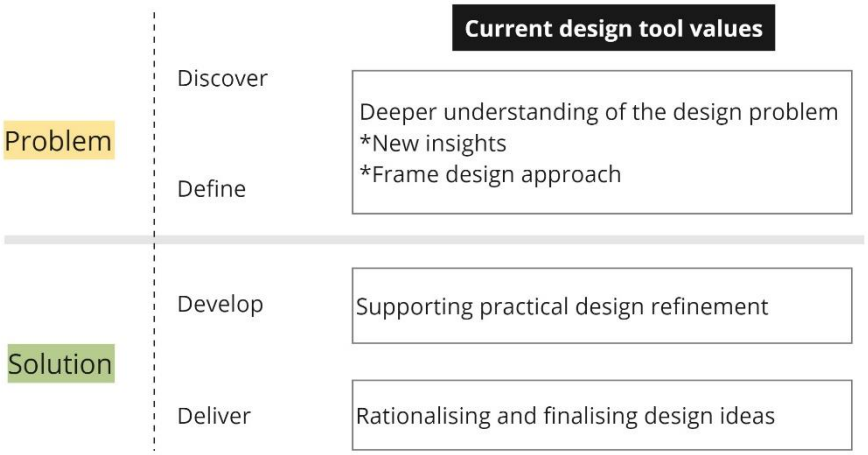


Figure 9.4 Illustration of the design tool value in the design process from Double Diamond perspective

- *Discover and define – deep understanding of the design problem*

In the earlier stages, corresponding to the discover and define phases, the focus of this period was on problem definition, including conceptual development, consumer research, and data analysis (see section 7.2.3.3). This reflected the intensive exploration and definition of the design problem. During which period, the tools were valued in facilitating the acquisition of new information, gathering insights, and applying theoretical strategies to shape their design approach. The rating of the design tool information (see section 7.2.3.3.1), task clarity, and self-efficacy reached their highest levels during this period in testing study 2 (see section 7.2.3.3.2), further validating a clear understanding of the design problem.

The results of testing study 1 also supported that the design tool helped designers develop a deeper understanding of the design problem and encouraged broader thinking (see section 7.1.4.3).

- *Develop – support design refinement*

As the project moved into the develop phase, the tool shifted its role toward supporting practical design refinement. Inspiration score of the design tool stayed high during this time (see section 7.2.3.3.1), as designers adjusted and iterated on their concepts, informed by the data and feedback collected earlier. This aligns with the focus on prototyping and concept refinement of the double diamond process. Besides, designers reported they would use the tool for inspiration when they have no design ideas or to refine their initial design ideas if they already have some (see section 8.3.3.1).

- *Deliver – support rational and finalisation of the design ideas*

By the final stage, aligning with the deliver phase, focusing on refinement and finalisation. The design tool continued to provide essential support, particularly in rationalizing and finalising design ideas. To be specific, the rating of information (see section 7.2.3.3.1) and the rating of self-efficacy (see section 7.2.3.3.2) returned to max at the last week and the design tool was reported providing informational and theoretical rational to their design idea for finalise the details and the design idea presentation. Designers also expressed they would like to use it to support and communicate their design ideas with others (see section 8.3.3.1).

9.5.3 Applications for different users and scenarios

Different users may use the tool in different ways based on their purpose. The following key points were drawn from designers' use of the tool, along with the feedback and insights they provided.

Application for designers

Design practice:

As reflected by designers that the design tool could benefit both novice designers and experienced designers (see section 8.3.3.2). For novice

designers, the tool provides essential guidance and background knowledge, offering structured design strategies to help them make informed design decisions. In contrast, experienced designers, they may use the tool as a supplementary resource, gaining new insights and refining their ideas with the help of inspirational section, such as the specific packaging strategies and design examples. In addition, this design tool is not limited to a specific food, as it provides general information, making it applicable to various foods or products (see section 8.3.2.1).

Supporting and communication:

Besides, student designers reported that the tool was particularly useful during the 'Deliver' stage, supporting them articulate and justify their design decisions (see section 7.2.3.3). Similarly, professional designers also found the design tool valuable for communication (see section 8.3.2). Specifically, they would like to use it to support their design ideas, present the tool to clients, or communicate designs with team members.

Applications for design firm and the food company

Deliver design task

The tool's application can extend beyond individual use, due to its value in facilitating communication. It can be applied within collaborative design environments. For example, in companies with clear departmental divisions, the tool is especially valuable for the design planning department (*"as it provides a solid foundation for assigning design tasks to the design execution team" (PD_07_06)*). It can help them clarify the design background and efficiently convey the design tasks to the design execution team or individuals, thereby improving coordination between departments. In addition, when food companies approach design firms for packaging development, they can use it to communicate their design needs for the food packaging.

Collaboration for projects

As revealed from designer need study (see section 6.3.1), most designers limited packaging design to the appeal focus. This design tool shifts the focus towards a more holistic approach, integrating consumer health considerations

into the design process. The design team members can use it to exchange ideas and ensure that design strategies are communicated effectively, helping them to refine strategies and align to the project goals (see section 8.3.2).

Seeking for extra support (organizations or policy makers)

Designers expressed concerns about the conflict between profit and health (see section 6.3.1.2). In addition to balancing this within the design itself, it is also necessary to seek external support to mitigate or avoid the impact of this conflict (Freudenberg and Galea, 2008). Such support could come from business-supporting organisations or policymakers, who could offer high-level support or financial subsidies for health-promoting design projects. This design tool can be used to seek broader support by emphasising the impact of food packaging design and its values and benefits for public health (*"The tool conveys a new design topic that is clearly reflected in the content, users can grasp the design concepts and messages being communicated." (PD_01_10)*).

Applications for academics and educators

Design education

The tools can be used in design education context. For example, this tool could support students in developing design practices in this specific packaging design topic as the feasibility has been showed in current testing studies with student designers. Besides, the quiz section of this design tool is considered as interesting and interactive (see section 7.1.4.1), which makes the tool suitable for education context where the interactive process is highly recommended (Ponomariova, 2016). Furthermore, it can serve as an example for teaching design for behaviour change, problem-solving, and addressing broader social and health issues.

Design research

This tool can be used by researchers in related fields to identify research gaps and guide new research directions. For example, the tool presents the impact of tested packaging features on food intake, allowing researchers to explore other packaging elements of food products. If researchers believe a particular design element has potential for further investigation, they can explore it

further. Additionally, certain design examples presented in the design tool could be subjected to user testing, providing more user feedback to inform related research fields.

In conclusion, this design tool demonstrates diverse value and broad applicability, supporting both individual creativity and collaborative communications in this specific design context, as well as enhancing a deeper understanding of the packaging design and consumer health to the target users. Its continued development and potential adaptation to other fields position it as a useful resource for designers and other across fields.

Chapter summary

This chapter recapped the main findings of each chapter and presented an overview of their connections to the main topic and to each other. Three conflicting perceptions of healthy eating were revealed including healthiness perception vs actual healthiness, portion control vs resistance and health vs business. The feasibility of using packaging as a nudging tool to promote healthy eating was discussed from several perspectives: choice architecture, liberty preservation, potential for long-term behavioural change, cost-effectiveness, and its appeal to a broader audience. Besides, the user-centred approach of design tool development, the usefulness of the design tool and the need for additional research and efforts to enhance its impact were discussed. Furthermore, this chapter discussed the contribution of the research to the field of DfBC. It also explored the power of designers and how packaging design can function as a socially supported tool to influence eating behaviours. The design tool presented different values in design process, in particular, it provided deep understanding of the design problem in problem identification process and supported the design refinement and finalisation in the design solution process. This chapter also discussed how the tool's testing generated insights into its application, along with proposed target users and potential use scenarios.

Chapter 10
CONCLUSION

This chapter provides a summary of the study conducted, main outcomes of this research and how they answer the research questions. The contribution to knowledge is highlighted and the limitations and recommendations for further work are outlined.

10.1 Overview of the research

An index of objectives and their corresponding thesis chapters was summarised and illustrated in Figure 10.1 to demonstrate how the design objectives outlined in Chapter 1 were achieved through the studies presented in each chapter.

Questions		Objectives	Chapters	
RQ1	1	To demonstrate a detailed understanding of the healthy eating, approaches to influence eating behaviour, design for behaviour change, the role of packaging design and design tool for designers.	Chapter 2 Literature Review	EXPLORATORY PHASE
	2	To investigate the impacts of packaging attributes on food intake and its characteristics, identifying the attributes that facilitate portion control.	Chapter 4 Systematic review	
	3	To explore the consumer insights from their real life on the packaging impacts on their food consumption.	Chapter 5 Consumer Study	
RQ2	4	To investigate the challenges and needs of designers in creating packaging designs that promote healthy eating.	Chapter 6 Designer Study	DEVELOPMENT PHASE
	5	To develop packaging design tool to support designers in shaping packaging that encourages healthy eating.	Chapter 6 Design Tool Development	
	6	To test, refine, and enhance the design tool through iterative development and feedback from designers.	Chapter 7 Design Tool Testing & Improvement	IMPROVEMENT PHASE
	7	To evaluate the design tool prototype in terms of its usefulness, values and applications for supporting the packaging design aimed at healthy eating.	Chapter 8 Evaluation design tool prototype	EVALUATION PHASE

Figure 10.1 Illustration of the thesis chapters addressing the research objectives.

10.1.1 Meeting the objective and answering RQ1

RQ1: What are the characteristics of packaging design in influencing consumer food intake?

1) *To demonstrate a detailed understanding of the healthy eating, approaches to influence eating behaviour, design for behaviour change, the role of packaging design and design tool for designers*

The literature review (Chapter 2) addressed objective 1 by reviewing research across many different fields, including healthy eating issues, design for behaviour change, packaging design and its impacts on consumers, design ideation and design tool to support ideation. Reviewing literature on healthy eating and imbalanced diets, along with the environmental and internal factors that pose challenges to achieving a balanced diet, revealed the significance of extra support for healthy eating. The review of design for behaviour change underscores the contribution of design on shaping health behaviour and the potential of design on eating behaviour. Packaging, as a key environmental cue, was reviewed in terms of its design and impact on consumers, further demonstrating its potential to guide consumer consumption. Reviewed design tool showed varied support approach and its values for assisting designers, the content and format of the design tool for ideation were summarised. However, it also highlights the lack and the importance of providing tailored support to help designers more effectively utilise food packaging design to promote healthy eating.

2) *To investigate the impacts of packaging attributes on food intake and its characteristics, identifying the attributes that facilitate portion control*

To address objective 2, a systematic review was conducted, gathering studies that experimentally tested the impact of packaging elements on food intake. Current research summarised and categorised these elements, along with their influence and characteristics on varied food (HED foods and F&V) and populations (adults, children, elders) in various setting (both in lab and in field). This comprehensive understanding of how changes in food packaging design affect intake was achieved by analysing 40 studies across 23 included articles. The findings of this study further confirmed that a variety of packaging elements influence food intake, particularly

when considering structural features and visual cues, adding depth to previous research on environmental nudging strategies.

3) *To explore the consumer insights from their real life on the packaging impacts on their food consumption.*

To address the objective 3, a photo-elicitation study was conducted with consumers. The analysis of 250 food packaging photos submitted by consumers and supported by detailed interview explanations revealed the types of packaging elements that capture consumers' attention, and the features associated with food intake and portion decisions. This study further confirmed, from the consumer's perspective, the impact of packaging elements on food intake, as well as consumers' focus and attitudes toward certain packaging elements. The results also revealed some of the confusion caused by existing packaging regarding portion decisions, along with consumers' suggestions for improvements in food packaging design for healthier portion decision.

10.1.2 Meeting the objective and answering RQ2

RQ2: What strategies and tools can be developed to support designers in designing food packaging that promotes healthy eating?

4) *To investigate the challenges and needs of designers in creating packaging designs that promote healthy eating.*

An exploratory study, focused on promoting healthy eating through packaging design, was conducted with both professional and student designers to address the objective 4. This study investigated designers' understanding of the design topic and their concerns on it, uncovering the challenges they currently face and the support they need when addressing this design problem. The findings revealed a lack of awareness regarding the impact of food packaging on food intake, which has led to some misunderstanding of the design topic and imposed limitations on the designers' design approach. This underscored the need for additional support to help designers better understand and leverage the emerging role of packaging in promoting healthier behaviours and provide clear direction for the design tool development.

5) *To develop packaging design tool to support designers in shaping packaging that encourages healthy eating.*

To address objective 5, the content of the design tool was developed by providing targeted support based on the challenges previously identified with designers. The content related to design background (such as healthy eating, food energy, and portion sizes) was compiled from relevant literature and websites. The impact of packaging features on food intake, summarised in Chapter 4, was transformed into digital cards, and the data and results from Chapter 5 were integrated into the tool to offer evidence and inspiration for designers. Three health and behaviour change models were introduced and incorporated to develop design strategies that guide packaging design for promoting healthy eating. Additionally, examples from the design exploration study, where designers completed design tasks, were included to provide additional inspiration for designers. Thus, the initial version of the design tool's content was developed by combined all above content together and presented in PDF format for further testing and refinement.

6) *To test, refine, and enhance the design tool through iterative development and feedback from designers.*

Two rounds of testing with student designers were conducted to achieve objective 6. The first round testing focused on evaluating the clarity of the content and the usefulness of it as a design tool. Feedback and suggestions for improvements were collected and summarised into a framework to guide further refinement of the tool. In the second round of testing, after improvements were made, a similar set of test questions from the first round was used. However, this long-term testing also included the use of a design log and design flow scale to better understand designers' activities and the tool's role in the design process. The results from both rounds were positive and consistent, demonstrating the usefulness and specific value of the design tool content. Additionally, both qualitative and quantitative insights revealed the tool's role throughout the design process.

7) To evaluate the design tool prototype in terms of its usefulness, values and applications for supporting the packaging design aimed at healthy eating.

An evaluation study with professional designers was conducted to address the objective 7. Building on the feedback from the previous round of testing and the requirements identified during the needs assessment in Chapter 6, the previously tested tool content was transited into a web-based prototype. This prototype was introduced to professional designers, who were encouraged to explore its content through packaging design tasks. Through interviews, further insights were gathered regarding the usefulness and values of current design tool. Drawing on feedback from all testing and evaluation studies, the tool's usefulness and user experience were assessed in relation to its role in the design process. Its applications were further considered across different user groups and scenarios, providing insights into its flexibility and adaptability for its broader use.

10.2 Contributions to knowledge

This research makes several key theoretical contributions, particularly by providing the first summary of packaging features influencing consumer food intake, gathering insights from both experimental studies and consumer perspectives. Additionally, it extends behavioural change models into the design domain, offering a new framework for packaging aimed at promoting healthier eating behaviours. Finally, it contributes to the fields of design tool development. This research also provides practical contributions to this design field by developing a design tool tailored to support packaging design for promoting healthy eating, and illustrating its features and values to show how different users can benefit from its application.

10.2.1 Theoretical contributions

A summary of packaging features influencing consumer food intake: insights from experimental studies and consumer perspectives

This research presents the first systematic review examining the impact of varied packaging features on food intake, synthesising evidence from 40 studies across 14

different packaging exposures. Unlike previous reviews that only focused on one type of packaging aspects, such as on -pack labelling (Thøgersen, 2023), current research provides a broader perspective, highlighting how diverse packaging attributes can impact consumption. It also identifies unexplored features, such as packaging textures and materials, which offer promising directions for future research. Furthermore, this research is the first to apply a participant-driven photo-elicitation (PDPE) approach to explore food packaging from the consumer's perspective. Unlike traditional methods, which often rely on controlled testing or interviews where variables are defined by researcher (see Chapter 4), this approach allows participants to capture and discuss real-life examples of food packaging. By letting participants share food packaging photos that could answer the question from researchers and guide the interviews through discussing these visual examples, offering a more authentic understanding of packaging design from the consumer's view. In addition to identifying eye-catching packaging features and those that influence portion decisions, the study uncovers underlying values that explain why certain designs work effectively in portion control while others do not. By integrating controlled studies and real-life perspectives, it highlights both established influences and unexplored opportunities in packaging design.

Integrating behavioural theories to packaging design strategies and user-centred design approach for design tool development

This research makes a significant contribution by using user-centred design approach to develop a design tool and integrating behavioural theories to generate tailored design strategies. To be specific, unlike previous design tools which often overlook designer input during development, this research contributes to user-centred design theory by prioritising designer needs throughout the tool's development process (Still and Crane, 2017), by actively involving designers to ensure the tool addresses their challenges, needs, and expectations (see section 9.4.1). This reinforces the idea that users are active participants, not just end consumers, where designers themselves help shape the tools they will use. Furthermore, current design tool integrated three behavioural models (Theory of Reasoned Action/Theory of Planned Behaviour, Health Belief Model, Persuasive Technology) to form the packaging design strategies for promoting healthy

behaviours. It links packaging design to behaviour change, extending the application of behavioural theories from social psychology to the design field. It proposes using theory informed design strategies to guide packaging design towards healthy eating, bringing unique insights and approaches to the field of DfBC. Besides, the iterative development and evaluation process further validate the tool's applicability and provide a valuable reference for future design tool development across specific fields and targeted design topics.

10.2.2 Practical contributions

The development of a design tool tailored for supporting the packaging design aimed at promoting the healthy eating

Different from other design tool which is for random inspiration or guide the deign in a specific area, a key contribution of current research is the development, testing, and refinement of a tailored design tool that supports designers in integrating health-focused features into packaging. This tool provides structured resources, including design principles, visual stimuli, and behaviour change strategies, to help designers navigate complex design challenges. Specifically, as discussed in section 9.4.2, this design tool assists designers at a practical level efficiently access to useful materials which helps better understand this design problem and bring new design insights and inspiration for the development of food packaging to shift user intake behaviour. This design tool brings varied support in different design stages. Specifically, it supports understanding the design problem, provides new insights, and helps frame the design approach in the 'Discover' and 'Define' stages. Additionally, it aids design refinement in the 'Develop' stage and supports rationalising and finalising design ideas in the 'Deliver' stage.

Varied users and application scenarios of the design tool

This design tool can benefit a wide range of users, including designers, design firms, food companies, and design educators. For designers, the tool serves as a valuable source of information and inspiration, aiding in both the design process and the presentation of design concepts. For food companies, it can be used to clearly communicate design briefs to design departments or design firm and to facilitate

collaboration in design team. Additionally, it can be leveraged to seek additional support from relevant institutions or organisations. For design educators, the tool can be integrated into design education, either as a case study in behaviour change design to connect with other fields, or as a guide to encourage broader perspectives in food packaging design. It also offers opportunities to uncover new directions for design research.

10.3 Limitations in this research

This section reflects on the limitations in terms of the research data, data collection and findings which guide the further work considerations in section 10.4.

The systematic review of current research was conducted four years ago, while the field of food packaging and its influence on food intake is evolving, and new studies may provide fresh insights that were not available four years ago. Without incorporating the latest research, the findings might not fully reflect the current findings of the influential packaging features. New packaging attributes may be researched, allowing for further updates to the content of the design tool. In addition, other factors such as packaging technology, changing food regulations or packaging policies, and evolving consumer preferences may influence the development, presentation, and effectiveness of packaging designs in promoting healthy eating, which were beyond the scope of this study.

The design tool underwent two rounds of testing with student designers during the tool development phase may have certain limitations. While the course is highly relevant to current design topic, student designers may be lack of practical design experience, and their needs and the areas of focus may differ from those of professional designers. Although this broadens the tool's applicability, it may reduce its effectiveness in providing targeted support for the professional designers during the practical stages. Therefore, it is necessary to consider the feasibility and necessity of developing separate design tools tailored to the specific needs of different user groups around this design topic.

During the needs assessment with designers and in the subsequent evaluation stages, the study involved a broad range of designers working in various fields of

design. Although some of them were involved in packaging design, and many had experience in food packaging, the study did not specifically recruit designers who specialise in food packaging design. It may limit the findings due to a lack of insights directly relevant to the food packaging industry and its unique requirements. This was mainly due to the fact that designers who only focus on packaging, particularly food packaging, are rare and hard to reach, as most designers today work on a variety of design projects. However, to fully realise the tool's practical value in guiding design practice, it would be ideal to collect data from designers who are working for the food packaging design development, which could provide deeper insights. Ideally, to address this, collaboration with food companies should be considered, allowing for data collection and tool testing with experienced food packaging designers, and potentially even the development of new food packaging designs.

Additionally, this research focused on changing consumer behaviour. Thus, to effectively solve healthy eating problems, the packaging design idea should be tested with consumers in real-world contexts. This suggests that it is necessary to prototype the design concepts developed with the support of this design tool and test them with consumers to further validate the tool’s effectiveness. For example, the design concepts collected from designers can be further tested with consumers for impact analysis. The limited time available for current research makes it impossible to conduct these design concepts testing with consumers which may leave to the further work.

Despite these limitations, the findings of this research provide valuable insights into the role of packaging design in promoting healthy eating, as well as the usefulness, versatility, and broad applicability of the design tool.

10.4 Further work recommendations

Apart from addressing the identified limitations in future work, several considerations for tool improvements were made, reflecting the feedback gathered during the testing activities, which were beyond the scope of the current research. Besides, packaging design for dietary behaviour change is an emerging field that

has only been partially explored, offering numerous opportunities for future research. Based on these considerations, the following sections propose some recommendations for further work.

Tool improvement and expansion.

Considerations for improving the current version of design tool (web-based prototype) are mostly related to content hierarchy and additional functions based on what emerged during the testing and evaluation studies. Here are the areas where the tool could be further improved. First, each section of the content in the design tool could be further categorised into different levels, from core to less important, based on the frequency they were mentioned and the reported impacts in the designers' feedback. Then, by validating the relevance and interest level of the content with designers, and assessing the logic of its order, the tool can be further refined. The hierarchical structure of the digital platform, combined with visual navigation panels, can be used to present the further categorised content in a way that aligns with designers' expectations for a direct and intuitive homepage. This improvement will allow for seamless navigation, enabling users to quickly access relevant information based on their different level of needs and specific interests. Additionally, regarding extra features, the searching and sharing functions that designers have requested can be implemented immediately once the current version of the tool is fully functional. However, the demand for interactive features will require further collaboration with web developers or designers to integrate additional functionality modules. This would enable the website to serve as a platform for sharing information, exchanging design ideas, and even uploading creative food packaging designs, addressing the current lack of design case studies.

Another consideration is expanding the tool’s applicability across different contexts and user groups. The potential users and possible application scenarios of this design tool were previously discussed based on its content, features, and values as identified through designer feedback. However, to fully confirm its value in different contexts, further validation with relevant users is necessary. Besides, for different potential users, their needs and areas of focus regarding the content

provided by the design tool may be varied. Therefore, it is worthwhile to carry out a more targeted needs analysis and adjust the content and format of the tool accordingly to better address the specific needs of each user group. For example, the communication value of the design tool was highlighted, which makes the design tool could be adapted for use in collaborative settings, such as brainstorming sessions within design companies or departments. To better support teamwork and discussions, the tool's format could be adjusted, transforming all content into card-based formats. The physical format would facilitate discussion and idea exchange more effectively. Further test of the new format of design tool could be conducted through workshops with designers in food packaging area. This would help verify the effectiveness of design tool in inspiring design ideas in collaborative environments.

Emerging research opportunities: packaging design for dietary behaviour change

Other reflections emerged from unexplored areas of packaging's impact on consumer intake, along with further research opportunities identified through the design tool's content and evaluation. According to the systematic review study, while many food packaging features that influence food intake have already been researched, several other packaging elements remain unexplored, such as packaging materials and textures. Additionally, further research is required on the effects of specific packaging features in different contexts, including their impacts across different consumer groups and food types. Further research opportunity is on exploration of the combined effects of multiple packaging features on food intake when they appear together on the same packaging. As highlighted in the limitations, some packaging design concepts developed under the guidance of the design tool can be further tested with consumers to validate their impacts on food intake. In addition, based on the design strategies provided by the tool, corresponding food packaging concepts or prototypes can be developed and tested with consumers, one by one, to further validate their effectiveness and contribute to the relevant theory development.

Appendix

Appendix 1

The study quality assessment of the included studies in systematic review.

The assessment results of article quality (n=23).

Study ID	Study quality (score and percentage)				
	Reporting quality	External validity	Internal validity-bias	Internal validity- confounding (selection bias)	General
Aerts and Smits, 2017	10/10 (100%)	1/1 (100%)	5/6 (83%)	2/4 (50%)	18/21 (86%)
Aerts and Smits, 2019	10/10 (100%)	1/1 (100%)	5/6 (83%)	1/4 (25%)	17/21 (81%)
Argo and White., 2012	7/10 (70%)	0/1 (0%)	5/6 (83%)	1/4 (25%)	13/21 (62%)
Bui et al., 2017	9/10 (90%)	1/1 (100%)	6/6 (100%)	1/4 (25%)	17/21 (81%)
De Bondt et al., 2017	10/10 (100%)	1/1 (100%)	5/6 (83%)	2/4 (50%)	18/21 (86%)
Deng and Srinivasan, 2013	9/10 (90%)	0/1 (0%)	5/6 (83%)	2/4 (50%)	16/21 (76%)
Eykelenboom,et al, 2018	10/10 (100%)	0/1 (0%)	5/6 (83%)	2/4 (50%)	17/21 (81%)
Gregori et al., 2013	9/10 (90%)	1/1 (100%)	4/6 (67%)	2/4 (50%)	16/21 (76%)
Gregori et al., 2014	10/10 (100%)	1/1 (100%)	4/6 (67%)	2/4 (50%)	17/21 (81%)
Holden & Zlatevska, 2015	9/10 (90%)	1/1 (100%)	5/6 (83%)	1/4 (25%)	16/21 (76%)
Keller et al., 2012	10/10 (100%)	1/1 (100%)	4/6 (67%)	2/4 (50%)	17/21 (81%)
Koo and Suk, 2016	10/10 (100%)	1/1 (100%)	6/6 (100%)	1/4 (25%)	18/21 (86%)
Madzharov and Block, 2010	8/10 (80%)	0/1 (0%)	5/6 (83%)	2/4 (50%)	15/21 (71%)
Mantzari et al., 2017	8/10 (80%)	0/1 (0%)	4/6 (67%)	2/4 (50%)	14/21 (67%)
Marchiori et al., 2012	9/10 (90%)	0/1 (0%)	5/6 (83%)	2/4 (50%)	16/21 (76%)
Neyens et al., 2015	9/10 (90%)	1/1 (100%)	5/6 (83%)	3/4 (75%)	18/21 (86%)
O.C. Werle et al., 2016	10/10 (100%)	1/1 (100%)	4/6 (67%)	2/4 (50%)	17/21 (81%)
Petit et al., 2018	10/10 (100%)	0/1 (0%)	4/6 (67%)	2/4 (50%)	16/21 (76%)
Raynor et al., 2009	9/10 (90%)	0/1 (0%)	4/6 (67%)	2/4 (50%)	15/21 (71%)
Stroebele et al., 2009	10/10 (100%)	0/1 (0%)	5/6 (83%)	1/4 (25%)	16/21 (76%)
Versluis and Papies, 2016	9/10 (100%)	1/1 (100%)	5/6 (83%)	2/4 (50%)	17/21 (81%)
Versluis et al., 2015	9/10 (90%)	1/1 (100%)	5/6 (83%)	2/4 (50%)	17/21 (81%)
Wansink et al., 2011	10/10 (100%)	1/1 (100%)	5/6 (83%)	2/4 (50%)	18/21 (86%)
Total studies (on average)	9.30/10 (93%)	0.61/1 (61%)	4.78/6 (80%)	1.78/4 (45%)	16.47/21 (78%)

Appendix 2

The study details of the included studies in systematic review.

Characteristics extraction of the studies included in the systematic review (N1 = number in articles; N2 = number included; NA = not available)

Reference	Study Design			ID	Participants		Setting	Exposures	Comparison	Outcome measures	Core findings (differences between conditions)
	Number		Type		Number	Details					
	N1	N2									
Aerts and Smits, 2017	2	2	Experimental trial	1.1	96	Male = 50 Female = 46 Mean age = 6.43	Children's own classroom	Package size Food flavour	A regular plain packaging (30 g) compared to a large plain packaging (60 g) of popcorn with either sugared or salted flavour	Consumption (in grams)	Children consumed about 25 grams more popcorn from a large pack than from a regular pack. This package size effect is large for both popcorn types, but it is most prominent for sugared popcorn.
			Experimental trial	1.2	55	Male = 29 Female = 26 Mean age = 4.67	Children's own classroom	Package size Snack type	The small packages (80 g carrots or 30 g cookies) compared to the large packages (130 g carrots or 48 g cookies)	Consumption (in grams)	Children ate about 7 grams more cookies from the large pack compared to the regular one. In contrast, the package size effect was small to non-existent for carrots.
Aerts and Smits, 2019	2	2	Experimental trial	2.1	47	Male = 18 Female = 29 Mean age = 6.60	Primary school	Suggested portion size on the package Snack type	The healthy snack compared to less healthy snack (grapes vs chocolate nuts) and the regular suggested portion size sticker (20 chocolate nuts or grapes) compared to the larger suggested portion size sticker (40 chocolate nuts or grapes)	Consumption (in grams)	Children ate about 15 grams more grapes when on-pack sticker suggested a large portion than a regular one. In contrast, depicted portion size did not affect chocolate nuts consumption.
			Experimental trial	2.2	24	Male = 11 Female = 13 Mean age = 5.62	The dining area of the school	Suggested serving size on the package Spread type	Perceived healthy cheese spread compared to relatively less healthy chocolate spread and the regular-sized spread (15 grams) on the depicted slice of bread compared to the large-sized spread (73 grams) on the bread slice	Amount of spread on the first slice (in grams) Total amount of used spread (in grams)	Children ate about 2 grams more spread on the first slice of bread when exposed to a large serving suggestion than to a regular one. The total consumption of spread had no big difference.
Argo and White., 2012	5	5	Experimental trial	3.1	76	Male = 0 Female = 76 Mean age = NA	University laboratory	Package status	Small-package present (five small packages) compared to small-package absent (the candy was loose in the bowl)	Consumption (in grams) Appearance self-esteem (ASE)	The low-ASE consumers ate about 22 grams more candy when the small package was present than when it was absent. But this effect was not pronounced among the high-ASE consumers.

Reference	Study Design			ID	Participants		Setting	Exposures	Comparison	Outcome measures	Core findings (differences between conditions)
	Number		Type		Number	Details					
	N1	N2									
			Experimental trial	3.2	207	Male = 84 Female = 123 Mean age = NA	University laboratory	Package status Visibility of product quantity	Small-package (eight) candy-coated chocolates compared to large-package (two) candy-coated chocolates and all of the packages were either transparent (visible condition) or opaque (not visible)	Earlier ASE index Consumption (in grams)	There were significant effects for package status, visibility of product and the ASE index. In small package condition, low ASEs consumed about 25 grams more from the transparent package than from the opaque package.
			Experimental trial	3.3	187	Male = 66 Female = 120 Unreported=1 Mean age = 35	At desk (in an office or a cubicle)	The location of the caloric information	Eight small packages of chocolates with a front nutrition label compared to with a back nutrition label compared to with no label	Earlier ASE index Consumption (in grams)	Low ASEs consumed more when the caloric information was located on the front than on the back and was absent (63.86 g vs 38.55 g vs 36.54 g).
			Experimental trial	3.4	297	Male = 0 Female = 297 Mean age = NA	University laboratory	Package status Communicated caloric content	Small-package candy-coated chocolates (eight packages) compared to small-package absent (no packaging) and provided the information that products contain high calorie (150) compared to low calorie (50) compared to no calorie information	Earlier ASE index Consumption (in grams)	There were significant effects for package status, communicated caloric content and ASE. When the package was present, low ASEs ate more when they were informed that the caloric content was low than when they were informed it was high or absent (69.99 g vs 23.97 g vs 55.86 g).
			Experimental trial	3.5	105	Male = 0 Female = 105 Mean age = NA	University laboratory	Package status Cognitive load	Small-package candy-coated chocolate compared to small-package absent and either in low-load cognitive condition (memorize a two-digit number) compared to in a high-load cognitive condition (memorize an eight-digit number)	Consumption (in grams) ASE index	When small packages were present, low ASEs ate about 47 grams more when cognitive load was low than when it was high, while high ASEs did not differ in consumption.
Bui et al., 2017	3	1	Experimental trial	4.3	67	Male = 32 Female = 35 Mean age = 27	University laboratory	Partitioning condition of package Food healthfulness	Perceived healthy (granola) compared to perceived as unhealthy (cookies) and no partitioning (1 with 16 pieces per bag) compared to high partitioning (4 packages with 4 pieces per bag)	Consumption (in pieces) Feelings of guilt	Participants ate more granola from no partitioned packages compared to highly partitioned packages (7.5 p vs 4.7 p). Cookie consumption across the package partitioning conditions did not differ.

Reference	Study Design			ID	Participants		Setting	Exposures	Comparison	Outcome measures	Core findings (differences between conditions)
	Number		Type		Number	Details					
	N1	N2									
De Bondt et al., 2017	3	2	Field experiment	5.2	79	Male = 44 Female = 35 Mean age =20.62	The theatre	The reseal ability of package	A bag of jelly beans (450 g) that was resealable compared to a non-resealable bag of jelly beans (450 g)	Consumption (in grams)	Participants ate about 89 grams less candies when they received a resealable bag than those who received a non-resealable bag.
			Field experiment	5.3	43	Male = 13 Female = 30 Mean age =24.58	Home	The reseal ability of package	A box with four types of snacks (M&M's, gummy bears, sugar-coated mini cookies and salted peanuts (each 250 g)) that in either resealable or non-resealable packages	Consumption frequency Total intake (in grams) Consumption of per snack (in grams)	Package resealability did not spur the snacking frequency. Resealable packages limit the participants ate about 41 grams less than non-resealable packages. This effect does not depend on the snack.
Deng and Srinivasan, 2013	5	5	Experimental trial	6.1	123	Male = 81 Female = 42 Mean age = NA	University laboratory	The transparency of package Food visual attraction	Visually attractive food (Froot Loops) compared to visually plain food (Cheerios) and transparent packages compared to opaque packages	Consumption (in grams)	People ate 69% more of Froot Loops from the transparent package than from the opaque package. The consumption of Cheerios was same across transparency conditions.
			Experimental trial	6.2	183	Male = 93 Female = 90 Mean age = NA	University laboratory	The transparency of package Food size	The large, visually attractive food (cookies) compared to the small, visually attractive food (candies) and transparent packages compared to opaque packages	Consumption (in grams)	For candies, people ate 58% more from the transparent package than from the opaque package. For cookies, people ate 28% less from the transparent package than from the opaque package.
			Experimental trial	6.3	51	Male = 19 Female = 32 Mean age = NA	University laboratory	The transparency of package	Partially transparent packages compared to opaque packages (M&M's candies)	Consumption (in grams)	Participants ate 76% more M&M's candies from the partially transparent package than from the opaque package.
			Experimental trial	6.4	41	Male = 8 Female = 33 Mean age = 41	University laboratory	The transparency of package	Transparent packages compared to opaque packages (M&M's candies)	Consumption (in grams)	Participants ate 88% more M&M's candies from transparent package than from opaque package.
			Experimental trial	6.5	65	Male = 38 Female = 27 Mean age = NA	University laboratory	The transparency of package	Transparent packages compared to opaque packages compared to partially transparent packages (baby carrots)	Consumption (in grams)	Participants ate less baby carrots from the fully transparent package than from the partially transparent package and the opaque package (22.69 g vs 24.48 g vs 41.92 g).

Reference	Study Design			ID	Participants		Setting	Exposures	Comparison	Outcome measures	Core findings (differences between conditions)
	Number		Type		Number	Details					
	N1	N2									
Eykelenboom et al., 2018	1	1	Randomized controlled trial	7	205	Male = 52 Female = 153 Mean age = 70.5	Ridge clubs or community centre	Package size	Peanut butter in the small package (350 g) compared to in the large package (1000 g)	Usage volume (in grams)	Increased package size has no effect on the usage volume of peanut butter in older adults. (*participants had the chance to eat the food)
Gregori et al., 2013	1	1	Randomized controlled trial	8	600	Male = 300 Female = 300 Mean age = NA (3 to 10 years)	A room in the school buildings	Exposure to the toy inside the package Exposure to TV The number of advertising	Food alone (chocolate) compared to food with toy and either shown or not shown a movie cartoon, with three exposure levels to commercials in the TV viewing condition (1, 2 or 3 advertisements)	Consumption (in grams) Energy intake (in calories)	The presence of a toy inside a snack package did not alter the amount of the item consumed by children in a Latin American context.
Gregori et al., 2014	1	1	Randomized controlled trial	9	1680	Male = 840 Female = 840 Mean age = 6.5	A room in the school buildings	Exposure to the toy inside the package Exposure to TV The number of advertising	Food (chocolate) alone compared to food with toy and either shown or not shown a movie cartoon, with three exposure levels to commercials in the TV viewing condition (1, 2 or 3 advertisements)	Consumption (in grams) Energy intake (in calories)	Food consumption by children in a Indian context was not influenced by the presence of added toys in package.
Holden and Zlatevska, 2015	1	1	Experimental trial	10	108	Male = 50 Female = 58 Mean age = NA	University laboratory	Partitioning of package Diet consciousness	M&Ms candy in a single bag (1x200 g) compared to four bags (4x50g) and diet consciousness was activated (with a body image questionnaire) compared to not activated	Consumption (in grams)	When the diet-consciousness was activated, partitioning led to higher consumption than non-partitioned portions (46.5 g vs 17.6 g). The lower diet consciousness group ate more after the activation of diet consciousness (37.9 g vs 22.5 g). The higher diet consciousness group was little affected by activation (10.1 g vs 8.0 g).
Keller et al., 2012	3	3	Experimental trial	11.1	43	Male = 17 Female = 26 Mean age = 5.9	University laboratory	The brand state of meals	The "unbranded" meals, served in plain, white plastic containers compared to two "branded" meals, served in original brand packaging (turkey and cheese, ham and cheese, peanut butter and jelly sandwiches, pretzels, graham crackers, apple slices, carrot sticks, pudding, plain and chocolate milks)	Meal intake (in calories)	No consumption differences between the branded and unbranded conditions when all children were combined. However, overweight /obese (OW) children ate about 41 kcals more when foods were branded, while non-OW children ate about 45 kcals less branded foods compared to unbranded food.

Reference	Study Design			ID	Participants		Setting	Exposures	Comparison	Outcome measures	Core findings (differences between conditions)
	Number		Type		Number	Details					
	N1	N2									
			Experimental trial	11.2	41	Male = 21 Female = 20 Mean age = 8.4	University laboratory	The brand state of meals	Meal "branded" with the logo of a popular fast food compared to "unbranded" meal, served in plain white packaging.	Meal intake (in calories)	Children eat more at the branded meal compared to the unbranded meal (793 kcals vs 730.0 kcals).
			Randomized controlled trial	11.3	16	Gender = NA Mean age = NA (4-5 years)	Home	The food branding cues	Control group (received F&V in plain plastic containers for all 7 weeks) compared to intervention group (during weeks 3-6, received F&V in containers decorated with their favourite cartoon characters) (F&V: beets, broccoli, carrots, red peppers, pineapple and blue berries)	Daily total F&V intake (in grams)	At baseline, the intervention group increased about 20 g vegetable intake per day. At treatment, the intervention group increased about 125 g in total F&V consumption over four days. At follow-up, the intervention group showed a 200 g increase over four days compared to baseline.
Koo and Suk, 2016	5	1	Experimental trial	12.5	74	Male = 37 Female = 37 Mean age = 25.1	University laboratory	Package shape The mindful calorie intake priming	Mango smoothie contained in an elongated clear plastic bottle (230 ml) compared to a less elongated clear plastic bottle (230ml) and the exposure to the healthiness knowledge about fruit smoothies compared to exposure to the fruit smoothies flavour information	Consumption (in volume)	When primed to be mindful of calorie intake, more of the mango smoothie in the taller bottle was consumed than that in the wider bottle (51.88 ml vs 43.60 ml). When the priming was absent, no consumption difference was found.
Madzharov and Block, 2010	6	4	Experimental trial	13.3	17	NA	University laboratory	The number of product units displayed on the package	The picture of a package displayed 5 animal crackers compared to the picture of a package displayed 25 animal crackers	Consumption (in number and ounces)	Participants ate more of the product when they saw the 25-cracker package than when they saw the 5-cracker package (in number: 2.40 vs 0.65 ; in ounces 0.16 vs 0.04).
			Experimental trial	13.4	94	NA	University laboratory	The number of product units displayed on the package Cognitive load	The picture of a package displayed 1 cracker compared to the picture of a package displayed 9 crackers and the cognitive load condition (given a list of nine words to remember) compared to non-cognitive load condition	Self-reported consumption (in number)	Participants ate more when they viewed more crackers on the package (5.21 p vs 3.14 p). Participants in no-load condition ate more crackers after viewing a greater number of cracker image (6.65 p vs 2.43 p). In the load condition, no consumption difference was found.

Reference	Study Design			ID	Participants		Setting	Exposures	Comparison	Outcome measures	Core findings (differences between conditions)
	Number		Type		Number	Details					
	N1	N2									
			Experimental trial	13.5	66	NA	University laboratory	The number of product units displayed on the package	The picture of a package displayed 5 pretzels compared to the picture of a package displayed 30 pretzels. (Next to each of these pictures, the verbal information embedded in the nutrition facts panel was provided)	Level of visual processing Self-reported consumption (in number)	Participants at a high level of visual processing reported eating more from the package displayed more pretzels (19.80 p vs 8.73 p). Participants at a low level of visual processing, the number of pretzels displayed did not affect food intake. This image effect is powerful even in the presence of verbal information.
			Experimental trial	13.6	59	NA	University laboratory	The number of product units displayed on the package	The picture of a package displayed 3 pretzels compared to the picture on the package displayed 15 pretzels	Consumption (in number and ounces)	Participants ate more pretzels (about 5 pieces/ 0.3 ounces) from the package with more pretzels on the front than from the package with fewer pretzels on the front.
Mantzari et al., 2017	1	1	Field experiment	14	16	Male = 4 Female = 12 Mean age = 33	Home	Bottle size	Participants received a set amount of cola each week in bottles of one of four sizes: 1500 ml, 1000 ml, 500 ml, or 250 ml, in random order.	Consumption for each week (in volume)	There was no significant consumption difference in different bottle size conditions.
Marchiori et al., 2012	1	1	Experimental trial	15	88	Male = 62 Female = 26 Mean age = 20.1	University laboratory	Container size Portion size	Medium portion size (PS) (200g) of M&M's with small container size (CS) (250ml) compared to medium PS (200g) with large CS (750ml) compared to large PS (600g) with large CS (750ml)	Consumption (in grams)	A larger container increased intake by 129% when PS was kept constant, and increased intake by 97% when it was associated with a larger PS.
Neyens et al., 2015	1	1	Experimental trial	16	22	Male = 10 Female = 12 Mean age = 4.36	The lunch room of school	The image-size of front of pack Sugar content	The packaging with a larger image-size compared to the packaging with a smaller image-size and a higher sugar content cereal compared to lower sugar content cereal	Poured and consumed cereal (in grams) and milk intake (in ml)	Larger image-size lead more cereal was poured (18.39 g vs 14.80 g) and eaten (20.59 g vs 15.93 g), and more milk was drunk (216.34 ml vs 199.18 ml) than a smaller image-size. Cereal consumption only differed when sugar content was low (21.68 g vs 14.68 g).

Reference	Study Design			ID	Participants		Setting	Exposures	Comparison	Outcome measures	Core findings (differences between conditions)
	Number		Type		Number	Details					
	N1	N2									
O.C. Werle et al., 2016	3	2	Experimental trial	17.2	77	Male = 42 Female = 35 Mean age = 20	University laboratory	Package type	M&M's peanuts were packaged in original package compared to these were packaged in plain package.	Consumption (in grams)	No consumption difference was found across packaging conditions. Males ate more from the plain packaging than from the original packaging (34.05 g vs 26.08 g).
			Experimental trial	17.3	99	Male = 44 Female = 55 Mean age =20.65	University laboratory	Package type	Original packaging compared to plain packaging compared to light packaging (in the front of a classic M&M's peanuts packaging tag a clear blue label showing "Low Fat")	Consumption (in grams)	Participants ate more from plain and low-fat label packaging than from the original packaging (49.73 g vs 50.14 g vs 37.5 g). Females ate more from low fat label packaging than from the original and the plain packaging (28.13 g vs 17.87 g vs 18.61g). Males ate more from plain packaging than from the original packaging and the low-fat packaging (31.13 g vs 19.63 g vs 22.02).
Petit et al., 2018	2	1	Experimental trial	18.2	76	Male = 54 Female = 22 Mean age = 21	University laboratory	The portion illusion	The same quantity of cereals was shown on the front of both versions of the packaging, but served in either a larger- or smaller-rimmed bowl.	Serving weight (in grams) Simulation of eating experiences	Participants poured 19.72% less cereals from the packaging showing a smaller-rimmed bowl. The participants with medium and high scores of mental simulations poured less cereals (23.16%, 36.23%, respectively) after seeing the smaller-rimmed bowl than after seeing the larger-rimmed bowl.
Raynor et al., 2009	1	1	Randomized controlled trial	19	19	Male = 1 Female = 18 Mean age = 50.6	Home	The portion state of food package Food type	Breakfast packaged in single servings compared to these packaged in non-portioned packages (cereal: 22x0.68 boxes vs 1x15 box, peaches: 12x4 cans vs 3x15 cans, applesauce: 12x4 cans vs 3x15 cans, cheese: 16x1 blocks vs 2x10 blocks)	Energy intake (in calorie)	Single-serving packages resulted in a reduction in energy intake when compared to intake from the non-portioned packages. (27 kcal for cereal and peaches per day/25 kcal for applesauce and cheese per day)

Reference	Study Design			ID	Participants		Setting	Exposures	Comparison	Outcome measures	Core findings (differences between conditions)
	Number		Type		Number	Details					
	N1	N2									
Stroebele et al., 2009	1	1	Randomized controlled trial	20	59	Male = 18 Female = 41 Mean age = 37.3	Home	Package size Food proving order	Standard size packages snacks (units ranged from 187 g to 368.5 g per package) compared to 100 kcal packages (units ranged from 19.2 g to 26 g per package) and provided two different packaged food in different week order	Consumption per week (in grams)	Participants ate 186.9 grams fewer snacks per week when receiving 100 kcal snack packs compared to standard size packages of snacks. Participants receiving the 100 kcal snack packs first ate only 113.5 g more of the standard sized snacks in the second week. The participants receiving the standard size packages first ate 260.4 g less when receiving the 100 kcal snack packs.
Versluis and Papies, 2016	2	1	Experimental trial	21.2	224	Male = 132 Female = 92 Mean age = 21	University laboratory	Pack size Commercial type	M&M's peanuts in size small pack (200 g bag) compared to size large pack (400 g bag) and diet commercials compared to non-diet-related commercials	Consumption (in grams) Dietary restraint	The participants ate less when they were exposed to diet commercials (36.9 g vs 46.0 g). The restrained eaters ate about 156 calories less of M&M's from large pack when reminded of their dieting goal than when did not (24.98 g vs 55.47 g).
Versluis et al., 2015	3	1	Experimental trial	22.3	89	Male = 39 Female = 51 Mean age = 20	University laboratory	The pictorial suggested portion size	An open package of M&M's peanuts with the pictorial serving size recommendation sticker compared to no serving size recommendation	Taken amount (in grams) Consumption (in grams) Memory of the sticker	The serving size recommendation lowered the amount of peanuts participants served themselves, but only when it was noticed by participants. However, the consumption showed no difference in different conditions.
Wansink et al., 2011	1	1	Experimental trial	23	37	Male = 22 Female = 15 Mean age = 20.3	University laboratory	Package size	4x100-calorie packages of crackers compared to 1x 400-calorie package of crackers	Estimated consumption (in calorie) Actual consumption (in calorie)	Participant ate 25.2% less when given 100-calorie packages than when given 400-calorie package. The intake of overweight participants decreased by 54.1% when given 100-calorie packages.

Appendix 3

The ethic approval evidence of the elicitation study with consumers and all exploration study with student designers and professional designers.

FW: LTDESN-139 - AHC FREC Application Outcome

From Erin Pickles <E.R.K.Pickles@leeds.ac.uk>
on behalf of
AHC Research Ethics <AHCResearchEthics@leeds.ac.uk>
Date Wed 2021-03-03 15:32
To Ruiqi Chu <sdrc@leeds.ac.uk>
Cc Marion Hetherington <M.Hetherington@leeds.ac.uk>; Tang Tang <T.X.Tang@leeds.ac.uk>

Dear Ruiqi,

Re: LTDESN-139: Photo-elicitation of package use in adult consumers

Further to the submission of the responses to the AHC FREC committee on the 23rd February (in the chain below), I am pleased to inform you that the committee has now reviewed and accepted your application for Light touch ethics agreement.

Please retain this email as evidence of approval in your study file.

Please notify the committee if you intend to make any amendments to the original research as submitted and approved to date. This includes recruitment methodology. All changes must receive ethical approval prior to implementation. Please refer to the amendment form or contact the Research Ethics & Governance Administrator for further information (ahcresearchethics@leeds.ac.uk) if required.

Please remember that your research should be undertaken in accordance with all prevailing Government and University restrictions in force to prevent the spread of coronavirus. I am sure that you are already well aware of these, but to reiterate this currently (at the time of sending this email) means that you must conduct this research remotely (digitally) and from home. We therefore want to just flag that the digital platforms that you may use to carry out this research (Zoom, Teams, Skype etc) raise issues for both yourself as the researcher and for the participants. Specifically you should be aware that:

- Participants will be in their own home when being interviewed. This may limit the topics that are safe for discussion.
- That your own home environment will be exposed via video communication to research participants. Where possible the visible environment in your background must be minimised (or managed) to protect your own safety and to prevent distraction or influence over the subject of study
- If obtaining verbal consent from your participants then it must adhere to the University's 'Verbal Consenting Protocol' - please see attached for further information.

Please note: You are expected to keep a record of all your approved documentation, as well as documents such as sample consent forms (if you continue to do this by post), risk assessments and other documents relating to the study. This should be kept in your study file, which should be readily available for audit purposes. You will be given a two week notice period if your project is to be audited.

It is our policy to remind everyone that it is your responsibility to comply with Health and Safety, Data Protection and any other legal and/or professional guidelines there may be.

Some funders require official confirmation that ethics approval has been achieved. If you require this email agreement in letter form please do let me know. I would be happy to provide this if it is needed.

I hope the study goes well. If you have any questions please do email me.

Appendix 4

The support documents of the photo-elicitation study with consumers.

Appendix 4.1

The information sheet provided to consumers in the photo-elicitation study.

Information Sheet

This study has been approved by the University of Leeds Research Ethics Committee

(Ethics Ref No: LTDESN-139)

About the study

We would like to invite you to take part in a study on packaging. This research project is designed to identify packaging features for the improvement of packaging design.

Details of the study

Participation in the study involves completion of a participant information form, a photo task and a short recorded interview.

- Participant information: you will be asked some personal information, which you have finished in the online survey.
- Photo tasks: we will give you some instructions to take some photographs of packaging of food and drink items.
- An interview: we will invite you to answer some questions about the photos you take and this short interview will be audio-taped by the researcher then later transcribed (should take no more than 10-15 min)

Ethics

This research has been approved by the University of Leeds Research Ethics Committee (Ethics reference: LTDESN-139). Any identifying personal details obtained will only be available to those directly carrying out the research and will be stored securely. The video and audio recordings made during this research will be used only for analysis and may be used for illustration in conference presentations and lectures (with permission only). No other use will be made. Confidentiality and anonymity will be maintained. Any personal information that could identify you and your family will be removed or changed before files are shared with other researchers or results are made public.

Do I have to take part?

Your involvement in all elements of the project is entirely voluntary. If you decide to take part in this research, you will be asked to sign a consent form to say you have understood the study requirements and agreed to participate.

P7	meal	Please take one photograph from lunch or dinner meal of any packaging that has helped you to pay attention to the portion size or serving size. If you do not have an example, please take a photograph of a package which is confusing about portion size.
P8	salty snacks	Please take one photograph from salty snacks of any packaging that has helped you to pay attention to the portion size or serving size. If you do not have an example, please take a photograph of a package which is confusing about portion size.
P9	sweet snacks	Please take one photograph from sweet snacks of any packaging that has helped you to pay attention to the portion size or serving size. If you do not have an example, please take a photograph of a package which is confusing about portion size.
P10	beverage	Please take one photograph from a beverage (non-alcoholic) of any packaging that has helped you to pay attention to the portion size or serving size. If you do not have an example, please take a photograph of a package which is confusing about portion size.

＊ Please name your photographs using P1, P2 … P10 and upload them to the link: https://drive.google.com/drive/folders/1Swv3moBOtP672uDawJGus9V5xaz0orEr?usp=sharing in a week after you consent to participate in this study. Then, you will receive an email inviting you to participate an interview and explain why you take these photos.

Appendix 4.2

The consent form provided to consumers in the photo-elicitation study.

Consent Form

This study has been approved by the University of Leeds Research Ethics Committee
(Ethics Ref No: LTDESN-139)

Information - we sincerely invite you to participate in our design for healthy eating study. If you are willing to take part in our study, please read the consent form below and tick each box that applies. We will record all your responses but there will be no names used in any public material. Thank you!

Consent: Please read the following statements and initial the box if you agree with the statement to the left. In order to continue with the study you must agree to the following statements:

Statement	**Tick here**
I confirm that I understand that this is a packaging design activity for healthy eating and that I have the opportunity to ask questions or refuse to participate.	☐
I consent for the research team to use anonymised information obtained for research purposes (e.g. disseminating the results at conferences, in publications or for training purposes) and that the anonymised data will be kept for 5 years.	☐
I understand that information specific to this study may be looked at by responsible individuals from the research teams and will only be shared in an anonymised form via the appropriate data sharing procedures.	☐
I understand that my participation is voluntary and that I am free to withdraw at any time, without giving a reason, without my medical care, or legal rights being affected.	☐
I understand that the video or audio recordings made during this research will be used only for analysis and may be used for illustration in conference presentations and lectures with permission. No other use will be made.	☐
I agree to take part in this study	☐

Ethics approval_____; granted__/__/__

Appendix 4.3

The interview questions for the photo-elicitation study.

Interview questions guidance

Part one:

1. 1 Look at the photographs you took for the Task 1. Please describe what grabbed your attention and explain why you find attention-grabbing. (Explain each photo)

1.2 Do these packaging have all the features and functionalities you expected? (If not) What is missing? (When needed, give examples, material, function, shape, design...)

Part two:

2.1 Look at the photographs you took for Task 2. Please tell me how the packaging has helped you to pay more attention to the portion size or serving size/What is the feature you think we should add to help you decide how much of a food to consume?

2.2 According to your experience, please choose five of the following options that you think are relevant to your portion decision? And why?

Here are some options in the table:

☐ Product price	☐ Packaging size	☐ Product weight/amount
☐ Packaging shape	☐ Packaging colour	☐ Packaging material
☐ Caloric content	☐ Caloric content location	☐ The size of on-pack images
☐ Packaging reseal-ability	☐ Packaging partitioning	☐ Packaging transparency
☐ The number of product units displayed on package	☐ Serving recommendation (number/text)	☐ Serving recommendation (images)
☐ Portion perception from packaging	☐ Healthiness perception from packaging	☐ Quality perception from packaging
☐ Brand (popular/favourite)	☐ Packaging attractiveness	☐ Packaging decoration (plain or common or unusual)

Part 3: Portion choice and packaging related questions

1. Have you even looked at the packaging before eating/drinking? If so, what? when? And why?

2. Do you usually check and follow the serving recommendation on the packaging? And why?

3. What does the portion size mean to you? How do you usually decide how much to consume?

4. What types of products/supports would you like to have to help you decide how much of a food to consume (e.g. Messages? Application? Services?)? And why?

5. Any suggestions about possible improvements to the packaging design to help with portion control (e.g. for foods/drinks that are high in fat, sugar or salt)?

Appendix 5

The interview questions for the design needs exploration study.

Interview questions

Design topic understanding

1. Have you paid attention to the design for healthy eating before? Any design example?
2. How do you understand design for healthy eating?
3. Please tell more about your understanding of this design topic after reading the design brief?
4. Did you have any questions or concerns about this design topic before you started to design?

Design process and Design idea

5. What's your first step for generating the packaging design idea for this topic?
6. Could you tell the other key actions during your design process? (as specific as possible)
7. Which aspects are important and need to be considered for the design of the packaging for healthy eating?
8. Based on your sketch, please introduce your design idea (including the main features, expected effect/ function of your design, why it could help with healthy eating, how do you think it will be used and other design details)

Design needs

9. What information do you need to complete this design task?
10. How did you found these information? Was it easy to find? Any difficulty?

If there is a design tool to assist your packaging design for healthy eating, then,

11. What content do you expect this design tool can provide?
12. What format of design tool could be helpful and why?
13. What desirable characteristics would make such tool valuable to designers?
14. Any other needs or suggestions for such design tool?

Appendix 6

The support documents of the design tool testing studies with student designers.

Appendix 6.1

The design brief provided to the student designers.

Specialist project 2 Packaging design for healthy eating

Dr Tang Tang

Overview

Chronic excess energy intake contributes to the development of overweight and obesity, which has been described as one of the most serious public health challenges in the 21st Century and it is troublesome for people of all ages. Solutions are needed to guide consumers towards reducing food intake, especially high energy density (HED) and highly palatable foods.

Food packaging, a key element of the eating environment, offers a potential solution to assist consumers in portion control. As the "barrier" between people and HED foods and drinks, packaging design features influence food intake in different ways. For example, packaging size, images on the front of the pack, as well as functional features such as partitioning and resealability all helped to reduce intake (Chu et al., ref).

Your contribution

This design brief calls for creative design ideas to protect and help to improve people's diet. The aim of this project is to come up with novel packaging design ideas that facilitate portion control of "treat" foods/drinks, those which are high in energy content (high in fat, high in carbohydrate such as sugar).

Your design will either help reduce HED food and drinks being consumed or increase consumption of healthy (low energy density) foods like fruit and vegetables, in your choice of setting – the home, a store, a restaurant, the workplace/University and/or when they are on the go.

Appendix 6.2

The interview questions for the design tool test study.

Interview questions:

1. Tell me more about whether you have found any other sources of information about portion size or nutrition which you have found useful?

2. Tell me more about any other information you may need to help with your design task?

3. How clear the content of packaging design tool is? Which part that you think it is hard to understand? Why?

4. Tell me more about the improvements of the content need to be made?

5. What was your impression of the quiz?

6. What aspects did you already know and what were new?

7. Could you introduce the details of your design concepts? (Including the main features, expected effect/ function of your design, why would it help with healthy eating, how do you think it will be used, what theory did you refer to and other design details)

8. Tell me which part of this design tool you found valuable and helpful to your concept design?

9. What kind of new understanding or inspiration is brought to you by provided content?

10. Do you have any additional ideas or suggestions about a design tool that can assist designers to create packaging design solution to promote healthy eating? Any expectation?

Appendix 7

The pre and post survey for the design tool testing study

Feedback of the packaging design tool

Creativity test (8)

Please indicate the score that better describe the situation after you used the design tool.

1. Gaining knowledge regarding the healthy eating?

Time-consuming	1	2	3	4	5	6	7	Quick
Effortful	1	2	3	4	5	6	7	Convenient
Difficult	1	2	3	4	5	6	7	Easy

2. Gaining knowledge regarding packaging influences on food intake

Time-consuming	1	2	3	4	5	6	7	Quick
Effortful	1	2	3	4	5	6	7	Convenient
Difficult	1	2	3	4	5	6	7	Easy

3. Synthesising knowledge regarding design strategies for the packaging design for healthy eating

Time-consuming	1	2	3	4	5	6	7	Quick
Effortful	1	2	3	4	5	6	7	Convenient
Difficult	1	2	3	4	5	6	7	Easy

4. I feel that I am good at coming up with novel ideas for this project.

Strongly disagree	1	2	3	4	5	6	7	Strongly agree

5. I have confidence in my ability to solve problems creatively for this project.

Strongly disagree	1	2	3	4	5	6	7	Strongly agree

6. I am confident in developing creative design solutions (s) with similar topics.

Strongly disagree	1	2	3	4	5	6	7	Strongly agree

7. The existing knowledge I gained resulted in

Known insights and ideas	1	2	3	4	5	6	7	New insights and ideas
Insights and ideas with no potential	1	2	3	4	5	6	7	Insights and ideas with high potential

8. The existing knowledge I gained is

Uninspiring	1	2	3	4	5	6	7	Inspiring
Very useless	1	2	3	4	5	6	7	Very useful

Short survey of the experience of the tool using

Please indicate the score that better describe the situation

Using the tool was:

Boring	1	2	3	4	5	6	7	Fun
Time-consuming and effortful	1	2	3	4	5	6	7	Quick and convenient
Uninstructive	1	2	3	4	5	6	7	Instructive
Uninspiring	1	2	3	4	5	6	7	Inspiring

Using the tool resulted in:

Known insights and ideas	1	2	3	4	5	6	7	New insights and ideas
Insights and ideas with no potential	1	2	3	4	5	6	7	Insights and ideas with high potential

Using the tool in my work of packaging design for healthy eating would be:

Irrelevant	1	2	3	4	5	6	7	Rewarding
Difficult	1	2	3	4	5	6	7	Easy

Appendix 8

The design log template and the design flow scale used in the design tool testing study with student designers.

Design log template

Section 1: Project progress

1. Activity - DONE Use the code provided to describe what you have done.	**2. Progress - DONE** What has happened since our last meeting/Were the goals outlined in the previous meeting achieved? (If not, explain)
01 - Develop (refining selected concept) 02 - Defining requirements (evaluating information) 03 - Ideation (sketch drawing or making sketch models.) 04 - Research (find out the information you need) 05 - Solution (preparing presentation materials) 06 – Other, please specify_____	

3. Q&A Whatever is appropriate for your work, e.g., research progress, direction of dissertation, etc.? Record useful feedback if needed.	**4. Action - TO DO** What are your next steps?

Section 2: experience

Indicate the number of statements which corresponds most closely to your experience in completing your design project.

Example

Totally disagree	1	2	3	4	5	6	7	8	9	10	Totally agree

1. I got involved.

Totally disagree	1	2	3	4	5	6	7	8	9	10	Totally agree

2. I got anxious.

Totally disagree	1	2	3	4	5	6	7	8	9	10	Totally agree

3. I clearly know what I am supposed to do.

Totally disagree	1	2	3	4	5	6	7	8	9	10	Totally agree

4. I get direct clues as to how well I am doing.

Totally disagree	1	2	3	4	5	6	7	8	9	10	Totally agree

5. I think I can handle the demands of the situation.

Totally disagree	1	2	3	4	5	6	7	8	9	10	Totally agree

6. I feel self-conscious.

Totally disagree	1	2	3	4	5	6	7	8	9	10	Totally agree

7. I get bored.

Totally disagree	1	2	3	4	5	6	7	8	9	10	Totally agree

8. I have to make an effort to keep my mind on what is happening.

Totally disagree	1	2	3	4	5	6	7	8	9	10	Totally agree

9. I would do it even if I did not have to.

Totally disagree	1	2	3	4	5	6	7	8	9	10	Totally agree

10. I get distracted.

Totally disagree	1	2	3	4	5	6	7	8	9	10	Totally agree

11. Time passes (slowly.....fast).

Totally disagree	1	2	3	4	5	6	7	8	9	10	Totally agree

12. I enjoy the experience, and the use of my skills.

Totally disagree	1	2	3	4	5	6	7	8	9	10	Totally agree

Section 3: the use of the design tool

1. Have you used the design tool? If yes, answer the following questions

If not, please tell us why_____

2. To what extend did the information was useful in providing you the information you did not know?

low	1	2	3	4	5	6	7	8	9	10	high

Could you give any details about anything useful?

_____

3. To what extend did the content was useful in inspiring or suggesting you the things you had not thought of?

low	1	2	3	4	5	6	7	8	9	10	high

Could you give any details about anything useful?

_____

Please leave your comments or suggestions regarding the design tool provided.

_____

Appendix 9

The interview questions for the design tool (web-based design tool) evaluation study with professional designers.

Participant information:

To ensure that we understand your background and perspective, could you please provide the following details about yourself

1. What is your area of expertise in design?
2. How many years of professional experience do you have in this field?
3. What is your current position or job title?
4. What is your highest level of education you have completed (BSc, MSc, etc)?
5. how old are you?
6. What is your gender?
7. Could you briefly describe your familiarity with using design tools in your work?

Questions before the tool introduction

How do you perceive the role of packaging design in healthy eating?

Interview questions

1. How do you perceive the role of packaging design in healthy eating now?
2. Which types of food packaging have the potential to contribute most effectively to healthy eating ?
3. Who will benefit from the most from packaging designs aimed at promoting healthy eating? (are there specific consumer group(s) that you believe will be influenced by the packaging design for healthy eating? Target audience of the design?)
4. What are your initial thoughts on the information provided by the design tool (website) regarding food packaging design for promoting healthy eating? Please share your thoughts on its usability, clarity and potential effectiveness in aiding packaging design for healthy eating promotion.

4.1 Please describe why and how this information contributes to your understanding.

4.2 What do you think of the content of the design tool in terms of its effectiveness for generating design ideas?

5. What are your thoughts on the overall usefulness of the design tool?

6. Can you envision yourself using this design tool/website in your future work? If so, how do you think it could be integrated into your design process? In what situation do you believe it would be most helpful?
7. What potential benefits do you think the design tool could offer to (1) novice designers; (2) experienced designers?
8. Could you introduce and evaluate the your design ideas? In your experience, what do you think are the main challenges associated with implementing of packaging designs aimed at promoting healthy eating?Additionally, what support or resources do you think would be necessary to overcome these barriers?
9. Do you have any suggestions for improving this design tool or for enhancing its relevance and applicability to the real-world design practice? Any comments are welcome.

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