Curtin School of Population Health

Predicting Perceived Problems in 24-hour Dietary Recall, and Evaluating its Potential for Behaviour Change: A Quantitative Think-Aloud Approach in an Australian Population

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Declaration

To the best of my knowledge and belief, this thesis contains no material previously published by any other person except where due acknowledgment has been made.

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

Human Ethics: The research presented and reported in this thesis was conducted in accordance with the National Health and Medical Research Council National Statement on Ethical Conduct in Human Research (2007) – updated in March 2014. The proposed research study received human research ethics approval from the Curtin University Human Research Ethics Committee (EC00262): Approval Numbers #HREC2021-0295 (Chapter 2) and #HREC0251-2022 (Chapter 3).

Student: Katlyn Mackenzie

Date: 13th April 2023

Acknowledgement of Country

Ngala kaaditj Wadjuck Nyungar moort, kura, yeye, boordah, keyen kaadak nidja boodja.

We acknowledge that Curtin University works across hundreds of traditional lands and custodial groups in Australia and with First Nations people around the globe. We wish to pay our deepest respects to their ancestors and members of their communities, past, present, and to their emerging leaders. Our passion and commitment to work with all Australians and peoples from across the world, including our First Nations peoples are at the core of the work we do, reflective of our institutions' values and commitment to our role as leaders in the Reconciliation space in Australia.

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List of Published Papers

Journal Articles (***** included in the thesis).

***Mackenzie, K. M.,** Kerr, D. A., Whitton, C., Talati, Z., McCaffrey, T. A., Mullan, B. A. (2022). Predicting Perceived Problems in Self-administered 24-hour Dietary Recalls: A Quantitative Think-Aloud Study Comparing Automated Self-Assisted 24-hour Dietary Assessment Tool (ASA24®) and INTAKE24© in University Students. *Nutrients*, *14*(20). https://doi.org/10.3390/nu14204281

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To note: The published manuscript has been modified to better meet the thesis objectives and do not affect the results of the published manuscript. The current thesis is partially submitted by publication and may be repetitive in some areas. Headings for the introduction and discussion have been included for clarity. The citation and reference list may differ from the publication to fit APA7 formatting guidelines, but also is inclusive of all references across the chapters. Likewise, the referenced tables and figures will differ, to fit the formatting of the thesis appendices.

List of Conference Presentations

(***** presenting thesis findings)

***Mackenzie, K. M.,** Kerr, D. A., Whitton, C., Talati, Z., McCaffrey, T. A., Mullan, B. A. (2021). *Predicting Problems in 24-HR Dietary Recall.* Presented online at Online Conference for Undergraduate Research in Australia (OCURA), October 2021.

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Thesis Abstract

Poor diet remains the leading preventable risk factor for non-communicable diseases (e.g., heart disease[s], stroke, diabetes etc.) contributing to most annual deaths in Australia (World Health Organization, 2022). A comprehensive understanding of the Australian population's dietary intake is required to provide accurate dietary recommendations, inform those at risk of disease, and aid in developing behaviour change interventions. However, self-reported data are influenced by many factors, making it challenging to inform epidemiology accurately. As such, this thesis questions the barriers encountered during 24-hour dietary recall (24HR), and if dietary self-monitoring impacts future dietary choices. Thus, in two separate studies the aims of the thesis is to better understand the types of errors that individuals experience during 24-hour dietary recall (24HR), and assess the influence 24-hour dietary monitoring may have on future positive dietary behaviour change. A novel aspect of this thesis was incorporating a think-aloud methodology to aid in understanding and quantifying perceived experiences during dietary recall and test whether self-evaluation can influence dietary behaviours. The objectives of study one were to (a) compare the perceived problems encountered when using two different 24-hour dietary recall programs and (b) explore whether mindful and habitual eating were associated with these problems. Study one found dietary habits and system usability were significant predictors of perceived problems for one recall program. The implications of these findings involve understanding what, how and why dietary self-report errors may occur, which could improve the reliability and usability of 24HR programs, and to deliver more accurate dietary data to government surveillance and nutritional guidelines. The exploratory nature of the method drew attention to a recurring theme expressed by participants of reflective internalisation. Uncovering this theme prompted an investigation into whether self-talk influences dietary perceptions and behaviours. As such, the objectives of study two were to explore whether 24-hour dietary recall and the think-aloud protocol

would influence dietary behaviours and whether habits are a potential barrier to these behaviours. Study two found habitual behaviours were a significant predictor of dietary behaviours. As dietary self-report is primarily used in nutritional research, combining two self-evaluative techniques is a unique addition to the literature and aids investigation into whether the maximum benefits are experienced from both their use. This study has provided insights into the cognitive processes behind dietary behaviours for use in developing behaviour change techniques. Consequently, we hope our findings can be implicated in reducing the prevalence of diet-related non-communicable diseases and population death.

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Statement of Contributors

The purpose of this statement is to detail the nature and extent of the intellectual contribution by the MRes Candidate, Katlyn Mackenzie, and all other co-authors of this study publication. Professor Barbara Mullan, Professor Deborah Kerr, Ms Clare Whitton, Dr Zenobia Talati, and Dr Tracy McCaffrey were involved in the overall supervision of Study 1 (Chapter 2), supporting the conception and design of the study, interpretation of results, and writing of the manuscript. Dr Kate Tonta was involved in suggesting the change of analyses and interpretation of the results of Study 2 (Chapter 3) alongside Professor Barbara Mullan and Dr Zenobia Talati who supported the writing of key sections of the thesis manuscript and overall feedback. Katlyn Mackenzie contributed to the conception and design of the studies and led the data collection, analysis, interpretation, and manuscript writing.

I affirm the details stated in the Statement of Contribution are true and correct.

Chapter 1: Introduction to Thesis

This chapter provides a comprehensive summary of the background and literature review of the thesis. First, the overarching problem is discussed, and some of the health risks involved in poor dietary behaviours and the need for reliability testing of their measures are described. Second, previous research conducted to better understand, improve, and control for self-report errors is summarised. Specifically, the use of computer-based, self-administered 24-hour dietary recall (24HR) tools and their potential applications are explored. Third, the limitations of dietary self-report errors are discussed, which explores previously identified determinants of dietary self-report error, including demographic and psychosocial factors. Fourth, the methodological underpinning of the thesis (i.e., the Think-Aloud methodology) and its use to better understand experiences during 24HR are introduced. Finally, the thesis objectives and a description of each chapter's specific contents are described.

The Overarching Problem

It is estimated that chronic diseases caused by poor diet are the leading contributors of disability and death worldwide, significantly contributing to non-communicable diseases (Abbafati et al., 2020; Afshin et al., 2017). Poor dietary consumption includes the overindulgence of foods high in fat, sugar, and salt, and the under-indulgence of whole foods, as well as foods high in fibre (World Health Organisation [WHO], 2020). These food items have poor nutrient value, are energy dense, and are commonly referred to in Australia as *discretionary* items/foods (Australian Bureau of Statistics, 2014). Excess intake of discretionary items and deficient intake of nutrient-rich foods is associated with risks that contribute to one in five deaths globally including, a higher risk of heart disease, type-two diabetes, stroke, cancers, and neurodegenerative diseases (Herman et al., 2022). Multiple studies investigating the diet quality of the Australian adult population have evidenced poor

compliance with the Australian Dietary Guidelines (Grech et al., 2017; Irwin et al., 2019; Mishra et al., 2015). In particular, individuals with low socio-demographic status, of young adulthood and those living with overweight, or obesity show the most vulnerability to poor dietary behaviours and nutritional knowledge (Backholer et al., 2016; Cleobury & Tapper, 2014; Grech et al., 2017; Marchese et al., 2022). However, findings from Dalbo et al (2017) suggests that Australian individuals' level of nutritional knowledge may not be a factor impeding good dietary choices. As such, a vast majority of individuals do not actively choose the healthier food alternative, however, some do consume discretionary foods and beverages in moderation (Miller et al., 2020; vanDellen et al., 2016). One example that Chernev and David (2010) discuss is that this may happen through moral licensing (i.e., consuming lower-calorie items to justify overindulgence in others). Over time, dietary justifications can be problematic and prompt the formation of risky nutritional habits, poor dietary beliefs, and lower nutritional awareness. Consequently, individuals struggle and often fail to change their diet, regardless of the knowledge or outcomes of their behaviours (Dalbo et al., 2017; Hofmann et al., 2008).

As such, *brief interventions* are often implemented in nutrition research to influence individuals towards positive dietary behaviour changes and involve minimal input and contact from participants (i.e., duration), with the aim of achieving significant behavioural impacts (Whatnall et al., 2018). However, brief nutritional interventions have shown differing results for which behaviour change technique/s are most effective (Ashton et al., 2019) as well as their outcomes long-term (Whatnall et al., 2018). As one example, positive dietary behaviour change in fruit and vegetable consumption has been previously found in short-term behaviour change interventions that included action-plan techniques (Wiedemann et al., 2012), as well as tailored nutrition education and feedback (Celis-Morales et al., 2015; Wallace et al., 2016). However, results from Godinho et al. (2015) argue this, finding no change in fruit and

vegetable consumption at one-week follow-up when applying tailored education and action-plan behaviour change techniques. Likewise, a significant portion of the population does not actively review or assess their diet long-term (Yu et al., 2015), which makes it difficult to inform behaviour change approaches, their adherence, and the accuracy of reported consumption (Turner-McGrievy et al., 2019). Given this, it is important to understand that accuracy of data is affected by many factors, and like any self-reported data, dietary intake information is vulnerable to measurement errors (Thompson et al., 2015). To promote appropriate dietary recommendations for healthy eating and reduce diet-related risks, as well as inform and plan effective dietary behaviour change interventions, accurate dietary data needs to be provided (Kumanyika et al., 2020).

Dietary Self-Report Error and Their Determinants

Modifiable behaviours, such as unhealthy dietary consumption, can influence a person's health, and risk of disease (Iriti et al., 2020). However, our understanding of the accuracy of dietary patterns is limited because few methodologies account for self-report errors, leading to pervasive limitations in nutritional study designs (Colombo et al., 2020; Wehling & Lusher, 2019a). For example, research has identified systematic errors in self-reported intake compared to quantitative biomarkers (e.g., doubly labelled water method; Tooze et al., 2004), despite strong agreement among instruments (Freedman et al., 2017). An arguably more concerning limitation of self-report error are the implications that they can have on informing nutritional guidelines and behaviour change techniques (Polivy et al., 2014). Providing inaccurate diet information to researchers introduces bias to the data used to inform population health, which is critical as they inform nutritional recommendations (e.g., National Health and Medical Research Council, 2020) health and behavioural risk factors (e.g., nutritional risk screening), and intervention effectiveness (Ashton et al., 2019).

Consequently, researchers may modify, reject, or accept an intervention based on results that may be skewed, slowing the progress of research into maintaining positive dietary behaviour change (Aaby & Siddique, 2021). As such, further research is needed to optimize reporting accuracy to prevent and treat diet-induced diseases.

There has been a lot of research on reporting errors when collecting dietary information that focus primarily on participants' characteristics such as age, gender, socioeconomic status, and body mass index (BMI; Polivy et al., 2014; Wehling & Lusher, 2019a; Whitton et al., 2022). Likewise, there is evidence that psychological characteristics such as heightened emotion (Wehling & Lusher, 2019b), social approval and desirability (Tooze et al., 2004; Whitton et al., 2022), as well as body perception (Mossavar-Rahmani et al., 2013) influence the accuracy of dietary self-report. For example, Stubbs et al. (2014) explored eating behaviours under strict observation and in a controlled environment. They found participants were more likely to under-report and restrain their intake when conscious of surveillance (Stubbs et al., 2014). Similarly, Lemacks et al. (2019) investigated the accuracy of dietary self-reporting by comparing a mobile food logging tool to a 24HR when provided with a controlled and portioned meal. By limiting information to participants regarding the study aims, the researchers created a controlled environment to observe the participants in their natural state. Lemacks et al. (2019) highlighted those participants under-reported consumption in both dietary data collection methods, though more so in the mobile food logging tool, influenced by the Hawthorne effect (i.e., the impact that observation has on participant behaviour; McCambridge et al., 2014). Alongside demographic determinants, Poggiogalle et al. (2021) explored the role that psychological, social, and cultural factors play in the dietary behaviours of healthy older adults worldwide. Findings from the systematic review established that dietary patterns have been most consistently associated with family structure and the home environment, education level, and income (Poggiogalle et al., 2021).

However, it is important to note that many of the included studies were cross-sectional, so only associations between the variables can be assessed at a single time (i.e., between dietary intake and their determinants). Such evidence raises validity issues, consequently distorting the relationship between diet and disease (Prentice, 2018). Therefore, previous work has not surpassed the investigation of surface-level determinants, so more focus needs to be given to areas that have not yet been thoroughly investigated.

Generally, the literature has shown *who* contributes to these errors, as shown via demographic and psychosocial determinants, however, it is important to investigate *why* the errors may occur. Without first-hand experience from participants, explanations for these errors can be difficult to determine. As later explained, the think-aloud methodology (Ericsson & Simon, 1993) may be useful for situations like these.

Dietary Recall Measures Aimed to Reduce Self-Report Error

There is no 'gold standard' for self-report measures as errors are subjective (e.g., from bias or measurement error) and cannot always be adequately captured or explained (Subar et al., 2015). However, this does not necessarily take away from the large volume of data that has previously been used to inform national dietary guidelines and track the health of a population. As a well-known example, researchers were able to link smoking to disease based on self-report measures of smoking, despite under-reporting of the behaviour (Gorber et al., 2009). Nevertheless, it is recommended that several self-report methods be used to capture dietary intake, such as a seven-day weighed dietary record, to increase reporting accuracy (Thompson et al., 2015).

Using several methods over an extended time can be burdensome for participants and often leads to misreporting (Livingstone & Black, 2003). As a result, several non-consecutive 24HR are used as part of large-scale population surveillance (de Keyzer et al., 2015) such as

the Automated Multiple-Pass Method (AMPM) 24HR (Conway et al., 2003). This method involves a computer program that collects 24HR via online self-administration online or by interviewer-led phone calls and aims to increase completion rates and accurate recall of food, reduce cost, and respondent burden. Additionally, using a web-based 24HR system minimises response error by considering participants' spelling mistakes, and by providing multiple prompts and reminders, whereby participants are assisted in estimating their portion sizes with the use of standard images of foods to guide their dietary recall process (Bailey, 2021). Despite the specificity of the dietary collection programs that aim to reduce the biases of self-report and measurement errors, they continue to persist, so it is important to better understand them, and to reduce their influence (Bradley et al., 2016). Nevertheless, when measures of self-report are controlled for biases and completed with accuracy, they can provide a greater range of responses than other forms of data collection (e.g., observational measures; Subar et al., 2015) especially in combination with the think-aloud protocol (Ericsson & Simon, 1980).

The Think-Aloud Methodology

In the absence of direct observation (and its inherent biases), researchers may be unable to identify or explain participants' experiences during self-reports. However, the verbalisation of thoughts can help infer cognitive constructs in psychological research by elaborating on participants' self-reported experience (Fox et al., 2011). A *think-aloud* is a method of observing participants as they complete a task, verbalizing all their thoughts and answering questions in real time (Ericsson & Simon, 1980; Güss, 2018). Think-aloud data are generally more descriptive when participants experience situations that are ambiguous, frustrating, or elicit memories (Fan et al., 2019). This type of method is effective for evaluating higher-level thinking as well as individual differences, and for researchers to examine the cognitive processes associated with a given task (Razali et al., 2020). Although

think-aloud is commonly used within qualitative literature, it has also been successfully quantified (Darker & French, 2009; Eccles & Arsal, 2017) and is useful for identifying problems specific to the measures being completed. Think-aloud may create opportunities for researchers to enhance the reliability of their self-report measures by providing insight into the validity of participants' answers (Evans et al., 2016; Gardner & Tang, 2014).

Previously, researchers have argued that think-aloud only offers a brief and minimal exploration of participant thought processes. Yet, when think-aloud is combined alongside other units of measurement (i.e., as a control method to validate quantitative answers; Eccles & Arsal, 2017), think-aloud can offer a richer portrayal of participants' experience (Rogiers et al., 2020). Modern applications of the think-aloud protocol, which involves being combined with quantitative measures, have reinforced the protocols utility by aiding the identification of problems specific to the measures being studied. For this reason, recent literature commonly applies the think-aloud methodology for usability testing (Fox et al., 2011). Think-aloud during *usability testing* involves participants thinking-aloud while using a program, testing a measure, or completing a test, and is used to gain insight into the users thought processes and experiences, to improve, modify or explain the results (Fan et al., 2019; Razali et al., 2020). For example, Darker and French (2009) aimed to recognise participants' interpretation of the Theory of Planned Behaviour questionnaire using think-aloud. Darker and French (2009) found that several problems were experienced during the completion of the Theory of Planned Behaviour questionnaire, with participants selecting the 'middle' response when they found the question ambiguous (Darker & French, 2009). More recently in psychological research, Schmidt et al. (2022) used the think-aloud protocol to test the usability of the three clinical instruments measuring internet use. The study identified four problematic areas amongst the instruments that potentially biased the results, with one example involving out-dated words that participants found hard to perceive and consequently answer inaccurately (Schmidt et al.,

2022). As such, the think-aloud method is beneficial because it allows participants to explain their thought processes whilst performing a task (Eccles & Arsal, 2017), providing valuable information about potential difficulties and suggestions for improvement (Fan et al., 2019). Such rich information allows researchers better insight into the validity of participants' answers, and to enhance their measure's reliability and thus, the accuracy of the data provided (Evans et al., 2016; Gardner & Tang, 2014).

In contrast, some researchers believe the think-aloud methodology is problematic due to participant reactivity (Chengsong et al., 2020; Fox et al., 2011). During the performance of a task, *reactivity* refers to the extent to which thinking aloud interferes with or changes a person's cognitive processes (Chengsong et al., 2020). A meta-analysis by Fox et al. (2011) explored whether think-aloud would alter performance due to participant reactivity. The findings supported the original works by Ericsson and Simon (1993), with think-aloud not significantly influencing performance accuracy. However, think-aloud has been found to prolong task completion time when the procedure involves describing or explaining thoughts as the primary objective, which differs from the participants' performance objective (i.e., for the researcher to understand the cognitive processes of the task (Dickson et al., 2000; Hertzum & Holmegaard, 2013). However, when the procedural instructions of think-aloud are explained clearly, with simple and effective reminders, the influences of think-aloud on performance accuracy is minor overall (Whitehead et al., 2022; Whitehead et al., 2015). As such, Fox et al.'s (2011) meta-analysis recommends participants be provided with clear instructions on the verbalisation task, as a secondary objective to the task being measured. Although the think-aloud data becomes secondary via this mode of instruction, it still provides insight into the cognitive processes underlying task performance. Given the think-aloud protocol has previously been incorporated as a means of identifying factors surrounding food purchases and choices (Reicks et al., 2003; S. M. Robson et al., 2020) and the cognitive

processes during nutrition tasks (Holmstrup et al., 2013), this thesis explores whether the protocol may be applicable in other areas of nutrition research, specifically, whilst using 24HR programs.

Aims and Outlines of the Thesis

The literature as shown little evidence towards successful maintenance of positive dietary behaviours and thus it is difficult to determine which components of behaviour change are influential (Ajzen, 1991; Carey & Stiles, 2016; Hall & Fong, 2015) and are stagnating global nutritional outcomes. Likewise, research has shown that errors in dietary recall occur, particularly in those with certain characteristics (e.g., high social desirability, and BMI; Mossavar-Rahmani et al., 2013; Wehling & Lusher, 2019a). However, it is also crucial to understand *how* and *why* these errors occur to improve the reliability of population dietary surveillance (Polivy et al., 2014). As such, diverse methodologies are essential to corroborate previous self-report data, overcome differential measurement errors, and understand the influence of misreporting on diet (Winne, 2020).

The aim of this thesis is to extend upon existing research regarding dietary self-report errors, by (1) exploring participants' perceived problems during 24-hour dietary recall, and (2) evaluating the influences that think-aloud and 24HR may have on future dietary behaviours. The first objective (i.e., Study one) is to compare the perceived problems encountered in two 24-hour recall programs, and determine whether certain cognitive factors, (further explained in Chapter 2), might contribute to the difficulties encountered. The second objective (i.e., Study two) extends on the findings from Chapter 2, by examining whether a simple introspection intervention during 24HR can promote nutritional awareness and subsequently influence diet quality (Chapter 3). There were two studies that addressed these objectives. Including this chapter (Chapter 1), the thesis is comprised of four chapters:

Chapter 2: *Predicting Perceived Problems in Self-Administered 24-Hour Dietary Recalls: A Quantitative Think-Aloud Study Comparing Automated Self-Assisted 24-Hour Dietary Assessment Tool (ASA24®) And INTAKE24© in University Students* (published in Nutrients; Mackenzie et al., 2022). This first study addresses aim (1) of the thesis, using an exploratory quantitative analysis of think-aloud data, to explore the perceived problems encountered during two separate, self-administered 24HR programs (INTAKE24© and ASA24®; Simpson et al., 2017; Subar et al., 2012), and whether dietary habits and mindful eating predicts these problems. Following a pilot study, a perceived problems checklist was created to quantify the think-aloud data for study one's main study. Study one found INTAKE24© to be participants' most preferred 24HR program, with dietary habits and systems usability of the program, being significant predictors of participants' perceived problems. In this Chapter, the aim is to better understand, and provide insight into, the perceived problems that are experienced when recalling dietary intake, and their potential cognitive determinants. Secondary to the aims of Chapter 2, and due to the study's exploratory nature which combined think-aloud and 24HR measures, a common theme of participant internalisation was discovered when analysing the audio-recordings (Mackenzie et al., 2022). The recurrence of verbalised introspection (e.g., some participants being surprised by their own consumption) was determined to be important to investigate, prompting the research topic for study two.

Chapter 3: *Evaluating 24-Hour Dietary Recall as a Behaviour Change Technique*. This chapter explores whether the think-aloud protocol and dietary recall, can be used as a technique to change poor dietary behaviours. Although 24HR alone has shown significant effects on positive dietary behaviour change (Acharya et al., 2011; Y. Chen et al., 2020), combining different behaviour change techniques has proven more beneficial than techniques used individually (van Genugten et al., 2016). In addition, previous research has demonstrated

the importance of self-talk for both self-awareness and self-regulation of behaviours (Morin et al., 2018), but not specifically in terms of diet. Therefore, study two examined two groups (think-aloud versus no think-aloud) during 24HR, to identify whether the think-aloud protocol may impact nutritional awareness and diet quality scores. Participants' habitual behaviours were incorporated as a potential barrier to behaviour change. Study two found that think-aloud and the 24HR were not effective in changing participants' nutritional awareness or diet quality scores, in either group. Automatic habitual behaviour was found to be a significant predictor of participants' nutritional awareness scores prior to and following 24HR, whereas for participants' diet quality scores, automatic behaviour was a significant predictor prior to 24HR only. In this chapter, we discuss whether there are other cognitive factors relating to dietary behaviour change that can be influenced by habitual behaviours.

Chapter 4: This chapter provides a general discussion of the findings of Study one (Chapter 2) and two (Chapter 3) and their implications, alongside recommendations for future research. An overview of the thesis findings and dietary self-report begins this chapter, before discussing the integration of the think-aloud protocol (Ericsson & Simon, 1993) and its potential implications for future dietary research. This section explains the ease, cost-effectiveness, and additional benefits of the think-aloud protocol. The chapter also discusses how think-aloud can be used to explore a phenomenon of interest more deeply and provide contrasting evidence to participants' answers to illuminate biases. Further, the strengths and practical implications of the thesis include a discussion of habitual behaviours, followed by weaknesses and future research recommendations. In combination with past research and the current thesis findings, it is overall suggested that methodological integration of the think-aloud protocol can be useful in future research for better understanding a variety of health-risk behaviours and thus, develop solutions to reduce them.

Chapter 2: Predicting Perceived Problems in Self-Administered 24-Hour Dietary Recalls: A Quantitative Think-Aloud Study Comparing Automated Self-Assisted 24-Hour Dietary Assessment Tool (ASA24®) And INTAKE24© in University Students.

Abstract

Demographic and psychosocial factors concerning dietary assessment error have been explored, but few studies have investigated the perceived problems experienced when completing dietary recalls. The aim of this research was to (i) compare the perceived problems encountered in two commonly used self-administered 24-hour dietary recall (24HR) programs (INTAKE24© and ASA24®) and (ii) explore whether mindful and habitual eating are associated with perceived problems during dietary recall. A randomised quantitative crossover design and think-aloud methodology were employed. Undergraduate university students (N = 55, M_{age} = 25.5, SD = 8.2, 75% female) completed a food habits and mindfulness questions pre-program, one 24HR (whilst thinking aloud), and a systems usability scale post-program. A week later, they completed the other 24HR (whilst thinking aloud). During a pilot, a coding frame of perceived problems was devised to quantify participants' perceived problems. INTAKE24© generated significantly fewer perceived problems across all categories compared to ASA24® (17.2 vs. 33.1, $p < .001$). Of the participants, 68% reported a preference for INTAKE24© over ASA24®. Hierarchical multiple regression showed that habits and systems usability were significant predictors of perceived problems for INTAKE24© only. No significant predictors were found for ASA24®. The results provide insight into perceived problems people may encounter when using 24HR tools.

Introduction

Chronic disease related to the consumption of a poor diet is currently the leading source of disability and death globally (Abbafati et al., 2020). Making dietary recommendations to promote healthy eating requires accurate data on population dietary intake (Kumanyika et al., 2020). However, various factors influence accuracy, and, as with any self-reported data, dietary intake information is vulnerable to measurement error (Thompson et al., 2015). It is essential to understand how and why these errors occur to improve the reliability of population dietary surveillance and epidemiology (Polivy et al., 2014).

Self-Reported Dietary Measures

There are multiple self-report methods used to capture dietary intake, with the 7-day weighed dietary record designed to capture more detailed information about food and beverages consumed (Thompson et al., 2015). Whilst cognitive difficulty is low for dietary records, participant burden is high and can contribute to misreporting of total energy intake (Livingstone & Black, 2003). As such, there has been a move towards the use of multiple non-consecutive 24-hour dietary recalls for large-scale population surveillance (de Keyzer et al., 2015). Most national surveys, such as the National Health and Nutrition Examination Survey (NHANES) in the United States of America (USA), include interviewer-administered Automated Multiple-Pass Method 24-Hour Recalls (24HR) within their population surveillance (Conway et al., 2003). The emergence of self-administered web-based 24HR aims to reduce cost and address participant burden and acceptability. Participants are guided through their dietary recall using a series of prompts (e.g., time of consumption) and standard images of foods to help estimate portion sizes (Bailey, 2021). Web-based 24HR minimises response error by considering spelling mistakes and having a simple-to-use database and

multiple prompts (i.e., reminders of commonly forgotten foods; Bailey, 2021). Two widely used self-administered web programs, INTAKE24© and the Automated Self-Administered 24HR dietary assessment tool (ASA24®; Simpson et al., 2017; Subar et al., 2012) capture participants' consumed food and beverages by guiding them through a structured recall from the previous 24 h, with images for portion estimation (Osadchiy et al., 2020). Understanding contributions to reporting errors is essential to the improvement of these self-report methods (Bradley et al., 2016).

Errors in Dietary Self-Report Measures

Previous research on reporting errors in dietary recalls has primarily focused on participants' characteristics, such as age, gender, socioeconomic status, and body mass index (BMI; Polivy et al., 2014; Wehling & Lusher, 2019a). For example, Livingstone and Black (2003) systematic review found that individuals who were high in BMI and health-conscious, of older age and female, and low socio-educational status, were more likely to underreport their energy intake. Other literature has argued that psychological characteristics, such as emotional influence (Wehling & Lusher, 2019b), fear of negative evaluation, food restraint (Tooze et al., 2004), and body perceptions (Mossavar-Rahmani et al., 2013), pose significant issues in self-reporting accuracy.

Compared to a more routine diet, dietary recall errors may occur when eating habits are varied or irregular (Lally & Gardner, 2013). For example, Osadchiy et al. (2020) tested whether progressive recall (recalling multiple times a day) was more accurate than a standard 24HR, completing follow-up interviews with participants on their experience. The study found that having a greater meal variety made it more difficult for participants to remember their intake when undertaking the 24HR than when they had more regular eating routines. Additionally, the study found no significant differences in the accuracy between the two recall

methods, with 65% of participants believing the 24HR better fit into their daily routines (Osadchiy et al., 2020).

The Influence of Habits and Mindfulness in Self-Report Error

Though studies have not previously found an association between habitual diets and recall accuracy, others have investigated repetition and recall in other memory research areas and found contrasting positive and negative (Hintzman, 2010; Peterson & Mulligan, 2012) associations. The negative repetition effect suggests that multiple presentations of the same stimulus can negatively affect memory recall (Peterson & Mulligan, 2012). As such, someone who eats the same daily snacks may not remember them as they are consumed automatically. Conversely, as habits are repetitive, they can enhance routine and limit memory error, as remembering completed tasks may become second nature (Gardner, 2015).

Furthermore, paying attention can reduce errors in memory recall (Anderson et al., 1998). For example, Higgs (2015) investigated the effect of manipulating attention during food consumption and concluded that memory of meals was impaired by distractions, indicating the importance of attention for accurate dietary recall. Attentive eating (mindful eating) helps participants to engage in and be aware while eating and has previously been measured by mindfulness eating questionnaires (Clementi et al., 2017). For example, Higgs and Donohoe (2011) found that those who ate mindfully had a more vivid memory of the meal later that day. Therefore, habit and mindfulness may contribute to how participants perceive problems during 24HR, but this has not yet been explored.

The Think-Aloud Methodology

With most research designs, researchers cannot understand participants' thoughts during self-report or the specific problems they may encounter. Think-aloud is an

observational method wherein participants verbalise all thoughts whilst completing a given task and engage in real-time feedback of thoughts and answers (Güss, 2018). In particular, the measure was designed to elicit present-time feedback on perceived problems, misreporting, and responses of emotion when working through questionnaires (Güss, 2018). For example, Razali et al. (2020) used the methodology to determine which teaching experience students most benefitted from.

Aims and Hypotheses

No previous research has explored how habitual behaviour and mindfulness are involved in perceived problems during 24-hour dietary recall. Therefore, the aim of this research was to (i) compare the perceived problems encountered in two commonly used dietary recall programs and (ii) to explore whether higher levels of mindful and habitual eating contributed to fewer perceived problems during dietary recall, as made salient via differences in think-aloud data.

Materials and Methods

Design

A randomised quantitative crossover design was used in the current study and was conducted from August 2021 to September 2021. The study empl(Ericsson & Simon, 1980)dology (Ericsson & Simon, 1980). The central measures of the study were the number of perceived problems raised when using INTAKE24© and ASA24® (Simpson et al., 2017; Subar et al., 2012).

Participants

Recruitment for the main study consisted of a convenience sample of undergraduate psychology students (years 1 to 3) at Curtin University, recruited via the SONA participant pool. SONA is an online student research participation system created for undergraduate psychology students, whereby students are required to achieve five face-to-face SONA 'points' each semester. SONA points cannot be exchanged for money, nor do they have any monetary value. There were no other exclusion criteria.

Procedure

After ethics approval from the Curtin University Human Research Ethics Committee (HREC-2021-0295), recruitment commenced. The study was advertised to the participant pool, inviting them to participate. Information provided to participants explained that their appointment times were to be the same for both weeks of participation. When the participants signed up, they were provided with the study information and consent form. To link the separate timeslot data and de-identify participants, they were asked to create an unidentifiable unique ID and provide their student ID. Questionnaires were administered via Qualtrics.com (copyright version August–September 2021, Provo, UT; Qualtrics, 2005) and personalised logins and links for INTAKE24© and ASA24® were created. Once consent to participate was provided, participants were asked to complete demographic information (i.e., age, identified gender, self-reported height, and weight), Creatures of Habit Scale (See Appendix A), and Mindfulness Eating Questionnaire (see Appendix B), taking approximately 10 min. Height and weight were calculated for BMI categories (BMI cut-offs: Underweight ≤ 18.49 kg/m^2, Healthy Weight 18.5 to 24.9 kg/m^2, Overweight 25 to 29.9 kg/m^2, and Obese ≥ 30 kg/m^2; Australian Government Department of Health, 2021). Participants reported to the Psychology Experimental Research Laboratories at Curtin (PERL-C) at their chosen timeslot, where they

were provided with a brief study description explaining the think-aloud design. The 24HR programs were randomised to reduce order effects, whereby half completed ASA24® as their first recall, and half completed INTAKE24© as their first recall. After any questions had been answered, participants were asked to complete the first 24HR whilst thinking aloud. The researcher exited the room once the audio recording began. After the 24HR was complete, participants were asked to complete the Systems Usability Scale (see Appendix C) via Qualtrics.com (copyright version August–September 2021, Provo, UT; Qualtrics, 2005) for the 24HR program. Participants were asked to knock on the door to let the researcher know they were finished, and the recording was stopped. A limited debrief was provided to remind participants of their second timeslot and allow any questions about their 24HR to be answered. No information was given about the requirements for the second timeslot so as not to influence participants' responses. A week later, participants returned for their second timeslot and followed the same procedure but completed the second 24HR program and usability questions. A single forced question was asked in the final recall as to which tool they preferred (INTAKE24© or ASA24®), followed by a final debrief. Each timeslot to complete the 24HR took approximately 30 min. Students were awarded five SONA points for participation after completion of both timeslots.

Measures

24-Hour Recall Programs (INTAKE24© and ASA24®). Participants used the computer-based programs INTAKE24© and ASA24® to recall what they had consumed in the previous 24 h. Both methods are based on the USDA Automated Multiple-Pass Method (AMPM), which uses a five-step approach to enhance completion and accuracy when collecting dietary data (Steinfeldt et al., 2013). The AMPM method begins by asking participants to list all consumed items in an unstructured way. Over the next three steps, the program structurally

selects each item recalled in the first step and asks specific questions to probe participants' memory on the portion size, amount consumed, brand, and cooking method of each item. The final step asks participants if any items may have been missed or forgotten, using time frames without items as a memory probe (Steinfeldt et al., 2013). ASA24® is an easy-to-use, low-cost, self-administered 24HR tool and was one of the first AMPMs, developed by the National Cancer Institute, Bethesda, MD, with validation amongst adults and children (ASA24®-Kids; Subar et al., 2012; Thompson et al., 2015). Similarly, INTAKE24© is an opensource, self-completed, computerised 24HR that includes placeholders for various meals and snacks (Simpson et al., 2017). The system was designed by a multidisciplinary team using an iterative process informed by user testing with 11–24-year-old users at Newcastle University, UK, with the purpose of data collection in national food and nutrition surveys (Bradley et al., 2016; Simpson et al., 2017). The current study used the Australian-adapted INTAKE24© (https://intake24.com/; accessed from July – August 2021) and ASA24® to permit usage of the food composition data from AUSNUT 2011-12 (accessed from July – August 2021; Food Standards Australia New Zealand, 2014).

Creatures of Habit Scale. The Creatures of Habit Scale is a 27-item questionnaire designed to measure habitual and routine behaviour and is made up of two factors (i.e., routine and automaticity) combined into an overall habit score (Ersche et al., 2017). The routine component has 16 questions, and automaticity has 11 questions. An example item includes, "I generally eat the same things for breakfast every day". Only the questions related to food (n = 15) were used (see Appendix A). Given this, people with higher scores on these food-related questions had stronger food habits. Participants were required to rate their food habits on a five-point Likert scale from 1 (strongly disagree) to 5 (strongly agree), with total scores ranging from 15 to 75. Ersche et al. (2017) found the full scale to be a valid and reliable measure for assessing habitual behaviour (Cronbach alpha [α]) for routine (α = 0.89) and automaticity (α =

0.86). The food-only questions yielded excellent reliability for the current study's sample (α = 0.86).

Mindfulness Eating Questionnaire. The 20-item, two-factor abbreviated Mindfulness Eating Questionnaire was used to measure mindful eating (see Appendix B). This questionnaire is made up of two factors (i.e., awareness and recognition) and the results are combined into an overall mindful eating score (Clementi et al., 2017). The awareness component has 11 questions and recognition has 9 questions (i.e., if they felt hungry or full). Participants were asked to choose the option that best describes how they feel when they eat. An example item includes "I taste every bite of food I eat". The Mindfulness Eating Questionnaire uses a four-point Likert Scale from 1 (not representative) to 4 (representative), with scores ranging from 20 to 80, with scores nearing 80 representing greater mindful eating. Previous validation of the scale found it to be a reliable measure of mindful eating for awareness (α = 0.75) and recognition (α = 0.83; Clementi et al., 2017). The current study's sample yielded good reliability across awareness and recognition (α = 0.71).

Think-Aloud. Ericsson and Simon first explored the think-aloud methodology in 1980 (Ericsson & Simon, 1980); however, the instructions that were provided to participants in the present 'think-aloud' methodology were adapted from more recent work by Darker and French (2009), and French et al. (2007). Briefly, participants were asked to verbalise all thoughts that came to mind when completing the 24HR. To reduce any influence, the researcher was not in the same room as the participant. As a reminder, a paper printout stating "Please Remember to Think-Aloud" was placed at the top of the computer screen. A convenience sample (n = 7) of five undergraduate students and two members of the public was recruited for the pilot. The pilot audio recordings were transcribed and analysed to observe any perceived problems in the procedure and develop a standard checklist of participants' perceived problems for use in the main study (see Appendix D). Usability evaluators may encounter problems due to the

methodology's unnatural nature, which may cause participants to alter their answers or provide descriptive data rather than explanatory data. This has previously been addressed by allowing test participants to perform the task silently and comment afterwards on their performance (known as retrospective think-aloud; RTA Ericsson & Simon, 1980). However, the study's objective was to observe the problems raised using the two 24HR programs and retaining retrospective memory following a cognitively demanding food recall may provide inaccurate results (Alhadreti, 2021; Ericsson & Simon, 1993). Earlier work by Alhadreti (2021) showed that concurrent think-aloud (CTA) outperformed RTA during usability testing, with participants reporting more problems during CTA, providing validation for its use in the study.

Systems Usability Scale. The Systems Usability Scale is a fast and easy way to measure how usable participants find a specific system (Bangor et al., 2008). The scale's specific measurements include system efficiency, effectiveness, and satisfaction graded on a five-point Likert scale, scoring from 0 to 100 (see Appendix C). Based on Bangor et al.'s (2008) 'university grade analogy', scores closest to 100 were considered 'superior', scores less than 70 were considered 'in need of improvement', and scores of 50 or less were a 'usability failure'. Participants were asked questions from the original Systems Usability Scale statements to measure the usability of both INTAKE24© and ASA24® (Bangor et al., 2008). Additionally, the word "cumbersome" in item 8 was replaced with a more commonly known synonym (i.e., "awkward"), as was demonstrated to be effective in Bangor et al. (2008). Past validation found excellent reliability ($\alpha = 0.91$; Bangor et al., 2008). In the current study, good reliability was found for ASA24® ($\alpha = 0.88$) and INTAKE24© ($\alpha = 0.86$).

Program Preference. Program preference was measured using a singular question, "Taking into account both 24-hour food recalls, please indicate which program you preferred", with two choices: "Timeslot 1" or "Timeslot 2". As timeslots 1 and 2 differed for each

participant, the results were combined against each unique ID to ensure their preferred timeslot choice aligned with their randomised recall order. The data were then dummy coded with preference (1) indicating that the participant preferred INTAKE24© and (2) ASA24®.

Sample Size Calculation

Previous research on 24HR studies and the think-aloud methodology is limited, though a sensitivity analysis of a similar study yielded effects of a medium range (Darker & French, 2009) . Using G*Power 3.1 (Heinrich-Heine University, Düsseldorf, Germany; Faul et al., 2009), a minimum of 57 participants were determined to be sufficient to detect a medium effect size (f = 0.19, and 95% confidence interval) with a power of 0.80 and an alpha level of 0.05. Given this, a total of 65 undergraduate students gave informed consent and voluntarily signed up to participate in this face-to-face study. Of those who signed up, six participants did not attend their timeslots, three did not complete all the required information, and one forgot to think-aloud. Thus, they were excluded from the analyses, leaving 55 participants. After removing participants who did not complete all requirements, a missing-values analysis was run across all relevant variables. No participant answers were identified as missing; thus, expectation maximisation for missing values was unnecessary.

Assumptions

Before interpreting the results, assumptions and normality were checked and, after visual inspection, deemed to be normal. Short Likert-scale lengths are sensitive to skewness (Leung, 2011); thus, our study focused on the summation of items (i.e., total habit score, total mindfulness score, total systems usability score), so univariate normality was deemed to be interpretable. There were no multivariate outliers as Mahalanobis distance was below the critical χ^2 of 16.27 (α = 0.001) for three predictor variables (for any cases) in the data,

indicating no concern for multivariate outliers (Howell, 2013). Stem-and-leaf plots and boxplots indicated each variable's normal distribution in the regression without univariate outliers. After visually assessing the normal probability plot of standardised residuals and the scatterplot of standardised residuals against standardised predicted values, it was determined that normality, linearity, and homoscedasticity of residuals were acceptable. Finally, relatively high tolerance for all three predictors in the final regression model determined that multicollinearity would not interfere with the interpretation of the multiple regression analysis.

Data Analyses

Before testing the hypotheses, a bivariate correlation was run to analyse the associations between all target variables. The frequency of overall perceived problems within each recall program and the different perceived problems for each program were calculated. To test the primary objective of the study, a paired-samples *t*-test was performed to determine the differences in perceived problems between ASA24® and INTAKE24© (Analysis 1). To further explain differences, multiple paired-samples *t*-tests were run to determine what types of perceived problems were most common in each 24HR program, including between and within perceived problem categories for both programs. The results were then compared to participants' preferred programs to see if the difference between the perceived problems in each program aligned with the most preferred program. Secondarily, a hierarchical multiple regression analysis was conducted to test whether food habits, and mindful eating significantly predicted participants' number of perceived problems in ASA24® and INTAKE24© whilst controlling for systems usability (Analysis 2). Cohen's conventions were used to determine the effect size for each analysis (J. Cohen, 1988). All analyses were run

using SPSS (IBM SPSS Statistics for Windows, Version 28.0. Armonk, NY, USA; IBM Corp., 2021).

Results

Think-Aloud Checklist

Think-aloud data were coded quantitatively via an exploratory checklist using four of the seven participants during the pilot run. Four audio recordings were transcribed and coded by separate researchers (K.M. and D.K.) to create the checklist used to explore any perceived problems participants encountered during their recall. Both researchers discussed any disagreements and revised the coding framework. An additional six audio recordings from the main study were checked against the checklist to test inter-rater reliability. This validation method was based on a previous study by Darker and French (2009). A reasonable degree of reliability was found initially between the two raters ($k = 0.60$). After further discussion, a checklist was agreed upon and deemed to have perfect reliability ($k = 1$ Robson, 2002). Given the reliability, the quantifiable categories of 'perceived problems' raised during the think-aloud task were used on the remaining sample ($N = 55$) using the final checklist (see Appendix D).

The final coding frame comprised perceived problems with (1) remembering, (2) the program, (3) emotions (i.e., perceived emotional responses), and (4) no perceived problems. Category (1) consisted of perceived problems with remembering (a) consumption, (b) portions, (c) items, and (d) guessing from memory. Category (2) consisted of perceived problems with (a) what to input, (b) where to input, and (c) individual perceived problems with the program. Category (3) consisted of perceived emotions of (a) frustration and (b) confusion. Examples of quotes from participants are identified in Table 1a.

Table 1a. *Examples of Think-Aloud Quotes for each Perceived Problem Category and 24HR Program*

Perceived Problems	ASA24®	INTAKE24©
Remembering • Consumption • Portion • Item • Guessing	• "Brand...pfff...don't know because I don't know brand, I never remember them… I'll click any brand…" • "Oh… uh, what did I have yesterday for lunch… I didn't eat food here I…, I had, so I had leftover meals, so it was… [unrelated talking] … I had brown rice" • "I forgot there was something that was in there as well… oh is that what it was? Nah that's probably about it." • "Oh, nah okay, maybe that's not the right way to… I'll go cups, I probably had a cup." • "I ate 3 or 4 slices… I'll just put 3" • "I keep forgetting things, what did I have?"	• "Jesus, what did I have?" • "Urgh… um, ah, let's say 4" • "Quinoa, peas, capsicum… what else did I ate... CMON! Um…" • how many of those did you have… oh s##t um…" • "I had 2 cups, no what am I talking about I just had 1" • "I had butter biscuits, oh, no, there is a specific name umm, butter, puff pastry?"
Program • What to input • Where to input • Individual problems	• "Mmmhmm, and then do I add my drink that I drunk too? Coz, I drunk a medium Fanta." • "I'll just write bites, but they were like jalapeno and mac and cheese bites, I can't find them on the computer…. " • "What should I say it is? Should I just say it's a pie? Or see if it's like bites" • "It was Cava? Cava? I've never had…. Oh, it's like a potatoey, Indian potato thingy, cava? Is it K? Kava? Can't find what I'm looking for, maybe type in Indian?" • "can't find what I'm looking for, is that how to spell it?" • "What else was in it…what is that cabbage that's fermented... Kimchi!" • "I don't know if you need that, but I'm going to put it in anyway"	• "I had an oatmeal biscuit… I wonder if I have to write that specifically?" • "I had um, a piece of um like, raw caramel slice… I'll just say caramel slice because I think argh it's like a healthy caramel slice [laughs] I want that to be known, its healthy" • "Ummm… what time was that? 8? 9? 7:20? 8:30 I had a chicken burger, I guess I probably have to put that in 1 item at a time…um…oh yeah, I'll do that..." • "Bacon…oh…uh, they want them separate, no, go back…"

	• "Where can I find chocolate [tuts]……uhhh… can't find what I'm looking for..." • "I wonder if I should add it in… that would be a lot"	
Emotion • Frustration • Confusion	• "Mmmmm. You must add one food before you hit finish your meal. Oh, I thought I did. Why did I not. Okay its. Subway, did I search it or like…" • "I don't know what like, it says what size was it? I don't know what like a half of, I think, it wouldn't be a litre, it will be millilitres, oh I don't know what millilitres are, sorry. But it wasn't, it was like, [frustrated clicking] why would it only let me pick 10 litres of bourbon and cola like, I'd be comatose." • "Uhhh… breakfast yesterday… I had it quite early, so it was around about 6am, yeah, uhhhh… oh between 10:30 and, oh, um… I had it quite early though?... oh, whatever yeah, I'll just do that…" • "Oh wow, this is verrry specific" • "Chocolate flavoured jellybaby… NO! what the hell is that?" • [large sigh when struggling to find an item] • "arghhhhhhhh...!"	• [big breath in when unable to find the brand] • "Chickpeas… ooh um, … lentils?" • "Oh s##t ummm…" • "Oh, I don't know how to spell it" • "Oh wait, no I saw it before, was it Greek yoghurt or Greek-styled yoghurt. It was a dark blue and white container I got… what's the difference?

Demographics

The final sample included 75% female and 25% male university student participants aged 18–49 years (M = 25.56, SD = 8.2). Means (M), standard deviations (SD), and descriptive statistics for food habits and mindfulness scores are displayed in Table 2a.

Table 2a. *Means (M), Standard Deviations (SD) Scores for Male (n = 14), Female (n = 41) and Total (N = 55) Participants Height, Weight, Age, BMI, and Combined Perceived Problems.*

Demographics	*n*	%	Total (*N* = 55)	Male (*n* =14)	Female *(n=41)*
Height (cm)			167.7 (8.1)	175.9 (3.9)	164.9 (7.5)
Weight (kg)			69.7 (15.5)	82.2 (11.1)	65.4 (8.1)
Age			25.5 (8.2)	35.5 (11.4)	31 (8)
Body Mass Index (BMI, kg/m2)			24.7 (4.9)	26.6 (2.9)	24.1 (1.3)
Underweight	2	3.6	17.5 (.70)	n. a	17.5 (.70)
Healthy Weight	32	58.2	21.8 (1.7)	22.4 (1.6)	21.7 (1.7)
Overweight	10	18.2	26.2 (.70)	26.8 (.8)	26.0 (.6)
Obese	11	20	33.0 (2.4)	34.9 (2.9)	31.9 (1.3)
Combined Perceived Problems	55	100	50.3 (25.4)	46.3 (18.3)	51.6 (27.5)
Remembering	55	100	30 (16.3)	26.3 (12.0)	31.3 (17.5)
Program	55	100	9.1 (7.5)	8.3 (5.6)	9.4 (8.1)
Emotion Variable Scores	55	100	11.1 (9.1)	11.7 (9.9)	10.9 (9.0)
Food Habits	55	100	53.2 (11.6)	51.5 (9.2)	53.7 (12.3)
Mindfulness	55	100	55.7 (7.2)	54 (6.8)	56.3 (7.4)

BMI cut-offs: Underweight ≤ 18.49kg/m^2, Healthy Weight 18.5 to 24.9 kg/m^2, Overweight 25 to 29.9 kg/m^2, and Obese ≥30 kg/m^2 (Australian Government Department of Health., 2021). Combined Perceived Problems includes the sum of INTAKE24© and ASA24® perceived problems for each category. N.a refers to Not applicable.

Preliminary Analyses

Intercorrelations from the bivariate correlation were analysed to determine the associations between the target variables (see Table 3a). Overall, perceived problems were significantly associated with all categories of problems ($p < .05$). Separate analyses for each problem category were not conducted, given the significantly large associations and overlap of problems (i.e., participants experienced memory problems that were also accompanied by emotion problems).

Table 3a. *Bivariate Correlation Coefficients to Determine Significant Relationships for all Target Variables (N = 55).*

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Age	-														
2. BMI	**.35****	-													
3. Total Mindfulness Score	.07	-.23	-												
4. Total Habit Score (Food Only)	**-.33***	-.10	-.26	-											
5. Program Preference	.14	-.02	-.18	-.23	-										
6. Overall System Usability (2)	.09	.10	**-.34***	-.00	**.45****	-									
7. Overall System Usability (1)	-.04	.23	-.27	.08	**-.35****	.20	-								
8. Overall Perceived Problems (2)	.08	-.10	**-.27***	.20	-.01	.18	-.07	-							
9. Remembering Perceived Problems (2)	-.01	.07	-.17	**.30***	-.01	.26	-.01	**.86****	-						
10. Program Perceived Problems (2)	.09	-.08	-.21	-.03	.06	.09	-.20	**.69****	**.44****	-					
11. Emotion Perceived Problems (2)	.16	.20	-.23	.02	-.06	-.05	-.02	**.56****	.16	.21	-				
12. Overall Perceived Problems (1)	.01	-.05	-.07	**.27***	.22	.00	**-.33***	**.56****	**.55****	**.48****	.12	-			
13. Remembering Perceived Problems (1)	-.09	-.01	-.05	.21	.13	.01	-.18	**.44****	**.52****	**.34***	-.00	**.81****	-		
14. Program Perceived Problems (1)	.04	-.13	-.04	.12	.22	-.05	**-.38****	**.37****	**.37****	**.41****	-.00	**.72****	**.28***	-	
15. Emotion Perceived Problems (1)	.15	-.02	-.07	**.28***	.18	.03	**-.28***	**.44****	**.29***	**.37****	**.33***	**.72****	.24	**.65****	-

**p* < .05 (two-tailed). ***p* < .001 (two-tailed). Program preference is whether participants chose ASA24® (2) or INTAKE24© (1) as their preferred recall program.

Analysis 1

On average, participants experienced 33.1 (*SD* 17.4) problems while completing ASA24® and 17.2 (*SD* 11.3) problems while completing INTAKE24© ($p < .001$). On average, participants had 15.8, 95% CI [−19.8, −11.9] fewer perceived problems using INTAKE24© which was 1.9× fewer compared to ASA24® $p < .001$. Differences between and within problem categories (i.e., discrimination within each program's perceived problem categories) for both programs are displayed in Table 4. Overall, INTAKE24© was the most preferred program, with participants reporting fewer perceived remembering (8.8), program (3.0), and emotion problems (4.0; $p < .001$; see Table 4a).

Table 4a. *Program Preference (%) and Results Paired Samples t-Test, including Means (M), and Standard Deviations (SD) and Significance Values (p) for the Differences Within and Between Problem Category's (Remembering, Program, and Emotion) and Systems Usability for ASA24® and INTAKE24© (N = 55).*

Variables	**ASA24®**	**INTAKE24©**
	Total	
Program Preference	32	68
	M (SD)	
Systems Usability	78.8 (14.6)	82.7 (11.1)
Paired Samples *t*-Test		
Mean Differences in Perceived Problems *Between* ASA24® and INTAKE24©		
Overall Perceived Problems	**33.1 (17.4) ****	**17.2 (11.3) ****
Remembering	**19.4 (11.4) ****	**10.6 (7.3) ****
Program	**6.1 (5.5) ****	**3.1 (3.4) ****
Emotions	**7.6 (6.8) ****	**3.6 (4.2) ****
Mean Differences in Perceived Problem Categories *Within* ASA24® and INTAKE24©		
Remembering*Program	**13.3 (10.2) ****	**7.5 (7.1) ****
Remembering*Emotion	**11.9 (1.7) ****	**7.0 (7.5) ****
Program*Emotion	1.5 (7.8)	-.51 (3.2)

Systems usability and program preference are scored in percentage (%). ****** $p < .001$ (two-tailed).

Analysis 2

ASA24®. Hierarchical multiple regression showed that no single predictor was statistically significant (Table 5a). The systems usability score accounted for a nonsignificant 3.1% of variance, $R^2 = .03$, $F(1, 53) = 1.68$, $p = .200$, in perceived problems. This was followed by food habits and mindfulness, which accounted for an additional nonsignificant 6.8% of variance, $R^2_{change} = .07$, $F_{change}(2, 51) = 1.93$, $p = .156$ with a 'small to medium' effect ($f^2 = .11$; Cohen, 1988).

INTAKE24©. A hierarchical multiple regression showed that higher systems usability was associated with fewer perceived problems. After controlling for systems usability, a 1 SD increase in food habits score resulted in a .274 increase in perceived problems, B .274 [.014, .521], $p < .05$. The systems usability score accounted for a significant 11% of variance, $R^2 = .11$, $F(1, 53) = 6.53$, $p < .05$, followed by food habits and mindfulness, which accounted for an additional nonsignificant 9% of variance, $R^2_{change} = .09$, $F_{change}(2, 51) = 3.10$, $p = .054$. In combination, the three variables explained a significant 20% of variance, $R^2 = .20$, adjusted $R^2 = 0.16$, $F(3, 51) = 4.24$, $p < .01$, with systems usability and food habits being two significant predictors (Table 5a) producing a 'medium to large' effect ($f^2 = .26$; Cohen, 1988).

Table 5a. *Standardised (β) and Unstandardized (B) Regression Coefficients, and Squared Semi-Partial Correlations (sr^2) for Variables Predicting Overall Perceived Problems Associated in ASA24® and INTAKE24© During 24-hour Dietary Recall Using Hierarchical Multiple Regression Analysis (N = 55)*

Program	*B* [95% CI]	*β*	sr^2	*p*
ASA24®				
Model 1				
Constant	16.58 [-9.1, 42.5]	-	-	.200
Systems Usability	.21 [-.11, .53]	.18	.03	.200
Model 2				
Constant	36.39 [-27.7, 100.5]	-	-	.260
Systems Usability	.13 [-.21, .47]	.11	.01	.434

Program	*B* [95% CI]	*β*	sr^2	*p*
Food Habits	.22 [-.20, .64]	.15	.02	.295
Mindfulness	-.46 [-1.2, .25]	-.20	.03	.201
INTAKE24©				
Model 1				
Constant	**45.10 [23.0, 67.12] ***	-	-	.001
Systems Usability	**-.34 [-.60, -.07] ***	-.33	.11	.014
Model 2				
Constant	**43.50 [3.18, 83.73] ***	-	-	.035
Systems Usability	**-.39 [-.65, -.12] ***	-.38	.13	.005
Food Habits	**.28 [.01, .52] ***	.27	.07	.039
Mindfulness	-.15 [-.57, .26]	-.10	.01	.465

B = unstandardised regression coefficient, *CI* = Confidence Interval, *β* = standardised regression coefficient, sr^2 = % variance uniquely explained by each predictor, ***p* < .05 (two tailed).

Discussion

Given the myriad influences on self-report error and the limited research on controlling for this within dietary intake, the current study is one of the few to use the think-aloud methodology to understand participants' experiences better. As such, we found that participants experienced significantly more total perceived problems while completing ASA24® as compared with INTAKE24© across all problem types (i.e., remembering, program, and emotion). We found that systems usability and food habits were predictive of total problems within INTAKE24©, but no similar association within ASA24®.

Previous research (Bradley et al., 2016; Simpson et al., 2017; Subar et al., 2012) has focused on comparing program methods, features, and reliability or else on demographic and psychosocial factors to explain misreporting errors (Kupis et al., 2019). A novel aspect of the current study was to use the explorative concept of thinking aloud to better understand participants' perceived problems during their dietary recall experience. For example, a think-aloud method was previously utilised by (French et al., 2007) to distinguish the types of problems participants encounter while completing questionnaires or programs (Alhadreti, 2021; French et al., 2007). As such, more descriptive think-aloud results may arise when participants view ambiguous, frustrating, or memory-provoking situations (Fan et al., 2019) and are an effective way to evaluate higher-level thinking and individual differences in order for researchers to analyse cognitive processes during a task (Razali et al., 2020). Given this, participants' perceived emotion problems might be due to the influence of emotions on reasoning, attention, memory, and decision making (Tyng et al., 2017). Consistent with previous research (Hidalgo et al., 2015), increased frustration or stress may have clouded participants' memory, impairing free recall. Such results are plausible, as participants in a study by Kupis et al. (2019) verbalised their experiences of perceived emotion problems whilst using ASA24®, explaining they were due to the program's duration, confusion, and

specificity. It is possible that our findings also captured these emotions, and they may be explained by the repetitive prompts employed to reduce self-report error. Such prompts ask the same question multiple times for different items, are specific and challenging to answer confidently, and often discourage participants from adding all items (Kupis et al., 2019). This program design differs from INTAKE24©. Similarly, multiple pop-up ads or cookies may irritate people while online browsing, and perhaps repetitive prompts elicit this response. This emotional result is consistent with previous research in a similar young adult population that found multiple pop-up prompts throughout nutrition assessment were frustrating (Vereecken et al., 2014).

Furthermore, the results indicate that program usability only predicted the frequency of perceived problems for INTAKE24©, accounting for most of the variance. It may be that memory retrieval was easier in INTAKE24© because the system used greater positive and associative priming pictures (Voss et al., 2013) rather than the repetitive prompts and questions used in ASA24®, reaffirming an early study's findings on the relationship between priming and memory (Tulving & Schacter, 1990). For example, INTAKE24© provides a picture of what the meal or food item may look like (for participants to click on the image that most closely represents what they consumed; Simpson et al., 2017). In contrast, ASA24® asks where the meal or food item was bought and how it was made or cooked (in writing) before providing pictures for portion size (Subar et al., 2012). If this is the case, other dietary recall programs may benefit from the use of similar prompts, pictures, and questions to those employed in INTAKE24©. However, further research is required to identify possible priming influences. Such results are important to capture, as participants who found the program frustrating may be less willing to undertake future 24HRs. Possible improvement may involve changes to the pop-up question design (i.e., using a design more like INTAKE24©) so that duplication does not elicit unwarranted emotional responses. This approach may help to

increase participant engagement and satisfaction, thereby enhancing recall reliability (Kupis et al., 2019).

In many interventions for dietary recall, participants are asked to recall specific information from their memory whilst learning a new program. As we saw an overall greater number of perceived problems across ASA24®, it may be that the program had a heavier cognitive load than INTAKE24©. In line with previous results from Camos and Portrat (2015), increasing the cognitive load reduces immediate recall. Garrett (2021) discovered that those who learned to use a program via instructional video before completing a task could manage their cognitive load more successfully after accessing the video. Lower cognitive load may have been present when using INTAKE24©, for which participants were provided with a four-minute video tutorial as part of the standardised instructions. In contrast, ASA24® had a self-guided 'quick tour'. Past research has found that students prefer video instructions over text instructions (Gillie et al., 2017), with video instructions associated with significantly faster progress and fewer errors than no instructions or text instructions (Tyner & Fienup, 2015). Aligning with the current study's student sample, this could explain participants' preference for INTAKE24© over ASA24®. Given the study results in combination with previous literature (Garrett, 2021), future research could look at implementing access to programs before the commencement of experimental conditions. Such access could have participants practice using the programs before the study to lower cognitive load and thus associated perceived problems. Similarly, it may benefit ASA24® to incorporate a short video tutorial onto their website for participants to view before the recall task.

Mindful eating was not predictive of fewer perceived problems during either recall program. These findings do not align with the results of Higgs and Donohoe (2011), who demonstrated that greater mindfulness whilst eating predicted more accurate recall and behaviour change. However, it is likely that Higgs and Donohoe (2011) were able to draw

these conclusions because of the inclusion of control groups in their experimental design. Another possible explanation may be the experience of stress, inattentive eating, and time constraints in the study's student sample (Deliens et al., 2014). Given that mindful eating is heavily reliant on paying attention (Kabat-Zinn, 2015; Rodero, 2019) participants who may have eaten whilst studying or in a rush (e.g., if their attention is primarily focused elsewhere) could have incurred more perceived problems in the 'remembering' category. Furthermore, we may see this in conjunction with altered stress levels throughout the semester, as participants' stress levels may have influenced their emotions (Pitt et al., 2018). Additionally, stress influences attentional processes, cont(Wulff & Thomas, 2021)tortions (Wulff & Thomas, 2021). Whilst much of the literature on stress and attention surrounds recollection failures in eyewitness testimonies, it is essential for research to explore how inattentive eating and stress are present in university students (Lovibond & Lovibond, 1995). Future studies using a student sample may benefit by requesting further contextual information on how they consumed food (e.g., on the go or sitting down). Additionally, the Depression, Anxiety and Stress Scale (DASS-21; Lovibond & Lovibond, 1995) and mindful eating questions could be combined in this context to understand whether stress contributes to inattentive eating and inaccuracies in dietary recalls.

Greater food habits (i.e., more consistent dietary behaviours) accounted for significantly more perceived problems for INTAKE24© only. This result was not the same for ASA24®, which is likely due to ASA24® displaying greater variation within perceived problems. As such, food habits are a possible influential factor in assisting dietary recall; however, other factors likely contribute to its influence, and these appeared more salient for ASA24®. Although it is unclear why we obtained differing results for food habits between the two programs, a possible reason could be due to the automaticity of habits. To elaborate, this idea argues that repetition begins to produce action without conscious thought (i.e., requiring

no attention), thus resulting in either not recalling the intention of the behaviour or no memory of completing the automatic behaviour (Lumer, 2017). In contrast, this result may simply be explained by university students' general lack of a regular diet, as the standard deviation for the habit score was very large. Obradovic et al. (2021) found that students' dietary habits significantly varied according to their year level, gender, course type, and age. Platania et al. (2016) and Tam et al. (2017) explain that many students are just beginning to develop independent dietary choices and are influenced by a variety of factors (e.g., the time between work/study lifestyle, costs, living situation, and on-campus food). Although the student population was deemed most appropriate for the current study, its use limits generalisability to the broader population. Previous research using the Creatures of Habit Scale in the general and student population has been performed; however, there have not been any studies looking at the food questions only. Thus, it is difficult to determine whether our sample was atypical or homogenous. Replicating this study in other populations and across a more extended period (e.g., during the semester and outside of semester or exam time) might help highlight whether irregular food habits are an influencing factor. Purposive sampling amongst individuals who actively maintain habitual dietary habits might also provide different results.

Other studies report conflicting results on the association between repetition and recall (Hintzman, 2010; Peterson & Mulligan, 2012), with inconsistency possibly being due to the amount of repetition. It may be possible that an intermediate level of habit is more easily recalled. As in the Yerkes–Dodson law, an inverted-U repetition model could be a possible explanation (Yerkes & Dodson, 1908). In the future, including groups of different habit levels (e.g., high, medium, and low) could provide more insight into whether a bell-curve distribution can further explain the ambiguity in the literature between habitual learning and memory retrieval. For example, if an individual's coffee intake is highly habitual, they may

not differentiate between the number of cups they have each day. However, if they go to a barbeque at a friend's house once a week, they may be more likely to recall what was consumed. Although repetitive, the barbeque deviates from a regular daily routine such as coffee consumption. The inverted U has been evidenced in age groups like that in the current study (Schilling et al., 2013), and it was observed that explicit memory retrieval was best when intermediate cortisol levels (i.e., our primary stress hormone) were dosed; however, this has not been explored regarding implicit memory. Incorporating future measures to understand how habitually individuals consume a specific food item or meal might help further understanding of whether, at a particular level of habitual routine, habits are a factor involved in dietary recall.

Besides the novelty of using the think-aloud method, this study demonstrated that this method can be used to provide rich insights into the 24HR process. Such insights are highly valuable to dietary researchers working to detect associations between perceived problems and the hypothesised causes of the problems. Another strength includes the within-person randomised crossover design, making the comparisons between the two programs highly valid. Likewise, a data-driven checklist better defined the studied sample (e.g., our sample involved university students; the general population might have perceived problems differently). Thus, future studies are recommended to incorporate the think-aloud methodology to understand participants' experiences further and create a checklist derived from their data that best represents their sample.

The study does not come without limitations. Our sample was made up of university students and had significantly more females than males, limiting the generalisability of the findings. Given that our sample consisted of psychology students, the types of measurements used (i.e., Creature of Habit Scale; Mindfulness Eating Questionnaire) might have been influenced by their undergraduate knowledge, thus likely biasing our findings. Similarly,

introspection may come easier for an undergraduate psychology student learning these practices as part of their curriculum, likely influencing the impact of thinking aloud on their recall (Weger et al., 2018). As such, the study's methodology would need to be repeated in different age and demographic groups to determine whether the experiences of the two programs are repeated. Another limitation is that instances of misreporting of participants' intake were not specifically analysed. It could be hypothesized that fewer frustrations experienced when recording dietary intake might reduce the likelihood of dietary misreporting. However, the converse may also be true, in that the food list may not be comprehensive (i.e., limited inclusion of culturally diverse foods or portion sizes). Future analyses could be conducted to explore possible associations between the number of problems and reported energy intake to assess misreporting.

Furthermore, data on participants' ethnicity were not collected and may have influenced the findings if international or authentic foods (e.g., non-Australian-traditional ingredients) were unavailable in the program. Although we aimed to control the issue via a think-aloud method, self-report error is the most significant factor influencing accuracy in dietary recall (Freedman et al., 2017). However, there is minimal consideration in the literature regarding individual differences in articulating thought processes during think-aloud tasks (e.g., participants who struggled to think-aloud when this was unnatural for them and thus provided inaccurate data). Although pilot testing was beneficial in explaining some differences and the creation of a checklist, future research may benefit from post-program interviews to control reactivity in participants who may have struggled to articulate their thoughts or actively looked for problems.

Conclusions

The study aimed to compare the perceived problems encountered in two commonly used self-administered 24HR programs (INTAKE24© and ASA24®) and explore whether mindful and habitual eating is associated with perceived problems during dietary recall. In a group of predominantly female undergraduate students, INTAKE24© had the least number of perceived problems during 24HR and was the most preferred to use. This may suggest that design of dietary recall programs for ease of use may be associated with less problematic recall experience. However, further questioning to fully understand individuals' experiences should be considered. Systems usability and food habits were significant predictors of perceived problems when completing INTAKE24©. This reinforces the literature pertaining to habit automaticity (Lumer, 2017), cognitive load, and memory (Camos & Portrat, 2015) and tells us that attempts should be made to account for food habits when using a 24HR design.

Introduction to Chapter 3

We refer to the following as *secondary findings* throughout the thesis.

Since study one was exploratory in nature the following secondary findings, deviate from the stated aims of Chapter 2. These secondary findings were used to inform the topic for study 2 (Chapter 3) and are explained below.

Whilst analysing the audio data in study one (Chapter 2), there were instances where the researchers perceived the participants to be displaying verbal introspection during their 24HR when they were asked to think-aloud. To reiterate, when participants were inputting food items into either program (INTAKE24© and ASA24®; Simpson et al., 2017; Subar et al., 2012), some were perceived to be internalizing their consumption, and this was evidenced in the audio recordings during the think-aloud protocol. Some examples of participants' perceived internalisation include a surprised tone of voice when reading over their consumption, providing an explanation for their consumption, and questioning the portion of their consumption. The recurrence of verbalised introspection was determined to be important to investigate, prompting the research topic for study two (Chapter 3), "Evaluating 24-Hour Dietary Recall and the Think-aloud Protocol as a Positive Behaviour Change Technique".

Chapter 3: Evaluating 24-Hour Dietary Recall and the Think-Aloud Protocol as a Positive Behaviour Change Technique

Abstract

Health outcomes can be improved, and medical costs reduced, through dietary interventions that address risk factors and enable behaviour change. Directing behaviour change techniques toward a self-motivated approach, may foster less effortful and more maintainable outcomes. The aim of this study was to determine whether a brief dietary intervention (i.e., think-aloud during 24HR) would increase nutritional awareness (H1) and diet quality (H2) among Australian participants, and whether habitual behaviours are influential to any changes (H3). A prospective randomised multi-group design (think-aloud and no think-aloud group) was used from May to August 2022. In a three-part study (one pre-intervention and two post-intervention surveys), 74 participants (Group 1 n = 35; Group 2 n = 39) were recruited via social media and Curtin University. Participants completed demographic, nutritional awareness, diet quality, and habit measures (pre-intervention) three days before completing their 24HR (intervention). Directly following 24HR, participants completed a second nutritional awareness measure (first post-intervention survey). Three days post-intervention, participants completed a second diet quality measure (second post-intervention survey). Change scores, independent samples t-tests, and hierarchical multiple regressions were conducted. Nutritional awareness and diet quality scores showed no significant differences following 24HR between the groups ($p > .05$). Therefore, hypotheses one and two were rejected. Automatic habits, exercise, and diet quality significantly predicted nutritional awareness at both time-points; more so preceding 24HR ($R^2 = .523$, $p < .001$) than following ($R^2 = .272$, $p = .015$). Automatic habits, nutritional awareness, and age were significantly predictive of diet quality preceding 24HR ($R^2 = .441$, $p < .001$), but not following ($p > .05$).

Therefore, hypothesis three was partially accepted. The intervention was not successful for improving nutritional awareness or diet quality scores. However, the results suggest participants' automatic behaviours were less influential following the intervention, perhaps because habitual cues are ever-changing, or participants were made aware of them. Future research would benefit a follow-up habit measure.

Introduction

In an ageing population, healthcare systems face increasing burdens of long-term non-communicable diseases, posing capacity concerns (Araújo-Soares et al., 2019). Smoking, eating poorly, and not regularly exercising, are behavioural risk factors that are associated with chronic conditions; many of which are preventable (Lim et al., 2012). As such, interventions that address health risk factors to enable behaviour change and the effective self-management of chronic conditions, can substantially impact the populations health and well-being, as well as reduce the cost and burden of health care (Tahmassebi & BaniHani, 2020). Directing behaviour change techniques toward a more self-motivated approach (e.g., self-awareness) may aid in fostering a less effortful, and more maintainable behavioural outcome, that does not rely on self-control (Ludwig et al., 2020). This approach opposes traditional behaviour change techniques (i.e., risk perception, goal setting, problem-solving; Rigby et al., 2020), which rarely consider an individual's internal needs, goals, and states (Juechems & Summerfield, 2019).

Self-Talk for Self-Awareness

Individuals become self-aware when they realize there is a discrepancy between their ideal self and their actual self and turn to external sources for solutions (Morin et al., 2018). *Self-awareness* is the ability to understand how actions, thoughts, and emotions align with internal standards by attending to and managing them, to make better and more rational decisions (Chella et al., 2020). Likewise, self-awareness aids in executive functioning tasks (e.g., self-regulation), which are important for controlling and focussing actions or impulses toward goal-directed behaviour (Billore et al., 2023). To promote self-regulation, it has been suggested that individuals should engage in self-awareness practices, like self-talk (Ludwig et al., 2020).

Verbalising our experiences can have practical applications, such as keeping a healthy weight by monitoring food intake (i.e., via self-regulation; Morin et al., 2018), and decision making (Cokely & Kelley, 2009). However, the impact of verbalising dietary experiences during self-monitoring has not yet been investigated within nutritional behaviour change research. Previous literature has found that an essential part of self-awareness lies in self-talk (Morin et al., 2018) as the individual becomes focussed on themselves through introspection (e.g., through one's own thoughts, sensations, and emotions) whilst verbalising their experience (Chella et al., 2020). For example, Wicklund and Duval (1971) examined whether an individual's self-focus increased self-awareness. They found that those who were audio-recorded, placed in front of a camera, or mirror while completing a task, had a greater self-awareness. As such, dietary monitoring may encourage healthier eating behaviours, by allowing individuals to become aware of their full 24-hour intake, and the types of items and portions they may eat without conscious thought; providing insight into the need for positive dietary behaviour change (Acharya et al., 2011; Chen et al., 2020). Although dietary self-monitoring alone can result in effective dietary behaviour change (Patel et al., 2019; Rigby et al., 2020), van Genugten et al. (2016) argue that combining different techniques is more effective than using them in isolation. Similarly, Hurling et al. (2006) suggests interventions that incorporate self-monitoring with at least one other behaviour change technique tend to have larger effects than those that do not. As such, self-monitoring combined with self-awareness techniques (i.e., self-talk) may provide insight into dietary behaviours that may be beneficial and is yet to be explored in nutrition research.

Self-Awareness and Behaviour Change

Ludwig et al. (2020) proposed that effortful self-regulation (e.g., restricting fried food for weight loss) is often a struggle between a person's impulses and cognitive control. While

this approach may align with an overall goal (e.g., weight loss), effortful dietary restriction can be unpleasant, and can disrupt regulated appetite (Aldao et al., 2010). As such, Ludwig et al. (2020) challenge contemporary behaviour-change techniques that rely on effortful self-regulatory strategies, and instead, have recommended focussing on internal motivations that are congruent with the individual's values; proposing it offers a subjective feeling of reward, from free choice. Ludwig et al. (2020) proposes that increasing an individuals' self-awareness aids in separating the conscious cognitions (i.e., impulses, thoughts, etc.) from the poor health behaviours, by acknowledging and observing the cognitions, before deciding how to act on them (e.g., not binge eating when sad). Previously, self-awareness has been fostered in various training programs via mindfulness, by encouraging an acceptance of what is presently occurring. For example, these mindfulness training programs can induce behaviour change in different areas such as in those with eating disorders (Katterman et al., 2014), substance use disorders (Bowen et al., 2014), smoking, and other health-risk behaviours (Brewer et al., 2011, 2014). Mindfulness based techniques have also been used alongside dietary consumption (Ashton et al., 2019; Higgs & Donohoe, 2011), however these techniques have only involved methods by which participants are actively engaged (e.g., providing external motivations). As such, it unknown whether prompting participants internally (i.e., via self-awareness and self-talk) is an influencing factor towards changing nutritional health. Yet, secondary findings from study one suggests there may be potential (Mackenzie et al., 2022).

The Influence of Habits on Health Behaviour Change

The Health Belief Model posits that an individual's belief about health and health conditions, influence or motivate change in their health behaviours (Janz & Becker, 1984). Although, merely wanting to change a behaviour is not sufficient to maintain behaviour change (Prochaska & Norcross, 2002). Behaviour change relies on a cue to trigger the change,

which can be external (e.g., government health campaigns, death, or illness of someone close), or internal (e.g., physical symptoms like chest pain; Wood & Rünger, 2016). Similarly, our habitual behaviours are triggered by internal and external cues (Hall & Fong, 2007). As such, our habitual cues influence our automatic behaviours, and they work to reduce or strengthen the behaviour (Booker & Mullan, 2013; McAlpine & Mullan, 2022). Nevertheless, it is important to be aware of our habitual cues, especially if the consequential behaviour is a risk to our health. For example, it has been suggested that those who are more reliant on habitual cues and automatic behaviours (i.e., high habit automaticity) are more susceptible to poor dietary behaviours (e.g., binge eating, poor diet quality; Elliston et al., 2017; Fürtjes et al., 2020). Repetition of the habitual cue and desired behavioural response becomes automatic, requiring little cognitive effort, and making it hard to identify the cues to, or stop the health-risk behaviour (Wood & Rünger, 2016). As such, research in dietary habits and how to change its automatic nature is complex (Fürtjes et al., 2020; Gardner & Tang, 2014).Hence, it is important to consider the influence of automatic behaviours in dietary research as well as the contexts in which they occur, to better address interventions promoting positive behaviour change.

Incorporating the Think-Aloud Protocol

To our knowledge, no work has yet incorporated the think-aloud methodology alongside 24HR, and its potential impact on future dietary behaviours, nor whether habitual behaviours influence this (Ericsson & Simon, 1980). Given previous work has found situational cues to largely determine eating behaviour (Elliston et al., 2017; Wansink, 2004), combining a 24HR with the think-aloud protocol, may assist participants in recognising their cues and subsequent behaviours. We believe this to be the case from the reflective component of the 24HR (Hurling et al., 2006) and introspection as previously noted in the secondary

findings of Mackenzie et al. (2022; Chapter 2). In contrast, previous habitual behaviours are strong predictors of future behaviours (Booker & Mullan, 2013; Hall & Fong, 2007), whereby no significant change may likely be explained by the automaticity of dietary habits.

Aims and Objectives

The aim of the current research was to explore whether participants' nutritional awareness would improve following a 24HR and think-aloud protocol, and whether any change in nutritional awareness further prompts short-term change in participants' diet quality. Considering the influence of habitual cues on dietary behaviours, we also investigated habitual behaviour as a covariate when interpreting the effects of behaviour change following 24HR and think-aloud.

Materials and Methods

Design

A prospective randomised multi-group design was used from May to August 2022 to evaluate the effectiveness of dietary recall as a potential behaviour change intervention. There were two groups:

- Group 1: Think-Aloud
- Group 2: No Think-Aloud.

Participants

Recruitment consisted of convenience sampling of undergraduate psychology students at Curtin University via the SONA participant pool, and social media platforms (Facebook, Twitter, Instagram, Reddit; see Appendix E). Participants were deemed eligible if they currently lived in Australia and were over 18 years of age. There were no other exclusion

criteria. Participants who completed the study through SONA received five SONA points, and those recruited via social media were placed in a prize draw to win one of five $20 retail vouchers.

Procedure

Ethics approval was granted from Curtin University's Human Resources Ethics Committee (HREC: 0251-2022). The study was advertised through Curtin University to undergraduate psychology students in the SONA participant pool and via social media platforms, where potential participants were informed of the study requirements (i.e., three separate survey sessions) when signing up. After providing informed consent, participants completed the first survey session which consisted of demographic, nutritional awareness, dietary habit, and diet quality measures and were randomly allocated a group (1: think-aloud, or 2: no think-aloud). This first session took approximately 10 minutes to complete, and provided participants' baseline scores (i.e., time-point 1). Three days following the first survey session, participants were asked to complete the second survey session, which included the 24HR. Due to the uncertainty of government restrictions in place at the time following COVID-19, the study was conducted fully online. As such, for survey session two, participants were emailed a one-time personalised link for INTAKE24©, and instructions based on their group allocation (i.e., think-aloud or no think-aloud). During the 24HR, group 1 were instructed to audio record themselves whilst verbalising all thoughts that came to mind. Straight after completion of the 24HR, participants were asked to complete a post-recall survey measuring their nutritional awareness and made up timepoint 2 scores for this variable. Group 1 participants were asked to upload their audio recordings to the Qualtrics platform. Some participants who encountered difficulties with this, were advised to contact the researchers via a reply to the email. Group 2 did not have audio recordings for survey session

two but completed the same survey post-recall. The second survey session took approximately 15-20 minutes. Three days after the second survey session, participants who took part in session two, were emailed the third and final survey session. This session included the diet quality measure only and made up timepoint 2 scores for this variable. After completing all components, participants were sent a debrief and had the option to contact the researchers for further information or questions regarding the study. Prize winners were selected at random, before notified and rewarded.

Measures

Demographics. Demographic questions were asked once in survey session one and included age, BMI, gender identity, ethnicity, education, and employment. Additionally, participants were asked if they tracked their dietary consumption currently, previously, or never have. Given previous work has identified certain specific characteristics are associated with dietary recall ***(Wehling & Lusher, 2019a; Whitton et al., 2022)*** it was deemed important to include multiple demographic questions, to identify potential significant relationships with the variables of interest (i.e., nutritional awareness, diet quality, and habitual behaviour).

24hr Recall (INTAKE24©). The self-assisted 24HR, INTAKE24© (Simpson et al., 2017), was used to promote reflection on and awareness of dietary intake. The INTAKE24© program is an open source, computerised, self-completed 24HR that includes pictures and portion sizes of popular meals, snacks, and beverages (Osadchiy et al., 2020). In study one, INTAKE24© was found to be less problematic, more usable, and most preferred (compared to ASA24®) in an Australian student population (Mackenzie et al., 2022). These results were important, as the usability of programs are influential to the effectiveness of interventions (Kupis et al., 2019; van Genugten et al., 2016). Participants completed INTAKE24© once, in

survey session two. The current study used the Australian-adapted INTAKE24© (https://intake24.com/; accessed from May – August 2022).

Think-Aloud. In previous work by Mackenzie et al. (2022) participants' engagement in think-aloud was perceived by the researchers to have encouraged verbalised introspection of their dietary habits, which has previously been shown to increase motivated and goal-directed behaviour (Hertzum et al., 2009; Senay et al., 2010). Think-aloud was employed to the experimental group (group 1) during dietary recall to promote introspection and nutritional awareness. To validate the participation in the self-evaluation technique (i.e., think-aloud), group 1 was asked to audio record their think-aloud. Provided instructions sent via email read: "Whilst filling these questions out, we ask that you record yourself thinking aloud. This means, whilst you are completing the task, we want you to speak aloud all the thoughts that come into your mind. There is no right or wrong thing to say, it's just as if you are talking to yourself. Before you begin, please remember to start the audio recording".

Nutritional Awareness. The Nutrition Awareness Scale is a 17-item questionnaire designed to measure the level of awareness people have based on their nutritional habits and was adapted from various health awareness scales (see Appendix F; van Dillen et al., 2007). The scale is rated on a 5-point Likert scale (from 1: strongly agree to 5: strongly disagree), with total scores ranging from 17 to 85. Higher scores represent better nutritional awareness. Pilot testing of question 10, "I am prepared to leave a lot, to eat as healthy as possible", raised confusion and was therefore changed to "I am prepared to leave out a lot, to eat as healthy as possible". Development and validation of the nutrition awareness scale were conducted by van Dillen et al. (2007), yielding strong reliability (a = 0.89). The current study had good reliability for both survey time-points (1: $\alpha = .77$ and 2: $\alpha = .75$).

Habitual Behaviour. The Creatures of Habit Scale is a 27-item questionnaire measuring habitual and routine behaviour (2 factors: routine and automaticity) combined into an overall habit score (see Appendix A; Ersche et al., 2017). The routine component consists of 16 questions, and the automaticity component has 11. Participants are asked to rate their food habits on a 5-point Likert scale (from 1: strongly disagree to 5: strongly agree), with total scores ranging from 27 to 135. Higher scores on this scale indicate stronger habitual routine, and more automatic behaviours. An example item includes, "I generally eat the same things for breakfast every day". Previous validation found valid and reliable results for assessing habitual behaviour for routine ($\alpha = 0.89$) and automaticity ($\alpha = 0.86$; Ersche et al., 2017). The current study had excellent reliability for routine and automaticity ($\alpha = .84$, & .87, respectfully).

Diet Quality. The Short-Form Food Frequency Questionnaire (SFFFQ; see Appendix G) is a 21-item questionnaire designed to screen individuals' fruit and vegetable, fat, and sugar (i.e., non-milk extrinsic sugar), meat, fish, and fibre intake, and was adapted from the 217-item Food Frequency Questionnaire (Cleghorn et al., 2016). The questionnaire asks about participants' typical food and drinks consumed in the past month, with options ranging from rarely/never to five times a day for each categorised dietary item. Given that the study was conducted over a week, the questions were rephrased from "Please tick how often you eat at least ONE portion of the following foods and drinks over the past month", to "Please tick how often you eat at least ONE portion of the following foods and drinks over the past week." Likewise, the questionnaire includes questions on exercise activity, alcohol consumption, and type of milk. A healthy diet quality score was consistent with scores > 12, a moderate diet 9-11, and a poor diet < 8 (Cleghorn et al., 2016). The study had good reliability for the first ($\alpha = .61$) and final survey ($\alpha = .62$).

Sample Size Calculation and Hypotheses

Using G*Power (Heinrich-Heine University, Düsseldorf, Germany; Faul et al., 2009), an a-priori power analysis estimated that a small to medium effect size of $f = .20$ (power .80, a .05, covariates and df 1), and a sample size of 200 (100 per group) would be required for a two-way analysis of covariance (ANCOVA). This effect size was based on previous work by Mackenzie et al. (2022) with a similar methodological design. A two-way ANCOVA was hypothesised to determine whether there are both between and within group effects. That is, if there is a significant main or interaction effect between the think-aloud versus no think-aloud group, and if there is a significant difference in nutritional awareness and subsequently, diet quality scores pre-and post- 24HR in both groups. Specifically, it was hypothesised that there would be secondary effects on participants' diet quality following 24HR given that previously, nutritional awareness has been associated with diet quality (Alkerwi et al., 2015; Vaudin et al., 2021). Given this, the proposed hypotheses were:

H1: There will be a significant difference in participants' nutritional awareness scores following 24HR. This difference will be larger within the think-aloud group.

H2: There will be a significant difference in participants' diet quality scores following 24HR. This difference will be larger within the think-aloud group.

H3: Habitual behaviour will be an influential factor in nutritional awareness and diet quality scores, at both time-points.

Results

Sample Size and Demographics

Of the 207 participants who gave informed consent, 74 completed all three surveys correctly (M_{Age} = 29; *N*: Group 1 *n* = 35; Group 2 *n* = 39). Ninety-three participants did not continue past survey one, 17 past survey two, 18 completed the surveys incorrectly, three were duplicates and two did not pass the attention check question. BMIs as suggested by The National Health and Medical Research Council (2020) and were calculated and compared, amongst other demographic variables in Table 1b.

Table 1b. *Demographic Variables including Mean (M) Age, and Frequencies (n) of BMI, Gender, Employment, Education, and Ethnicity Across Both Groups.*

Demographics	**Group 1** (*n* = 35)	**Group 2** (*n* = 39)
Age (*M*)	29.9	32.3
BMI (*n)*		
Underweight	1	2
Healthy Weight	18	14
Overweight	6	13
Obese	5	5
Gender (*n*)		
Male	13	16
Female	21	22
Non-Binary	1	-
Prefer not to say	-	1
Employment (*n*)		
Full time	11	19
Part time	4	3
Casual	1	2
Not employed	1	3
Parental leave	5	2
Study	1	1
Study and Work	12	9
Education (*n*)		
Secondary (Year 10)	-	4
Secondary (Graduate)	9	10
Tafe	8	4
Undergraduate degree	14	12
Postgraduate degree	3	9
Ethnicity (*n*)		
American Indian	1	-

White American	1	2
African American	-	1
East Asian	1	3
Native Hawaiian	1	-
South Asian	3	2
South-east Asian	2	1
British	5	10
Eastern European	4	4
Northern European	3	1
Southern European	-	2
West European	1	4
Australian	26	29
South African	2	2

Note. There are 5 missing cases in both groups for BMI. Secondary education refers to those who completed up to years 10 or 11 but did not graduate. Ethnicity may add up to more than 100 as participants were able to select more than one answer.

Data analyses

Due to time and funding constraints of the master's thesis, recruitment for more participants was not feasible considering the multiple components of the study design. Additionally, the full attrition rate (64.25%) was unknown until further along the experimental period and after data cleaning and analyses. As such, the following analyses deviate from the original proposal which originally included a two-way ANCOVA for each dependent variable (i.e., nutritional awareness and diet quality; See Sample Size Calculation).

As such, the revised analyses included change scores and two separate independent samples *t*-tests. These analyses are suitable for comparing the mean differences in the dependent variables, between groups and time-points. The process of change scores involves removing the 'repeated measures' component, which is done by subtracting endline results from the baseline results, providing the participants' positive or negative change in their score (Zhang et al., 2014).

Given the smaller sample sizes precluded the use of ANCOVAs due to low power (Tabachnick & Fidell, 2019), change scores were analysed using *t*-tests to examine if there

were significant differences between groups 1 and 2, for the mean difference between pre and post-test scores for both dependent variables. This is considered acceptable when no significant differences are found in the pre-test scores between randomised group allocation (see Descriptive Statistics; van Breukelen, 2013). Likewise, Zhang et al. (2014) suggest that change scores analyses are valid when the data shows high correlations between the baseline and post-intervention scores (see Table 2b).

To test the mean difference in change scores between the two groups, two independent samples *t*-tests were run for both variables (i.e., nutritional awareness and diet quality). A bivariate correlation between all variables was run to assess any potential relationships that could be influential and thus be incorporated into a regression analysis (see Table 2b). Four separate hierarchical multiple regression analyses were run to assess whether habit and any other significant covariates were predictive of nutritional awareness and diet quality, across both time-points.

Table 2b. *Bivariate Correlation Coefficients to Determine Significant Relationships for all Target Variables (N = 74).*

	2	3	4	5	6	7	8	9	10	11
1. Diet Quality 1	.250*	.589**	.545**	.278*	.014	-.063	-.429**	-.283*	-.420**	.249*
2. Diet Quality 2	-	.169	.232	.044	-.065	.13	.097	-.170	-.064	.016
3. Nutritional awareness 1		-	.864**	.172	.153	-.203	-.442**	-.278*	-.446**	.434**
4. Nutritional awareness 2			-	.102	.111	-.273*	-.308**	-.204	-.301**	.399**
5. Age				-	.100	.396**	-.121	-.067	-.132	-.175
6. Group Category					-	.014	-.135	-.117	-.103	.053
7. BMI						-	.189	.108	.206	-.356**
8. Habit (Overall)							-	.823**	.810**	-.252*
9. Habit Routine								-	.332**	-.180
10. Habit Automaticity									-	-.233*
11. Exercise										-

Note. *******: Significance at a *p*-value of .05**.**

Preliminary Analyses

A missing values analysis was run across all relevant variables. Demographic variables constituted the largest portion of missing data (14 values). Little MCAR's test was non-significant ($p > .999$) and thus expectation maximisation (EM) substitution was used (two values were nutritional awareness, and seven values were habit).

Assumptions

Before analysing the data, assumption checks were performed to ensure the data were suitable for the chosen analyses. Three outliers were retained for the diet quality variable after transformations provided no significant change in distribution. Shapiro-Wilk was violated for the change scores of diet quality for group 1 only. However, analyses were continued given the sample size was greater than 50, and the skew of the data was similar amongst all groups and variables (Elliott & Woodward, 2007, as cited in Ghasemi & Zahediasl, 2012). Levene's test of equality indicated that the data has met homogeneity of variances ($p > .05$).

Descriptive Statistics

Statistics were computed to describe the sample based on all the target variables. When both time-points were combined, the mean nutritional awareness score was overall higher in group 2 ($M = 56.2$ v.s. $M = 54.1$) whereas overall mean diet quality score was comparable across the groups ($M = 9.9$). Between the two groups, the differences were non-significant ($p > .05$). Considering the full sample, nutritional awareness scores were lower following 24HR ($M = 56.1$ v.s. $M = 54.4$), as was diet quality ($M = 10.3$ v.s. M = 9.5). Overall habit scores were lower in group 1 and for both factors (i.e., automaticity and routine), with greater variability in scores found for group 2 (see Table 3b). Frequency statistics were

computed for participants' category of diet quality, alcohol consumption, milk-type, level of exercise, and dietary tracking history (see Table 4b).

Table 3b. *Means (M), Standard Deviations (SD) Scores for Time and Group Differences (Group 1: n = 35 and Group 2: n = 39) for Participants Nutritional Awareness, Diet Quality and Habit Scores.*

Measured Variable	Time 1		Time 2		Group 1		Group 2	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Nutritional Awareness	56.1	8.3	54.4	7.3	54.1	8.2	56.2	6.8
Diet Quality	10.3	1.8	9.5	1.7	9.9	1.4	9.9	1.3
Habitual Behaviour					90.3	17.8	85.9	15.4
					33.5	10.4	31.5	9.77
					56.8	12.0	54.4	8.6

Note. Combined group means displayed for each time-point and group category for nutritional awareness and diet quality variables. All differences between the groups were found non-significant ($p > .05$).

Table 4b. *Frequencies for Diet Quality, Alcohol Consumption, Milk Type, Exercise, and Dietary Tracking (N = 74).*

Lifestyle Variables	Group 1 *n* = 35		Group 2 *n* = 39	
	Time 1	Time 2	Time 1	Time 2
Diet Quality				
Poor	4	6	6	9
Moderate	23	25	25	26
Healthy	8	4	8	4
Alcohol Consumption				
Rarely/never drink	19	18	20	20
Less than 14 units	12	13	10	9
Between 14 and 21 units	4	4	4	9
More than 21 units	-	-	5	1
Milk type				
Full Cream	15	14	14	14
Skimmed	2	3	9	10
Semi-Skimmed	1	-	2	2
Rarely/Never use	3	2	4	3
Other	14	16	10	10

Lifestyle Variables	Group 1 *n* = 35		Group 2 *n* = 39	
	Time 1	Time 2	Time 1	Time 2
Exercise				
No exercise	5	5	1	-
Light exercise	11	7	12	13
Moderate exercise	1	8	11	10
Vigorous exercise	18	15	15	16
Dietary Tracking				
Currently tracking	5		5	
Previously tracked	12		20	
Never tracked	18		14	

Within-Group Differences for Diet Quality Items

Means and standard deviations were computed to assess any significant differences between each item within diet quality for each group and time-point (See Table 5b). For full significance table, see Appendix H.

Group 1. There was a significant decrease in mean potato crisp (p = .030), ice cream (p = .037), white (p = .013) and oily fish (p = .012) consumption, and a significant increase in mean red meat (p = .044) and white fish (p = .013) consumption for group 1, following 24HR and think-aloud.

Group 2. There was a significant difference in overall mean salad consumption within both groups (p = .048) at time-point 2. However, for group 2 only, the salad consumption significantly increased (p = .012) following 24HR.

Table 5b. *Means (M) and Standard Deviations (SD) of Singular Diet Quality Items of the SFFFQ Scale Consumed for Each Group Over Both Time-points.*

Diet Quality Items	Group 1 Think-Aloud *n* = 35 *M (SD)*		Group 2 No Think-Aloud *n* = 39 *M (SD)*	
	Time 1	Time 2	Time 1	Time 2
Discretionary Food Items				
Hot chips/fried potato	3.00 (1.3)	3.17 (1.3)	2.72 (1.2)	2.82 (1.4)
Processed red meat	2.50 (1.3)	2.23 (1.2)	2.80 (1.4)	2.80 (1.3)
Processed white meat	2.23 (1.1)	2.00 (1.0)	2.30 (1.3)	2.33 (1.3)

Diet Quality Items	Group 1 Think-Aloud *n* = 35		Group 2 No Think-Aloud *n* = 39	
	M (SD)		*M (SD)*	
	Time 1	Time 2	Time 1	Time 2
Discretionary Food Items				
Alcohol	1.60 (.70)	1.60 (.70)	1.90 (1.1)	1.80 (.90)
Non-alcoholic SSBs	2.17 (1.7)	2.17 (1.3)	2.13 (1.6)	2.03 (1.6)
Potato crisps/savoury snacks	3.20 (1.6)	2.80 (1.3)	**3.00 (1.5)***	2.82 (1.4)
Sweets and confectionary	3.30 (1.5)	3.54 (1.4)	3.62 (1.7)	3.80 (1.6)
Ice-cream or cream	2.20 (1.4)	1.80 (1.1)	**2.00 (1.1)***	2.00 (1.2)
Core Food Items				
Cheese or Yoghurt	4.10 (1.7)	4.10 (1.5)	4.13 (1.8)	4.10 (1.6)
Vegetables	4.86 (1.4)	5.10 (1.4)	4.92 (1.2)	5.00 (1.4)
Fruit	3.77 (2.0)	3.74 (1.9)	4.38 (1.8)	4.26 (1.8)
Fruit Juice	2.37 (1.6)	2.49 (1.7)	2.21 (1.7)	2.26 (1.7)
Salad	3.74 (1.5)	**3.51 (1.8)***	3.87 (1.5)	**4.28 (1.5)***
Wholemeal breads or chapattis	2.90 (1.6)	2.57 (1.8)	3.10 (1.0)	2.70 (1.5)
Fibre-rich breakfast cereals	3.03 (2.0)	3.20 (2.0)	2.95 (2.1)	3.10 (1.9)
Beans or pulses	2.74 (1.5)	2.71 (1.7)	2.90 (1.5)	3.20 (1.6)
Battered Fish	1.66 (.80)	1.50 (.92)	1.92 (1.0)	1.80 (1.0)
Whole white meat	3.60 (1.6)	3.80 (1.3)	3.44 (1.4)	3.44 (1.5)
Whole red meat	3.40 (1.4)	3.63 (1.4)	**3.60 (1.4)***	3.50 (1.3)
White fish	2.10 (1.3)	1.60 (.95)	**1.90 (1.0)***	1.80 (1.0)
Daily vegetable portions	2.90 (1.9)	2.90 (1.8)	2.93 (1.9)	3.44 (2.2)
Oily Fish	2.00 (1.4)	**1.50 (.90)***	**2.13 (1.2)***	2.10 (1.3)
Daily fruit portions	1.34 (1.3)	1.48 (1.0)	1.34 (1.0)	1.90 (1.5)

Note. *******: Significance at a *p*-value of .05.

Analyses 1: Pre and Post-Test Group Differences for the Dependent Variables

Nutritional Awareness. The mean difference in nutritional awareness scores for group 1 was .90 (n = 35, M = 1.26, SD = 4.50) larger, than the mean difference for group 2 (n = 39, M = 2.15, SD = 3.90). Over time, the mean difference in both groups decreased (i.e., nutritional awareness got worse), with this decrease being larger for those not instructed to think-aloud (i.e., group 2). However, this difference was not statistically significant (p = .358).

Diet Quality. The mean difference in diet quality scores for group 1 was .30 (n = 35, M = .60, SD = 1.90) larger, than the mean difference for group 2 (n = 39, M = .90, SD = 2.3). Over the time-points, the mean difference in both groups decreased (i.e., diet quality got worse), with

this decrease being larger for those not instructed to think-aloud (i.e., group 2). However, this difference was not statistically significant (p = .546).

Analyses 2: Pre and Post-Test Influence of Covariance

To explore the variance that habit accounted for in participants' nutritional awareness and diet quality scores, a regression analyses was run for each time-point only, since there were no significant mean differences found between the two groups (See Analyses 1).

Nutritional Awareness. Considering the significant relations found in the bivariate correlation (Table 2b), a hierarchical multiple regression showed that having higher habit automaticity was associated with having a lower nutritional awareness score, prior to and following 24HR. Unstandardised (B) and standardised (β) regression coefficients and squared semi-partial (or 'part') correlations (sr2) for each predictor on each step of the hierarchical multiple regression are reported in Table 6b.

Time-point 1. Habit automaticity accounted for a significant 21.8% of variance in nutritional awareness in block 1 [R^2 =.22, F(2, 71) = 9.88, p < .001]. When diet quality and exercise were added to the model (block 2), an additional 30.5% of variance in nutritional awareness scores was explained [R^2_{change} = .305, F_{change} (7, 66) = 10.33, p < .001]. Specifically, poor diet quality (p < .001), light (p = .045), or no exercise (p < .001) were significant predictors of participants' nutritional awareness scores. In combination, the variables explained a significant total of 52.3% [R^2 = .523, adjusted R^2 = .472, F(5, 66) = 8.45, p < .001], producing a large effect (f^2 = 1.1).

Time-point 2. Habit automaticity accounted for a significant 10.3% of variance in nutritional awareness in block 1 [R^2 =.103, F(2, 71) = 4.10, p = .021]. When diet quality and exercise were added to the model (block 2), an additional 17% variance in nutritional awareness scores was explained [R^2_{change} = .17, F_{change} (7, 66) = 3.53, p = .003]. Specifically,

light (p = .010), moderate (p = .021), or no exercise (p = .003) were significant predictors of participants' nutritional awareness scores. In combination, the variables explained a significant total of 27.2% [R^2 = .272, adjusted R^2 = .195, $F(5, 66) = 3.074$, p = .015], producing a large effect (f^2 = .37).

Table 6b. *Unstandardised (B) and standardised (β) regression coefficients and squared semi-partial (or 'part') correlations (sr^2) of each predictor variable for Nutritional Awareness.*

Time-point 1		Unstandardized Coefficients	Standardized Coefficients		
Model		*B* 95% CI [Lower, Upper]	*β*	*p*	sr^2
1	(Constant)	73.22 [63.40, 83.04]		<.001	
	Habit Automaticity	-.33 [-.51, -.15]	-.40	**<.001***	.14
	Habit Routine	-.12 [-.29, .06]	-.15	.194	.02
2	(Constant)	69.01 [60.46, 77.55]		<.001	
	Habit Automaticity	-.15 [-.31, .01]	-.19	.059	.03
	Habit Routine	-.04 [-.18, .11]	-.05	.626	.00
	Poor Diet Quality	-13.25 [-18.54, -7.96]	-.55	**<.001***	.18
	Moderate Diet Quality	-3.20 [-6.78, .38]	-.19	.079	.02
	No Exercise	-11.53 [-17.05, -6.01]	-.38	**<.001***	.13
	Light Exercise	-3.47 [-6.86, -.07]	-.20	**.045***	.03
	Moderate Exercise	-.43 [-4.55, 3.69]	-.02	.836	.00

Time-point 2		Unstandardized Coefficients	Standardized Coefficients		
Model		*B* 95% CI [Lower, Upper]	*β*	*p*	sr^2
1	(Constant)	65.17 [55.87, 74.47]		<.001	.06
	Habit Automaticity	-.19 [-.37, -.02]	-.26	**.031***	.06
	Habit Routine	-.08 [-.25, .09]	-.12	.328	.01
2	(Constant)	64.06 [54.98, 73.14]		<.001	
	Habit Automaticity	-.06 [-.24, .12]	-.08	.499	.00
	Habit Routine	-.07 [-.23, .09]	-.10	.376	.00
	Poor Diet Quality	-1.26 [-5.33, 2.81]	-.07	.539	.00
	Good Diet Quality	-2.58 [-7.61, 2.45]	-.11	.310	.01
	No Exercise	-10.72 [-17.65, -3.78]	-.37	**.003***	.10
	Light Exercise	-5.15 [-9.02, -1.27]	-.32	**.010***	.08
	Moderate Exercise	-4.70 [-8.67, -.73]	-.28	**.021***	.06

Note. *: Significance at a *p*-value of .05

Diet Quality. Considering the significant relations found in the bivariate correlation (Table 2b), a hierarchical multiple regression showed that being of an older age was associated with better diet quality scores. Likewise, having higher habit automaticity was associated with having a lower diet quality score, prior to 24HR. Unstandardised (B) and standardised (β) regression coefficients and squared semi-partial (or 'part') correlations (sr^2) for each predictor on each step of the hierarchical multiple regression are reported in Table 7b.

Time-point 1. Age and habit automaticity therefore accounted for a significant 24.8% of variance in diet quality in block 1 [R^2 =.25, $F(3, 70) = 7.70$, $p < .001$]. When nutritional awareness and exercise were added to the model (block 2), an additional 19.3% variance in diet quality scores was explained [$R^2_{change} = .193$, $F_{change}(7, 66) = 7.43$, $p < .001$]. Specifically, nutritional awareness was a significant predictor of participants' diet quality scores ($p < .001$). In combination, the variables explained a significant total of 44.1% [$R^2 = .441$, adjusted $R^2 = .381$, $F(4, 66) = 5.68$, $p < .001$], producing a large effect ($f^2 = .79$).

Time-point 2. Hierarchical multiple regression showed that no single predictor was statistically significant for diet quality at timepoint 2 ($p > .05$). In block 1, age and habit accounted for a nonsignificant 4.7% of variance [$R^2 = .047$, $F(3, 70) = 1.16$, $p = .331$] in diet quality scores, following 24HR. When nutritional awareness and exercise were added to the model (block 2), an additional nonsignificant 4% of variance, [$R^2_{change} = .40$, $F_{change}(2, 51) = .904$, $p = .509$] was found, producing a small effect ($f^2 = .09$).

Table 7b. *Unstandardised (B) and standardised (β) regression coefficients and squared semi-partial (or 'part') correlations (sr^2) of each predictor variable for Diet Quality.*

Time-point 1		Unstandardized Coefficients	Standardized Coefficients		
Model		*B* 95% CI [Lower, Upper]	*β*	*p*	sr^2
1	(Constant)	12.68 [10.31, 15.04]		<.001	
	Age	.03 [.00, .06]	.22	**.037***	.22
	Habit Automaticity	-.06 [-.10, -.02]	-.34	**.003***	-.32
	Habit Routine	-.03 [-.06, .01]	-.16	.161	-.15

Time-point 1		Unstandardized Coefficients	Standardized Coefficients		
Model		*B* 95% CI [Lower, Upper]	*β*	*p*	sr^2
2	(Constant)	5.53 [1.64, 9.43]		.006	
	Age	.03 [.00, .06]	.22	**.030***	.20
	Habit Automaticity	-.03 [-.07, .01]	-.17	.117	-.14
	Habit Routine	-.01 [-.05, .02]	-.07	.469	-.07
	No Exercise	.72 [-.62, 2.06]	.11	.289	.10
	Light Exercise	-.58 [-1.41, .25]	-.15	.166	-.13
	Moderate Exercise	-.44 [-1.39, .51]	-.09	.357	-.08
	Nutritional Awareness	.10 [.05, .15]	.47	**<.001***	.37

Time-point 2		Unstandardized Coefficients	Standardized Coefficients		
Model		*B* 95% CI [Lower, Upper]	*β*	*p*	sr^2
1	(Constant)	10.55 [8.01, 13.09]		<.001	
	Age	.00 [-.03, .04]	.02	.893	.02
	Habit Automaticity	-.04 [-.08, .01]	-.22	.084	-.20
	Habit Routine	.00 [-.04, .04]	.01	.938	.01
2	(Constant)	10.46 [5.75, 15.17]		<.001	
	Age	.00 [-.03, .04]	.03	.839	.02
	Habit Automaticity	-.03 [-.07, .02]	-.15	.261	-.13
	Habit Routine	.00 [-.04, .04]	.01	.919	.01
	No Exercise	-.97 [-2.87, .93]	-.15	.312	-.12
	Light Exercise	-.45 [-1.52, .62]	-.12	.402	-.10
	Moderate Exercise	-.77 [-1.82, .29]	-.20	.151	-.17
	Nutritional Awareness	.00 [-.06, .06]	.00	.979	.00

***Note* ***: Significance at a *p*-value of .05.

Discussion

Hypotheses One and Two

Our hypotheses that participants nutritional awareness and diet quality scores would differ following 24HR, more so in the think-aloud group, was not supported as the results found no significant differences between the groups. Therefore, hypotheses one and two were rejected. Regarding the aims of the study, this result means that 24HR and the think-aloud protocol were not successful in prompting a change in our samples dietary behaviours. However, the results highlighted significant differences between specific items on the diet quality scale (Cleghorn et al., 2016) across the time-points, predominantly for the think-aloud group (i.e., group 1). To elaborate, there was a significant increase in the consumption of salad, red meat, and white fish, and a significant decrease in the consumption of oily fish, potato crisps, and ice cream over the two time-points. Except for salad, these differences were found for group one only (i.e., the think-aloud group). Essentially, this result provides evidence for significant changes within the think-aloud group for changes in specific item consumption, which both align and oppose the suggestions from the healthy eating guides (National Health and Medical Research Council, 2013). However, as there was no overall significant difference found between the groups, we refrain from discussing these differences as they would be speculatory.

The Relationship Between Diet Quality and Nutrition Awareness

The current study displays results that both contrast and reinforce previous literature regarding the relationship between nutritional awareness and diet quality. The results found a significant positive relationship between participants' diet quality and nutritional awareness scores, at time-point one only. It is likely this result was found due to the design of the study,

whereby the second measure for diet quality and nutritional awareness, were completed three days apart. Given the nature of this measure (i.e., weekly context), it was required to be administered in isolation. Nevertheless, these variables have consistently shown a strong positive relation (Alkerwi et al., 2015; Vaudin et al., 2021), so it makes sense this relationship was found when the measures were completed together, but not when they were completed separately. However, this result does explain why participants' awareness of nutritional importance was not influential to diet quality a few days apart, nor why time-point two contrasts the literature. Although there is no way of knowing whether this was the case for the current study, it is recommended that counterbalancing future measurements of nutritional awareness and diet quality, may provide clarification.

The Validity of Nutritional Awareness Scores

Furthermore, nutritional awareness scores did not significantly change overtime, although the mean for time-point two was slightly lower than the mean at time-point one. Additionally, participants' automatic habits were less influential on their nutritional awareness scores, following the intervention. Whilst we expected nutritional awareness to increase following 24HR, we also expected that participants would have an accurate understanding of their nutritional awareness. As with all self-report measures, there are many factors influencing the accuracy of results (Short et al., 2009). Given this, we cannot rule out the possibility that participants did not have a clear sense of their nutritional awareness to begin with. That is, following the intervention, participants may have provided a more accurate representation of their nutritional awareness scores because it was directly followed by reflection on their dietary intake, and were less influenced by the potential errors when recalling automatic dietary habits (Gardner & Tang, 2014). Nevertheless, without the ability to measure whether this is true, (alongside the tools limitations; discussed further) we

interpret the determinants of our results with caution. However, future use of the Nutrition Awareness Scale (van Dillen et al., 2007) may benefit from asking participants to think about their previous 24-hour intake (or incorporating a 24HR) prior to administration to better determine the validity of the questionnaire.

Hypothesis Three

When considering hypothesis three, it was predicted that participants' habitual behaviours would be an influential factor in their nutritional awareness and diet quality scores, at both time-points. Automatic habits, exercise and diet quality were significantly predictive of participants' nutritional awareness scores at both time-points, more so in time-point one. Automatic habits, nutritional awareness and age were significantly predictive of diet quality at time-point one, but not time-point two. Therefore, we can refer to hypothesis three as being partially accepted. Regarding the aim of the research, this result means that the influence of participants' automatic behaviours differs following the intervention, or perhaps given their contextual cues to behaviour (Fürtjes et al., 2020; McAlpine & Mullan, 2022; Orbell & Verplanken, 2010).

Automatic Habits and Priming on Behaviour

In an environment where discretionary foods are easily accessible and cheap, the tendency to act automatically in response to external cues is easier than most believe (Elliston et al., 2017; Wansink, 2004). As mentioned previously, cues can be internal and external, and are unique to the individual, which makes them extremely complex to identify (Cleobury & Tapper, 2014; Schüz et al., 2015). As no other predictors (i.e., habit automaticity, nutritional awareness, and age) were significant for diet quality at time-point two, it may be that participants' nutritional awareness scores change regularly due to the differing context of the

environment and their dietary cues (Booker & Mullan, 2013; Cohen & Babey, 2012; Prinsen et al., 2013). Likewise, the increases in salad, red meat, and white fish, as well as the decrease in oily fish, ice cream, and crisps, could have been due to an internal reminder to eat (or not eat) these items due to priming, following the intervention (Papies, 2016). Perhaps participants significantly changed their consumption of these items unconsciously from having reflected and answered questions on their nutritional awareness, diet quality, and habitual behaviours. *Goal priming* involves activating a mental representation of a target behaviour (e.g., increased nutritional awareness) as a cueing intervention to change automatic poor dietary behaviours (Papies, 2016), and are used without participants being aware that they influence the target behaviour. Diet-related goal priming in this study was unplanned and unanticipated; similarly, participants were not actively informed of the behaviour change attempt. Therefore, we cannot exclude the possibility that active self-monitoring (i.e., 24HR and think-aloud) had no priming effect, given previous nutrition research shows priming can influence dietary behaviour. For example, Ohtomo (2017) investigated the effect of diet-related priming on unhealthy eating habits, using pictures of 'fit-looking' people. The study found that unhealthy eating habits strongly influenced dietary behaviours, even overriding the intention to eat healthy. In the same study, Ohtomo (2017) found the diet priming cues to moderate the influence of automatic eating habits and reduce unhealthy eating behaviours. Similarly, Sellahewa and Mullan (2015) investigated the effect goal-priming had on snacking behaviours in a depleted self-control and comparison group (i.e., not manipulated). The study found that participants in the goal-priming group consumed less discretionary snack foods than participants who were not primed, reinforcing the influence that goal priming can have on dietary behaviours (Sellahewa & Mullan, 2015). Additionally, the study found that snacking was greater in participants who were in the depleted self-control group, which is perhaps is a potential explanation for why the current study found no differences in the think-

aloud group. As such, the idea that 24HR and think-aloud could prompt a reduction in automatic dietary behaviours (i.e., via priming) should not be ruled out for future studies with larger sample sizes.

In contrast, other results have found no influence of priming on dietary choices, stating that the primed stimulus would need to be more noticeable for significant change to occur (Schlegel et al., 2021). Despite not being a direct purpose of the study, this may help to explain the overall significant findings for specific foods. However, considering there was a non-significant decrease in diet quality scores overall, we could also attribute the changes in the diet quality items to chance, provided it is likely that participants enjoy a variety of food items in their weekly meals (Embling et al., 2020). Additionally, previous work has shown those who prefer a greater food variety find it more difficult to consume the correct daily energy requirements (Raynor & Vadiveloo, 2018). As such, we recommend applying the five principles outlined in Papies (2016) review to further investigate whether priming effects are moderated by the chosen study design (and questions) following self-monitoring. These principles include 1) targeting participants who value the goals being primed, 2) specifically activating their motivation for the goal, 3) using cues effective for the specific goal, 4) capturing participants' attention at the most influential time, and 5) the goal must be achievable (i.e., known, and accessible; Papies, 2016). Future research may find it useful to explore whether 24HR and think-aloud can be used as effective priming cues to dietary behaviour changes (e.g., tested via control group/s), as dietary priming may be a simple method of reducing automatic dietary behaviours, to help address poor eating patterns (Ohtomo, 2017).

We cannot know for sure whether these results are secondary outcomes from the intervention or were due to external factors outside the control of the study. Even so, the inclusion of a social desirability and/or self-control measure may have helped further

determine whether this change was due to intervention influence or is better explained by other variables of interest (Burke & Carman, 2017; Hall & Fong, 2015). Alternatively, the inclusion of a question to assess the normality of participants' weekly consumption (e.g., multiple social events may increase consumption) could help to further understand whether these results were by chance, or intra-individual variation of diet (French et al., 2021).

Exercise and Dietary Intake

Furthermore, people have long associated food with a reward for exertion, in fact, even thinking about exercising has previously been found to increase calorie consumption (Werle et al., 2011). This aligns with the findings from the current study as exercise was a significant predictor of nutritional awareness. In particular, the results found a negative correlation between exercise and nutritional awareness, and diet quality at time-point one. It is likely that the participants in our sample held the belief that exercise compensates for poor dietary intake. The Compensatory Health Beliefs model proposes that completing one health-promoting behaviour (e.g., exercise) can counteract the negative effects of a poor behaviour (e.g., discretionary item consumption; Werle et al., 2011). Similarly, as an individual's exercise load increases, so does their overall dietary consumption (Koehler et al., 2021; Moshier et al., 2016); however, this should not sacrifice their overall diet quality. Cornil et al. (2020) suggests individuals overvalue kilojoules and their role in health, due to a combination of poor nutrition literacy and the belief that 'more food means more energy, for better performance'. Thus, it is suggested that future behaviour change research incorporates a variable to measure and control for individuals' beliefs on the relationship between caloric intake and exercise. Likewise, it may be beneficial for health researchers to use findings like these to educate those who identify with this belief with the aim to reduce overconsumption.

Strengths, Limitations, and Future Directions

Although brief dietary interventions prove many advantages (Whatnall et al., 2018), the current study provides contrasting evidence towards their effectiveness. Such evidence provides future research the opportunity to expand on whether this truly is the case, by investigating whether a longer intervention time would be more beneficial. Likewise, it may help to confirm whether the brief dietary intervention delivered in this study using an integrative methodological design, is simply not effective in dietary behaviour change. This is considered a strength as it can help to rule out the designs that do not work, guiding research elsewhere. Likewise, the study contributes to the minimal research (n = 2) incorporating an overall diet quality measure in combination with 24HR (Whatnall et al., 2018).

It is important to consider the limitations of the current research. As a result of a smaller than expected sample size, the results of this study concerning true determinants are suggestive. As such, replication of a similar study design with a larger sample size and counterbalancing the follow-up components (i.e., nutritional awareness and diet quality) is recommended. Additionally, a longer intervention trial may aid in better understanding whether there are any effects from this type of intervention. Although dietary patterns tend to remain stable over time, (i.e., habits are repetitive, particularly with increased habit strength; Evans et al., 2017; Hall & Fong, 2007), measuring the habit variable at multiple time-points may have added confirmation as to whether this was true for the study's sample, and reaffirmed the validity of our speculations regarding the automatic behaviour results. Alongside the measures, the Nutrition Awareness Scale is deemed old (i.e., 2007), which may have impacted its reliability. Further, the sample was not specific to individuals wanting to change their behaviour or invest their time, nor this information captured via measurement; an important factor amongst behaviour change that should, in the future, be considered (Prochaska & Norcross, 2002). Likewise, our sample was predominantly female and did not

account for factors that may impact BMI (e.g., pregnancy, eating disorders etc), therefore limiting the generalisability of findings.

Additionally, there is no way to measure or control for participants who actively attended to their dietary habits in anticipation of their free recall for diet quality at time-point two; nor, those influenced by the mere-measurement effect (Keatley et al., 2014). As participants were aware they would be asked about diet quality three days after 24HR, we cannot be certain whether they used alternative methods of diet monitoring to aid their weekly diet quality recall. This may have impacted the reliability of the results of the diet quality scores at time-point two, however, it also may explain the non-significant results found for habit. Likewise, attention can impact the accuracy of free recall (Anderson et al., 1998) which is also closely related to automatic behaviours (Larsen & Hollands, 2022; Parent et al., 2022). As such, this might be a plausible explanation for the higher variance accounted for by automatic habits in time-point one, where preparation for their diet quality measure was not anticipatory.

It is also important to keep in mind that during the research, the cost of living in Australia dramatically increased, following COVID-19; with food cost (and low social-economic-status) being a key predictor of poorer diet quality in Australia (Backholer et al., 2016; Grech et al., 2017) and internationally (Rao et al., 2013). This is influential to the interpretation of the results, as individuals who are dissatisfied with their finances, have an increased preference for high-calorie items for its energy value (Briers & Laporte, 2013). Future research investigating dietary behaviour change may benefit from including questions related to financial satisfaction or incorporating a mixed methods approach to allow for more enriched explanatory data following the intervention.

Conclusion

Since there are many factors influencing the accuracy of dietary measurements (Aaby & Siddique, 2021; Murakami & Livingstone, 2015; Whitton et al., 2022), it becomes difficult to determine whether a brief dietary intervention is effective. In addition, the accuracy of data in self-report measures can hinder researchers from designing and implementing effective interventions to reduce behavioural risk factors. The current study investigated whether the secondary findings in Mackenzie et al. (2022; Chapter 2) could be replicated, to see if think-aloud and 24HR could be used as a positive behaviour change technique. Specifically, the aim of the current research was to explore whether participants' nutritional awareness and secondarily diet quality, would improve following a 24HR. Furthermore, we aimed to examine whether habitual behaviour would be an influential factor on these variables across both time-points. Results from the current study found that participants' automatic habits were an influential factor in their nutritional awareness at both time-points, and for diet quality at time-point one only. Although there were significant differences in the consumption of some items, the think-aloud protocol in combination with dietary monitoring (24HR) was not successful for improving nutritional awareness, nor diet quality.

Chapter 4: General Discussion

Overview

The current thesis explores the types of self-report error that can occur during 24HR and whether the reflective component in completing a 24HR influences future dietary behaviours. A unique aspect of the thesis was the use of the think-aloud protocol to better understand 24HR experiences, and its potential benefits in dietary research. Additionally, Chapters 2 and 3 provided insight into the influence of habitual behaviours on dietary recall and nutritional awareness.

The accuracy of nutritional epidemiology is obstructed by the numerous factors that influence self-reported dietary data (Aaby & Siddique, 2021; Murakami & Livingstone, 2015; Polivy et al., 2014; Short et al., 2009). The study detailed in Chapter 2, revealed that the think-aloud protocol helped to uniquely uncover some of these factors, through the verbalisation of perceived problems during dietary recall. The think-aloud data also aided in the creation of a perceived problems checklist and in the quantification of perceived remembering, as well as program (i.e., INTAKE24© and ASA24®) and emotion problems encountered during 24HR. Alongside systems usability, automatic food habits were predictive of perceived problems during dietary recall for the 24HR program INTAKE24©. Second, the experience of dietary recall was perceived to be reflective and introspective during think-aloud, prompting the idea that verbalisation during 24HR may be beneficial to changing dietary behaviours. However, the findings in Chapter 3 suggested that the think-aloud and the 24HR experience, did not alter nutritional outcomes, most likely due to the automaticity of dietary habits, and brief intervention length. Overall, the findings in Chapter 3 did not reinforce those perceived in Chapter 2. Nevertheless, the overall aim to better understand the types of errors that can occur during dietary recall was achieved, as well as knowing that

reflective dietary recall is not likely to influence future nutritional behaviour. A discussion of the overall findings along with their implications for population health and behavioural interventions, follows.

Dietary Self-Report

Self-report error is difficult to control for, particularly when measuring dietary and automatic behaviours (Gardner & Tang, 2014). Dietary behaviours are often automatic due to the influence of environmental and internal cues (Gardner, 2015; McAlpine & Mullan, 2022; Prinsen et al., 2013), which makes planning for, and assessing intervention effectiveness difficult to accommodate. Individuals have been guided towards a healthier diet through a variety of interventions over the years (Ashton et al., 2019; von Philipsborn et al., 2019; Whatnall et al., 2018). However, global nutritional outcomes have stagnated, if not, decreased, which continues to have significant ramifications on health care demands and costs (Foreman et al., 2018). The reason for this, or at least in part, may be that potential barriers to behaviour change are overlooked and/or self-report error is not taken into consideration when assessing intervention effectiveness (Aaby & Siddique, 2021). This is not to say brief dietary interventions do not work or cannot be maintained, as there are many examples where they have succeeded (Al-Awadhi et al., 2021; Pollard et al., 2008). More so, there have been no significant changes in rates of non-communicable diseases (Foreman et al., 2018; World Health Organization, 2022). Additionally, it is difficult to determine whether any changes in behaviour is attributable to the effects of interventions or to self-reported errors in the data provided (Subar et al., 2015; Whatnall et al., 2018). Given this, and in combination with the findings of the thesis, we believe that incorporating the think-aloud protocol alongside other methods of dietary measurement may help researchers further understand why global

nutritional outcomes have stagnated and provide evidenced-based approaches for reducing the incidence of non-communicable diseases.

Methodological Integration and Implications

The Versatility of Think-Aloud

The think-aloud protocol has previously focused on the usability of computer programs, by using concurrent communicative feedback for updating their design (Fan et al., 2019). However, usability specialists with backgrounds in health-behaviour research can adapt the use of the think-aloud protocol to better fit their study aims, since their approaches focus on different aspects of user experience (Güss, 2018; Joe et al., 2015). For example, the study design in Chapter 2 (i.e., combining think-aloud with two separate 24HR programs using the same sample) allowed for the exploration of participants' dietary recall experience. Specifically, it provided insight into the factors that may influence dietary self-report error, by understanding the problems encountered during 24HR (Mackenzie et al., 2022). The checklist that was created in Chapter 2 by Mackenzie et al. (2022), was specific to the sample and research question, which may limit its generalisability to other populations. Nonetheless, we believe this reinforces the applicability of the think-aloud methodology, as it can allow for subjective expression of the topic of interest that is most representative of the studied sample.

It was shown in Chapter 3 that the think-aloud protocol can be used in an alternative way to previous research, by investigating whether the methodology's introspective component was influential to dietary behaviours. Although no significant changes in behaviour were discovered (that were attributable to think-aloud), the study used the methodology in a different way which reinforced its versatility in different study designs and alongside behavioural measures. Further, previous work has used the protocol successfully to test program usability (Alhadreti, 2021), understand problem solving techniques in students

(Kolomitro & MacKenzie, 2019), investigate cognitive and emotional reactivity (Fox et al., 2011; Güss, 2018), and create or update quantitative measures (Darker & French, 2009; Mackenzie et al., 2022). Therefore, we support the incorporation of the think-aloud protocol, given its benefits for interpreting results, and its can easily application to various study designs.

Think-Aloud and Measurement Reliability

Since ASA24® and INTAKE24© have previously been used in nutritional interventions, incorporating the think-aloud protocol alongside these programs may be useful for providing feedback and recommendations to improve the programs and thus their reliability. For instance, the think-aloud data were able to provide insight into the types of problems participants may experience during 24HR (i.e., remembering, program, and emotional problems) as well as their frequency. Such findings provide a starting point for solving these problems, and subsequently increasing the reliability of the data collected. For example, the frequency of problems that participants experienced in ASA24® were greater than those in INTAKE24©, which may be attributable to the program's design (e.g., different modes of instruction). Findings such as these may be considered in future research to provide justification for the use of one program over another. Alternatively, as suggested in Chapter 2, ASA24® may benefit from a design like INTAKE24©, particularly given that the program was found to raise fewer remembering problems. Thus, the think-aloud protocol aided in the discovery of these problems, which highlights a gap in the literature to inform the creation of countermeasures.

Furthermore, despite the think-aloud protocol's limited research in nutrition interventions and measurement validation, think-aloud could potentially be used to improve, or measure the accuracy of self-reported dietary consumption. For example, Cooke (2010)

examined the usability of a webpage and found that the data provided by think-aloud was accurate 80% of the time. Likewise, this has previously been shown when assessing the validity of behavioural questionnaires by exploring participants' perceived understanding of the questions and their subsequent answers (Darker & French, 2009). Not only did these findings help to change the way the question was phrased in updated versions (i.e., to yield a more accurate answer), it provided an opportunity for other important features within the phenomenon to be discovered. This was demonstrated in Chapter 2 (e.g., the types of problems found), which then prompted the topic of exploration within Chapter 3 (e.g., perceived introspective reflection during 24HR). Specific to dietary research, having participants speak aloud whilst inputting their consumption may be advantageous for nutritional researchers to understand more accurately what was consumed as well as portion sizes, by comparing think-aloud responses with their non-verbalised data. Therefore, we recommend integrating the think-aloud protocol into health behaviour research, particularly for investigating participant self-report error and enhancing measurement reliability.

Think-Aloud and Behavioural Interventions

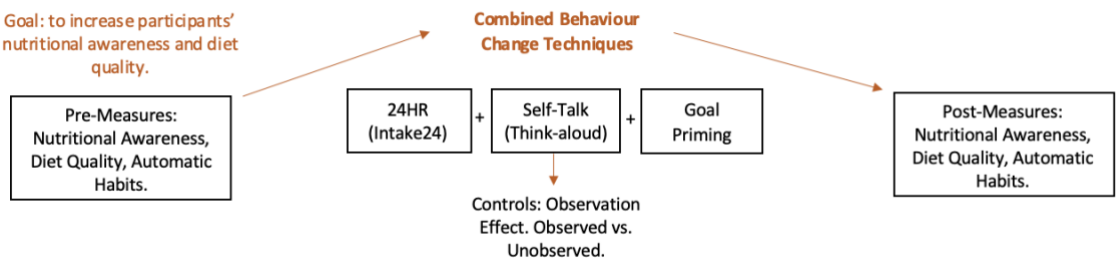
Research has shown that combining multiple behaviour change techniques (BCTs) leads to more effective behaviour change results (van Genugten et al., 2016). However, it is unknown as to which combination is most effective, or for which population. For example, Black et al. (2016) and Stok et al. (2012) found that normative information provided to participants (i.e., alcohol and fruit consumption, respectively) was effective in promoting positive behaviour change. However, according to van Genugten et al. (2016) meta-analyses, providing normative information for online interventions promoting health behaviours was not recommended. Furthermore, self-monitoring alongside other BCTs results in better behavioural outcomes for exercise and diet, compared to interventions without self-

monitoring (Michie et al., 2009). Although, since the design of Michie et al.'s (2009) and van Genugten et al. (2016) papers were not experimental, inferences cannot be made.

As such, the selection of appropriate BCTs can be difficulty. Thus, it is necessary for experimental research to investigate the effectiveness of single BCTs, as well as combinations of BCTs (i.e., explored in Chapter 3) to inform future research regarding their effectiveness. For example, Schroé et al. (2020) investigated the efficacy of three different BCTs, as well as their combinations, for increasing physical activity and decreasing sedentary behaviour. It was found that combining more than one technique was more effective for reducing sedentary behaviour and increasing physical activity (Schroé et al., 2020). Given these findings, researchers can rule out ineffective techniques (i.e., see Chapter 3), as well as try to replicate them in another population, or combine them with other techniques (Lucassen et al., 2021).

Furthermore, given previous research has found nutritional awareness and diet quality to have strong positive correlations (Alkerwi et al., 2015; Vaudin et al., 2021), there are potential benefits for future research to discover ways to increase one and consequently the other, to have a positive behavioural effect. However, it is suggested these two variables be measured together for a better representation of their relationship, as noted in Chapter 3. Using the results of Chapter 3, and their potential explanations, the self-monitoring technique may benefit the incorporation of more explicit goal priming (i.e., 24HR, Think-Aloud and Goal Priming; See Figure 1) to improve the behavioural outcomes. Likewise, given the likely influence of the observation effect (See section: Weaknesses and Future Research), it may be beneficial to incorporate control groups; with participants separated into observed and non-observed think-aloud groups.

Figure 1. *Proposed Future Combined Behaviour Change Technique Research Design*



Nevertheless, as we consider the thesis findings and previous literature, we believe that interventions would be more effective if they were customized to an individual's needs, goals, and automatic dietary cues. Fundamentally, using mobile programs or technologies have been deemed important as they can be tailored to the individual (Lucassen et al., 2021). However, despite the high number of programs available, only a small number have been validated to assess food intake, which is key to ensuring the reliability of the data collected (i.e., self-report error). As such, it is pragmatic to investigate the reliability of these programs first, before investigating which combinations of behaviour change techniques are effective. As shown in Chapter 2, this can be made apparent via the think-aloud protocol, which was useful for identifying components for program improvement. Likewise, data collected during behavioural interventions may benefit alongside think-aloud protocols to more accurately identify whether changes in behaviour are due to intervention effects or are better explained by the errors that occur in self-report.

Strengths And Practical Implications

While the benefits of exploratory-sequential and qualitative research are well established, concurrent think-aloud differs, as it emphasises cognitive experiences during a task, rather than after (Alhadreti, 2021; Ericsson & Simon, 1980). Such information is important to note as retrospective think-aloud can be reactive, consequently providing data that differs from what would be expected if described concurrently (i.e., influenced by bias; Fox et al., 2011). Additionally, the important components of language that occur naturally (i.e., speech features such as pitch, tone, or emotive language) are not considered. These components of language are important for perceiving problems like high cognitive load or emotional expressions (Chen et al., 2012) that may occur during measurement that can consequently impact the accuracy of results. As such, combining the think-aloud protocol

(i.e., concurrently) with 24HR was a strength of the thesis, as it aided in quantifying perceived problems during dietary recall (see Chapter 2) and prompted exploration into the potential benefits of thinking aloud during 24HR (see Chapter 3). Additionally, having a 'silent' control group in Chapter 3 was an important component of the study design, which should be emphasised in future studies to help determine the effectiveness of their interventions. The results of this thesis highlight the importance of integrating the think-aloud protocol in health behaviour research to provide alternative explanations for, and enhance the interpretation of, the quantitative results.

It is highly recommended in health research to incorporate habitual behaviour as a control variable, as habits (and their cues) have consistently shown to be significant predictors of poor health behaviours (Black et al., 2017; Liddelow et al., 2021; Orbell & Verplanken, 2010). The influence of automatic habits on dietary behaviour was also evident in the chapters of this thesis, helping to explain potential barriers to behaviour change (see Chapter 3) and locating where they may be more influential (i.e., the differing results between ASA24 and INTAKE24; see Chapter 2). Additionally, future work may benefit by combining habit measures alongside the think-aloud protocol as previously explored by Gardner and Tang (2014) who identified individual cues to poor behaviour, which perhaps could be addressed via individualised behaviour change approaches. Furthermore, addressing the influence that dietary habits have on self-reported behaviours can be useful for providing data that better represents population consumption (Aaby & Siddique, 2021; Gardner, 2015). To elaborate, the automaticity of dietary habits can influence accurate recall, skewing the data that inform nutritionists (Fürtjes et al., 2020). As such, by understanding how automaticity may affect dietary self-report accuracy, researchers will have the opportunity to reduce or eliminate its impact in the future. As a practical example, the incorporation of self-awareness and mindful eating strategies during interventions that incorporate 24HR may perhaps aid in more accurate

dietary recall (Higgs & Donohoe, 2011). Investigating these influences can be better understood in combination with the think-aloud protocol, which is also considered a practical implication itself. Not only is the think-aloud protocol easy to administer, cost-effective, and reduces researcher burden, it can deepen the understanding of quantitative data that currently dominates the literature. Additionally, the qualitative data collected via think-aloud during behavioural interventions does not require extensive effort from the participant and can reduce the burden of researchers looking to create quantitative measures (as displayed in Chapter 2).

Furthermore, measurement error interferes with analyses that determine if an intervention is effective, limiting the ability of researchers to design and implement effective interventions to reduce behavioural risk factors (Aaby & Siddique, 2021). The current thesis provides the opportunity for future research to better control for these errors (or at least bring them to light), via the think-aloud protocol. Likewise, it provides useful findings for the improvement of computer-based 24HR (specifically, the ASA24® and INTAKE24©) and their designs, as well as their accuracy. Implications of such findings can aid nutritionists in providing accurate health recommendations to the public, provide knowledge to program designers for improving the accuracy of 24HR programs, as well as aid health-behaviour interventionists in understanding the influential factors of behaviour change. Subsequently, we hope these findings can contribute to the understanding of the relationship between diet and disease (Thompson et al., 2015).

Weaknesses And Future Research

Notably, the think-aloud data in Chapter 2 was perceived by the researchers as having a reflective, introspective component which was proposed to influence participants' future behaviours. The results of Chapter 3, however, do not reinforce this. Perhaps what was

perceived during think-aloud was incorrect, as participants were negotiating with their 'ideal-self' and not necessarily their 'true-self. This aligns with the *observation effect*, by which participants' behaviour may change due to being aware of observation (Monahan & Fisher, 2010); previously noted as being influential (Lemacks et al., 2019). As such, the observation effect cannot be ruled out, considering that communication is a means of negotiating commitments, by which there is less pressure to do so when purely introspective than in a social context (Geurts, 2018). However, a study of greater power may be able to establish this finding more accurately. Nevertheless, these potential explanations highlight that measuring cognitive constructs that underpin behaviour is difficult, as they can be biased by researcher interpretations. Future re-analyses of think-aloud data that is guided by specific research objectives would be able to confirm whether this was the case. Even so, Cooke's (2010) use of eye tracking to measure cognitive constructs also emphasises the importance of methodological integration within psychological research to reduce bias. It may be advantageous for future research to reaffirm the accuracy of think-aloud data during 24HR via replication of a similar, yet stronger, study design (e.g., larger sample/power, longitudinal). Additionally, it must be mentioned that active speech can influence cognitive performance, especially when the task is score-based (e.g., timed tasks; Fox et al., 2011). As such, our recommendations for a multimodal approach using think-aloud remains useful for descriptive purposes rather than to assess performance.

It is recommended that future research in behaviour change consider a larger sample size particularly when self-reported measures are incorporated (Lucassen et al., 2021). In combination with a larger sample size, we also recommend that studies investigating behaviour change, incorporate an internal validation technique and/or methods to correct for any differential measurement errors (e.g., think-aloud). As such, future analyses may benefit comparing the two data types to understand whether there are other influences of accuracy at

play (e.g., what users say aloud may be different to what they input). Similarly (and specific to the current thesis), comparing the data may aid in confirming whether the reflective introspection found in Chapter 2 was also present in Chapter 3. In these instances, follow-up or member-checking would prove beneficial in future studies following a similar design to increase the reliability of what is perceived in the think-aloud data.

Perhaps there is also opportunity for the revaluation (and update) of the nutritional awareness scale (van Dillen et al., 2007), merely due to its age considering the everchanging social contexts that surround dietary behaviours (Prinsen et al., 2013; von Philipsborn et al., 2019). Additionally, there may be potential for a newly developed nutrition awareness scale. As an example, the current body positivity trend is an influential aspect this thesis did not account for (Cohen et al., 2019; Legault & Sago, 2022). Socially, overeating is becoming more acceptable, and people are thus becoming less concerned by the health risks of obesity and being overweight (Vandenbosch et al., 2022). This is not to speak on the visual aspects campaigning for body positivity, but more so on the impact that the social movement may have on population dietary consumption which informs epidemiology. Other social factors which are perhaps influential are the ease by which food cravings are satisfied (e.g., Uber Eats), and advertised to individuals (e.g., social media via companies, paid partnerships, and fear of missing out). Therefore, when measuring nutritional awareness, we believe future research should consider social-environmental influences given its relationship with poor dietary behaviours (Burke & Carman, 2017; Prinsen et al., 2013).

In addition, a systematic review examined the effectiveness of nutrition interventions for adults, suggesting that brief interventions can improve short-term dietary behaviours, but there is little evidence for longer term behaviour change maintenance (Whatnall et al., 2018). However, the 24HR methods involved in these interventions are limited because intake data is only provided for a short period of time. So, to investigate the link between disease and diet,

long-term dietary data is necessary (Shim et al., 2014). For example, repeated dietary measurements over multiple timeframes may be required to assess both the benefits and risks of future brief nutritional interventions, more accurately. As suggested by French et al. (2021), collecting two or more consistent days of 24HR data is encouraged when sensitivity analyses (i.e., think-aloud) are not combined with single-day 24HR. As such, we believe promoting longitudinal think-aloud studies may be beneficial in understanding true change in behaviour. This is because psychosocial aspects of diet are influenced by the environment, which is ever-changing. Therefore, analysing change over time, whilst using the think-aloud protocol, may promote understanding of the influences of automatic cues on poor dietary behaviour.

Conclusions

To ensure reliable dietary intake data, dietary assessment programs must be validated. However, due to their self-report nature, even validated programs may contain various errors, such as inaccurate portion sizes, inaccurate food identification, and incomplete data (Freedman et al., 2017; Mackenzie et al., 2022). As a result of this thesis, we have reached an understanding of how verbalisation can reveal different aspects of thinking when recalling and assessing dietary behaviours, and its importance within psychological and nutritional research. The results found no significant influence of think-aloud or 24HR on future dietary behaviours, however, the methodological integration of these measures proved beneficial in providing insight to the experience of dietary self-report. Aside from improving nutritional guidelines' accuracy, this thesis explored the understudied aspects of behavioural research that may have not been uncovered without think-aloud.

References

Aaby, D., & Siddique, J. (2021). Effects of differential measurement error in self-reported diet in longitudinal lifestyle intervention studies. *International Journal of Behavioral Nutrition and Physical Activity*, *18*(1), 125. https://doi.org/10.1186/s12966-021-01184-x

Abbafati, C., Abdollahi, M., Abedi, P., Abreu, L. G., Alanezi, F. M., Alizade, H., Amini, S., Ancuceanu, R., Ansari, F., Appiah, S. C. Y., Ayala Quintanilla, B. P., Azari, S., Barker-Collo, S. L., Basaleem, H., Basu, S., Baune, B. T., Bayati, M., Bedi, N., Beghi, E., … Lim, S. S. (2020). Five insights from the Global Burden of Disease Study 2019. *Lancet*, *396*(10258), 1135–1159. https://doi.org/10.1016/S0140-6736(20)31404-5

Acharya, S. D., Elci, O. U., Sereika, S. M., Styn, M. A., & Burke, L. E. (2011). Using a Personal Digital Assistant for Self-Monitoring Influences Diet Quality in Comparison to a Standard Paper Record among Overweight/Obese Adults. *Journal of the American Dietetic Association*, *111*(4), 583–588. https://doi.org/10.1016/j.jada.2011.01.009

Afshin, A., Forouzanfar, M. H., Reitsma, M. B., Sur, P., Estep, K., Lee, A., Marczak, L., Mokdad, A. H., Moradi-Lakeh, M., Naghavi, M., Salama, J. S., Vos, T., Abate, K. H., Abbafati, C., Ahmed, M. B., Al-Aly, Z., Alkerwi, A., Al-Raddadi, R., Amare, A. T., … Murray, C. J. L. (2017). Health Effects of Overweight and Obesity in 195 Countries over 25 Years. *The New England Journal of Medicine*, *377*(1), 13–27. https://doi.org/10.1056/NEJMoa1614362

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*(2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Al-Awadhi, B., Fallaize, R., Zenun Franco, R., Hwang, F., & Lovegrove, J. A. (2021). Insights Into the Delivery of Personalized Nutrition: Evidence From Face-To-Face and Web-Based Dietary Interventions. *Frontiers in Nutrition*, *7*. https://doi.org/10.3389/fnut.2020.570531

Aldao, A., Nolen-Hoeksema, S., & Schweizer, S. (2010). Emotion-regulation strategies across psychopathology: A meta-analytic review. *Clinical Psychology Review*, *30*(2), 217–237. https://doi.org/10.1016/j.cpr.2009.11.004

Alhadreti, O. (2021). Comparing Two Methods of Usability Testing in Saudi Arabia: Concurrent Think-Aloud vs. Co-Discovery. *International Journal of Human–Computer Interaction*, *37*(2), 118–130. https://doi.org/10.1080/10447318.2020.1809152

Alkerwi, A., Sauvageot, N., Malan, L., Shivappa, N., & Hébert, J. (2015). Association between Nutritional Awareness and Diet Quality: Evidence from the Observation of

Cardiovascular Risk Factors in Luxembourg (ORISCAV-LUX) Study. *Nutrients*, *7*(4), 2823–2838. https://doi.org/10.3390/nu7042823

Anderson, N. D., Craik, F. I. M., & Naveh-Benjamin, M. (1998). The attentional demands of encoding and retrieval in younger and older adults: 1. Evidence from divided attention costs. *Psychology and Aging*, *13*(3). https://doi.org/10.1037/0882-7974.13.3.405

Araújo-Soares, V., Hankonen, N., Presseau, J., Rodrigues, A., & Sniehotta, F. F. (2019). Developing Behavior Change Interventions for Self-Management in Chronic Illness. *European Psychologist*, *24*(1), 7–25. https://doi.org/10.1027/1016-9040/a000330

Ashton, Sharkey, Whatnall, Williams, Bezzina, Aguiar, Collins, & Hutchesson. (2019). Effectiveness of Interventions and Behaviour Change Techniques for Improving Dietary Intake in Young Adults: A Systematic Review and Meta-Analysis of RCTs. *Nutrients*, *11*(4), 825. https://doi.org/10.3390/nu11040825

Australian Bureau of Statistics. (2014). *Australian Health Survey Users' Guide, 2011-13: Discretionary Foods (No. 4363.0.55.001)*. https://www.abs.gov.au/ausstats/abs@.nsf/lookup/4363.0.55.001chapter65062011-13#

Backholer, K., Spencer, E., Gearon, E., Magliano, D. J., McNaughton, S. A., Shaw, J. E., & Peeters, A. (2016). The association between socio-economic position and diet quality in Australian adults. *Public Health Nutrition*, *19*(3), 477–485. https://doi.org/10.1017/S1368980015001470

Bailey, R. L. (2021). Overview of dietary assessment methods for measuring intakes of foods, beverages, and dietary supplements in research studies. *Current Opinion in Biotechnology*, *70*, 91–96. https://doi.org/https://doi.org/10.1016/j.copbio.2021.02.007

Bangor, A., Kortum, P. T., & Miller, J. T. (2008). An Empirical Evaluation of the System Usability Scale. *International Journal of Human–Computer Interaction*, *24*(6), 574–594. https://doi.org/10.1080/10447310802205776

Billore, S., Anisimova, T., & Vrontis, D. (2023). Self-regulation and goal-directed behavior: A systematic literature review, public policy recommendations, and research agenda. *Journal of Business Research*, *156*, 113435. https://doi.org/10.1016/j.jbusres.2022.113435

Black, N., Mullan, B., & Sharpe, L. (2016). Computer-delivered interventions for reducing alcohol consumption: meta-analysis and meta-regression using behaviour change techniques and theory. *Health Psychology Review*, *10*(3), 341–357. https://doi.org/10.1080/17437199.2016.1168268

Black, N., Mullan, B., & Sharpe, L. (2017). Predicting heavy episodic drinking using an extended temporal self-regulation theory. *Addictive Behaviors*, *73*, 111–118. https://doi.org/10.1016/j.addbeh.2017.04.017

Booker, L., & Mullan, B. (2013). Using the temporal self-regulation theory to examine the influence of environmental cues on maintaining a healthy lifestyle. *British Journal of Health Psychology*, *18*(4), 745–762. https://doi.org/10.1111/bjhp.12015

Bowen, S., Witkiewitz, K., Clifasefi, S. L., Grow, J., Chawla, N., Hsu, S. H., Carroll, H. A., Harrop, E., Collins, S. E., Lustyk, M. K., & Larimer, M. E. (2014). Relative Efficacy of Mindfulness-Based Relapse Prevention, Standard Relapse Prevention, and Treatment as Usual for Substance Use Disorders: A Randomized Clinical Trial. *JAMA Psychiatry*, *71*(5), 547–556. https://doi.org/10.1001/jamapsychiatry.2013.4546

Bradley, J., Simpson, E., Poliakov, I., Matthews, J. N. S., Olivier, P., Adamson, A. J., & Foster, E. (2016). Comparison of INTAKE24 (an Online 24-h Dietary Recall Tool) with Interviewer-Led 24-h Recall in 11-24 Year-Old. *Nutrients*, *8*(6), 358. https://doi.org/10.3390/nu8060358

Brewer, J. A., Elwafi, H. M., & Davis, J. H. (2014). Craving to Quit: Psychological Models and Neurobiological Mechanisms of Mindfulness Training as Treatment for Addictions. *Psychol Addict Behav*, *1*(S), 70–90. https://doi.org/10.1037/2332-2136.1.S.70

Brewer, J. A., Mallik, S., Babuscio, T. A., Nich, C., Johnson, H. E., Deleone, C. M., Minnix-Cotton, C. A., Byrne, S. A., Kober, H., Weinstein, A. J., Carroll, K. M., & Rounsaville, B. J. (2011). Mindfulness training for smoking cessation: Results from a randomized controlled trial. *Drug and Alcohol Dependence*, *119*(1), 72–80. https://doi.org/https://doi.org/10.1016/j.drugalcdep.2011.05.027

Briers, B., & Laporte, S. (2013). A Wallet Full of Calories: The Effect of Financial Dissatisfaction on the Desire for Food Energy. *Journal of Marketing Research*, *50*(6), 767–781. https://doi.org/10.1509/jmr.10.0513

Burke, M. A., & Carman, K. G. (2017). You can be too thin (but not too tall): Social desirability bias in self-reports of weight and height. *Economics and Human Biology*, *27*. https://doi.org/10.1016/j.ehb.2017.06.002

Camos, V., & Portrat, S. (2015). The impact of cognitive load on delayed recall. *Psychonomic Bulletin and Review*, *22*(4). https://doi.org/10.3758/s13423-014-0772-5

Carey, T. A., & Stiles, W. B. (2016). Some Problems with Randomized Controlled Trials and Some Viable Alternatives. *Clinical Psychology & Psychotherapy*, *23*(1), 87–95. https://doi.org/10.1002/cpp.1942

Celis-Morales, C., Abraham, S., Keenan, P., Ashor, A. W., Livingstone, K. M., Lara, J., & Mathers, J. C. (2015). Effect of web-based tailored lifestyle interventions on fruit and vegetable consumption in adults: A systematic review and meta-analysis of randomised controlled trials. *Proceedings of the Nutrition Society*, *74*(OCE1), E41. https://doi.org/10.1017/S0029665115000567

Chella, A., Pipitone, A., Morin, A., & Racy, F. (2020). Developing Self-Awareness in Robots via Inner Speech . In *Frontiers in Robotics and AI* (Vol. 7). https://www.frontiersin.org/article/10.3389/frobt.2020.00016

Chen, F., Ruiz, N., Choi, E., Epps, J., Khawaja, M. A., Taib, R., Yin, B., & Wang, Y. (2012). Multimodal behavior and interaction as indicators of cognitive load. *ACM Transactions on Interactive Intelligent Systems*, *2*(4), 1–36. https://doi.org/10.1145/2395123.2395127

Chen, Y., Perez-Cueto, F. J. A., Giboreau, A., Mavridis, I., & Hartwell, H. (2020). The Promotion of Eating Behaviour Change through Digital Interventions. *International Journal of Environmental Research and Public Health*, *17*(20), 7488. https://doi.org/10.3390/ijerph17207488

Chengsong, Y., Zhang, L. J., & Parr, J. M. (2020). The reactivity of think-alouds in writing research: quantitative and qualitative evidence from writing in English as a foreign language. *Reading and Writing*, *33*(2), 451–483. https://doi.org/http://dx.doi.org/10.1007/s11145-019-09970-7

Chernev, A., & David, G. A. L. (2010). Categorization Effects in Value Judgments: Averaging Bias in Evaluating Combinations of Vices and Virtues. *Journal of Marketing Research*, *47*(4), 738–747. https://doi.org/10.1509/jmkr.47.4.738

Cleghorn, C. L., Harrison, R. A., Ransley, J. K., Wilkinson, S., Thomas, J., & Cade, J. E. (2016). Can a dietary quality score derived from a short-form FFQ assess dietary quality in UK adult population surveys? *Public Health Nutrition*, *19*(16), 2915–2923. https://doi.org/DOI: 10.1017/S1368980016001099

Clementi, C., Casu, G., & Gremigni, P. (2017). An Abbreviated Version of the Mindful Eating Questionnaire. *Journal of Nutrition Education and Behavior*, *49*(4), 352-356.e1. https://doi.org/https://doi.org/10.1016/j.jneb.2017.01.016

Cleobury, L., & Tapper, K. (2014). Reasons for eating 'unhealthy' snacks in overweight and obese males and females. *Journal of Human Nutrition and Dietetics*, *27*(4), 333–341. https://doi.org/10.1111/jhn.12169

Cohen, D. A., & Babey, S. H. (2012). Contextual influences on eating behaviours: heuristic processing and dietary choices. *Obesity Reviews*, *13*(9), 766–779. https://doi.org/10.1111/j.1467-789X.2012.01001.x

Cohen, J. (1988). Statistical power analysis for the behavioral sciences (2nd ed.). Hillsdale, NJ: Lawrence Earlbaum Associates. *Lawrence Earlbaum Associates*.

Cohen, R., Irwin, L., Newton-John, T., & Slater, A. (2019). #bodypositivity: A content analysis of body positive accounts on Instagram. *Body Image*, *29*, 47–57. https://doi.org/10.1016/j.bodyim.2019.02.007

Cokely, E. T., & Kelley, C. M. (2009). Cognitive Abilities and Superior Decision Making under Risk: A Protocol Analysis and Process Model Evaluation. *Judgment and Decision Making*, *4*(1), 20–33.

Colombo, D., Suso-Ribera, C., Fernández-Álvarez, J., Cipresso, P., Garcia-Palacios, A., Riva, G., & Botella, C. (2020). Affect Recall Bias: Being Resilient by Distorting Reality. *Cognitive Therapy and Research*, *44*(5), 906–918. https://doi.org/10.1007/s10608-020-10122-3

Conway, J. M., Ingwersen, L. A., Vinyard, B. T., & Moshfegh, A. J. (2003). Effectiveness of the US Department of Agriculture 5-step multiple-pass method in assessing food intake in obese and nonobese women. *The American Journal of Clinical Nutrition*, *77*(5), 1171–1178. https://doi.org/10.1093/ajcn/77.5.1171

Cooke, L. (2010). Assessing Concurrent Think-Aloud Protocol as a Usability Test Method: A Technical Communication Approach. *IEEE Transactions on Professional Communication*, *53*(3), 202–215. https://doi.org/10.1109/TPC.2010.2052859

Cornil, Y., Gomez, P., & Vasiljevic, D. (2020). Food as Fuel: Performance Goals Increase the Consumption of High-Calorie Foods at the Expense of Good Nutrition. *Journal of Consumer Research*, *47*(2), 147–166. https://doi.org/10.1093/jcr/ucaa012

Dalbo, V., Hiskens, M., Teramoto, M., Kingsley, M., Young, K., & Scanlan, A. (2017). Residents of Central Queensland, Australia Are Aware of Healthy Eating Practices but Consume Unhealthy Diets. *Sports*, *5*(4), 94. https://doi.org/10.3390/sports5040094

Darker, C. D., & French, D. P. (2009). What sense do people make of a theory of planned behaviour questionnaire?: A think-aloud study. *Journal of Health Psychology*, *14*(7). https://doi.org/10.1177/1359105309340983

de Keyzer, W., Bracke, T., McNaughton, S. A., Parnell, W., Moshfegh, A. J., Pereira, R. A., Lee, H.-S., Veer, P. v, de Henauw, S., & Huybrechts, I. (2015). Cross-Continental

Comparison of National Food Consumption Survey Methods—A Narrative Review. In *Nutrients* (Vol. 7, Issue 5). https://doi.org/10.3390/nu7053587

Deliens, T., Clarys, P., de Bourdeaudhuij, I., & Deforche, B. (2014). Determinants of eating behaviour in university students: A qualitative study using focus group discussions. *BMC Public Health*, *14*(1). https://doi.org/10.1186/1471-2458-14-53

Dickson, J., McLennan, J., & Omodei, M. M. (2000). Effects of Concurrent Verbalization on a Time-Critical, Dynamic Decision-Making Task. *The Journal of General Psychology*, *127*(2), 217–228. https://doi.org/10.1080/00221300009598580

Eccles, D. W., & Arsal, G. (2017). The think aloud method: what is it and how do I use it? *Qualitative Research in Sport, Exercise and Health*, *9*(4), 514–531. https://doi.org/10.1080/2159676X.2017.1331501

Elliott, A. C., & Woodward, W. A. (2007). *Statistical analysis quick reference guidebook with SPSS examples* . SAGE.

Elliston, K. G., Ferguson, S. G., & Schüz, B. (2017). Personal and situational predictors of everyday snacking: An application of temporal self-regulation theory. *British Journal of Health Psychology*, *22*(4), 854–871. https://doi.org/10.1111/bjhp.12259

Embling, R., Pink, A. E., Lee, M. D., Price, M., & Wilkinson, L. L. (2020). Consumer perception of food variety in the UK: an exploratory mixed-methods analysis. *BMC Public Health*, *20*(1), 1449. https://doi.org/10.1186/s12889-020-09548-x

Ericsson, K. A., & Simon, H. A. (1980). Verbal reports as data. *Psychological Review*, *87*(3), 215–251. https://doi.org/10.1037/0033-295X.87.3.215

Ericsson, K. A., & Simon, H. A. (1993). Protocol analysis: Verbal reports as data (rev. ed.). In *Protocol analysis Verbal reports as data rev ed*.

Ersche, K. D., Lim, T.-V., Ward, L. H. E., Robbins, T. W., & Stochl, J. (2017). Creature of Habit: A self-report measure of habitual routines and automatic tendencies in everyday life. *Personality and Individual Differences*, *116*, 73–85. https://doi.org/https://doi.org/10.1016/j.paid.2017.04.024

Evans PhD, M., Gregory PhD, A., Feder MD, G., Howarth PhD, E., Hegarty PhD, K., Evans PhD, M., Gregory PhD, A., Feder MD, G., Howarth PhD, E., Hegarty PhD, K., Evans, M., Gregory, A., Feder, G., Howarth, E., & Hegarty, K. V. O.-31. (2016). 'Even "Daily" is Not Enough': How Well Do We Measure Domestic Violence and Abuse?-A Think-Aloud Study of a Commonly Used Self-Report Scale. *Violence and Victims*, *31*(1), 3–26. https://doi.org/http://dx.doi.org/10.1891/0886-6708.VV-D-15-00024

Evans, R., Norman, P., & Webb, T. L. (2017). Using Temporal Self-Regulation Theory to understand healthy and unhealthy eating intentions and behaviour. *Appetite*, *116*, 357–364. https://doi.org/https://doi.org/10.1016/j.appet.2017.05.022

Fan, M., Lin, J., Chung, C., & Truong, K. N. (2019). Concurrent think-aloud verbalizations and usability problems. *ACM Transactions on Computer-Human Interaction*, *26*(5). https://doi.org/10.1145/3325281

Faul, F., Erdfelder, E., Buchner, A., & Lang, A.-G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods*, *41*(4), 1149–1160. https://doi.org/10.3758/BRM.41.4.1149

Food Standards Australia New Zealand. (2014). AUSNUT 2011-13. *Australian Food Composition Database*.

Foreman, K. J., Marquez, N., Dolgert, A., Fukutaki, K., Fullman, N., McGaughey, M., Pletcher, M. A., Smith, A. E., Tang, K., Yuan, C.-W., Brown, J. C., Friedman, J., He, J., Heuton, K. R., Holmberg, M., Patel, D. J., Reidy, P., Carter, A., Cercy, K., … Murray, C. J. L. (2018). Forecasting life expectancy, years of life lost, and all-cause and cause-specific mortality for 250 causes of death: reference and alternative scenarios for 2016–40 for 195 countries and territories. *The Lancet*, *392*(10159), 2052–2090. https://doi.org/10.1016/S0140-6736(18)31694-5

Fox, M. C., Ericsson, K. A., & Best, R. (2011). Do procedures for verbal reporting of thinking have to be reactive? A meta-analysis and recommendations for best reporting methods. *Psychological Bulletin*, *137*(2), 316–344. https://doi.org/10.1037/a0021663

Freedman, L. S., Commins, J. M., Willett, W., Tinker, L. F., Spiegelman, D., Rhodes, D., Potischman, N., Neuhouser, M. L., Moshfegh, A. J., Kipnis, V., Baer, D. J., Arab, L., Prentice, R. L., & Subar, A. F. (2017). Evaluation of the 24-Hour Recall as a Reference Instrument for Calibrating Other Self-Report Instruments in Nutritional Cohort Studies: Evidence From the Validation Studies Pooling Project. *American Journal of Epidemiology*, *186*(1), 73–82. https://doi.org/10.1093/aje/kwx039

French, C. D., Arsenault, J. E., Arnold, C. D., Haile, D., Luo, H., Dodd, K. W., Vosti, S. A., Slupsky, C. M., Engle-Stone, R., Engle-Stone, R., French, C. D., Arsenault, J. E., Arnold, C. D., Haile, D., Wiesmann, D., Martin-Prevel, Y., Brouwer, I. D., Daniels, M. C., Nyström, C. D., … Miller, J. (2021). Within-Person Variation in Nutrient Intakes across Populations and Settings: Implications for the Use of External Estimates in Modeling Usual Nutrient Intake Distributions. *Advances in Nutrition*, *12*(2), 429–451. https://doi.org/10.1093/advances/nmaa114

French, D. P., Cooke, R., Mclean, N., Williams, M., & Sutton, S. (2007). What Do People Think about When They Answer Theory of Planned Behaviour Questionnaires?: A `Think Aloud' Study. *Journal of Health Psychology*, *12*(4), 672–687. https://doi.org/10.1177/1359105307078174

Fürtjes, S., King, J. A., Goeke, C., Seidel, M., Goschke, T., Horstmann, A., & Ehrlich, S. (2020). Automatic and Controlled Processing: Implications for Eating Behavior. *Nutrients*, *12*(4), 1097. https://doi.org/10.3390/nu12041097

Gardner, B. (2015). A review and analysis of the use of 'habit' in understanding, predicting and influencing health-related behaviour. *Health Psychology Review*, *9*(3), 277–295. https://doi.org/10.1080/17437199.2013.876238

Gardner, B., & Tang, V. (2014). Reflecting on non-reflective action: An exploratory think-aloud study of self-report habit measures. *British Journal of Health Psychology*, *19*(2), 258–273. https://doi.org/https://doi.org/10.1111/bjhp.12060

Garrett, N. (2021). Segmentation's failure to improve software video tutorials. *British Journal of Educational Technology*, *52*(1). https://doi.org/10.1111/bjet.13000

Geurts, B. (2018). Making Sense of Self Talk. *Review of Philosophy and Psychology*, *9*(2), 271–285. https://doi.org/10.1007/s13164-017-0375-y

Ghasemi, A., & Zahediasl, S. (2012). Normality tests for statistical analysis: a guide for non-statisticians. *International Journal of Endocrinology and Metabolism*, *10*(2), 486–489. https://doi.org/10.5812/ijem.3505

Gillie, M., Dahli, R., Saunders, F. C., & Gibson, A. (2017). Use of rich-media resources by engineering undergraduates. *European Journal of Engineering Education*, *42*(6). https://doi.org/10.1080/03043797.2017.1306488

Godinho, C. A., Alvarez, M.-J., Lima, M. L., & Schwarzer, R. (2015). Health messages to promote fruit and vegetable consumption at different stages: A match-mismatch design. *Psychology & Health*, *30*(12), 1410–1432. https://doi.org/10.1080/08870446.2015.1054827

Gorber, S. C., Schofield-Hurwitz, S., Hardt, J., Levasseur, G., & Tremblay, M. (2009). The accuracy of self-reported smoking: A systematic review of the relationship between self-reported and cotinine-assessed smoking status. *Nicotine & Tobacco Research*, *11*(1), 12–24. https://doi.org/10.1093/ntr/ntn010

Grech, A., Sui, Z., Siu, H., Zheng, M., Allman-Farinelli, M., & Rangan, A. (2017). Socio-Demographic Determinants of Diet Quality in Australian Adults Using the Validated

Healthy Eating Index for Australian Adults (HEIFA-2013). *Healthcare*, *5*(1), 7. https://doi.org/10.3390/healthcare5010007

Güss, C. D. (2018). What is going through your mind? Thinking aloud as a method in cross-cultural psychology. *Frontiers in Psychology*, *9*(AUG). https://doi.org/10.3389/fpsyg.2018.01292

Hall, P. A., & Fong, G. T. (2007). Temporal self-regulation theory: A model for individual health behavior. *Health Psychology Review*, *1*(1), 6–52. https://doi.org/10.1080/17437190701492437

Hall, P. A., & Fong, G. T. (2015). Temporal self-regulation theory: a neurobiologically informed model for physical activity behavior. *Frontiers in Human Neuroscience*, *9*. https://doi.org/10.3389/fnhum.2015.00117

Health., A. G. D. of. (2021). No Title. In *Body mass index (BMI) and waist measurement.* https://www.health.gov.au/health-topics/overweight-and-obesity/bmi-and-waist

Herman, P. M., Chen, A. Y.-A., & Sturm, R. (2022). Improving Diet Quality in U.S. Adults: A 30-Year Health and Economic Impact Microsimulation. *American Journal of Preventive Medicine*. https://doi.org/https://doi.org/10.1016/j.amepre.2022.01.022

Hertzum, M., Hansen, K. D., & Andersen, H. H. K. (2009). Scrutinising usability evaluation: does thinking aloud affect behaviour and mental workload? *Behaviour & Information Technology*, *28*(2), 165–181. https://doi.org/10.1080/01449290701773842

Hertzum, M., & Holmegaard, K. D. (2013). Thinking Aloud in the Presence of Interruptions and Time Constraints. *International Journal of Human-Computer Interaction*, *29*(5), 351–364. https://doi.org/10.1080/10447318.2012.711705

Hidalgo, V., Pulopulos, M. M., Puig-Perez, S., Espin, L., Gomez-Amor, J., & Salvador, A. (2015). Acute stress affects free recall and recognition of pictures differently depending on age and sex. *Behavioural Brain Research*, *292*. https://doi.org/10.1016/j.bbr.2015.07.011

Higgs, S. (2015). Manipulations of attention during eating and their effects on later snack intake. *Appetite*, *92*, 287–294. https://doi.org/https://doi.org/10.1016/j.appet.2015.05.033

Higgs, S., & Donohoe, J. E. (2011). Focusing on food during lunch enhances lunch memory and decreases later snack intake. *Appetite*, *57*(1). https://doi.org/10.1016/j.appet.2011.04.016

Hintzman, D. L. (2010). How does repetition affect memory? Evidence from judgments of recency. *Memory and Cognition*, *38*(1). https://doi.org/10.3758/MC.38.1.102

Hofmann, W., Friese, M., & Wiers, R. W. (2008). Impulsive versus reflective influences on health behavior: a theoretical framework and empirical review. *Health Psychology Review*, *2*(2), 111–137. https://doi.org/10.1080/17437190802617668

Holmstrup, M. E., Stearns-Bruening, K., & Rozelle, J. (2013). Quantifying Accurate Calorie Estimation Using the "Think Aloud" Method. *Journal of Nutrition Education and Behavior*, *45*(1), 77–81. https://doi.org/10.1016/j.jneb.2012.04.007

Howell, D. C. (2013). *Statistical methods for psychology* (8th ed.). Cengage Learning.

Hurling, R., Fairley, B. W., & Dias, M. B. (2006). Internet-based exercise intervention systems: Are more interactive designs better? *Psychology & Health*, *21*(6), 757–772. https://doi.org/10.1080/14768320600603257

IBM Corp. (2021). *IBM SPSS statistics for windows* (No. 27). IBM Corp.

Iriti, M., Varoni, E. M., & Vitalini, S. (2020). Healthy Diets and Modifiable Risk Factors for Non-Communicable Diseases—The European Perspective. *Foods*, *9*(7), 940. https://doi.org/10.3390/foods9070940

Irwin, C., Desbrow, B., Khalesi, S., & McCartney, D. (2019). Challenges following a personalised diet adhering to dietary guidelines in a sample of Australian university students. *Nutrition and Health*, *25*(3), 185–194. https://doi.org/10.1177/0260106019841247

Janz, N. K., & Becker, M. H. (1984). The Health Belief Model: A Decade Later. *Health Education Quarterly*, *11*(1), 1–47. https://doi.org/10.1177/109019818401100101

Joe, J., Chaudhuri, S., Le, T., Thompson, H., & Demiris, G. (2015). The use of think-aloud and instant data analysis in evaluation research: Exemplar and lessons learned. *Journal of Biomedical Informatics*, *56*, 284–291. https://doi.org/10.1016/j.jbi.2015.06.001

Juechems, K., & Summerfield, C. (2019). Where Does Value Come From? *Trends Cogn Sci*, *23*(10), 836–850. https://doi.org/10.1016/j.tics.2019.07.012

Kabat-Zinn, J. (2015). Mindfulness. *Mindfulness*, *6*(6), 1481–1483. https://doi.org/10.1007/s12671-015-0456-x

Katterman, S. N., Kleinman, B. M., Hood, M. M., Nackers, L. M., & Corsica, J. A. (2014). Mindfulness meditation as an intervention for binge eating, emotional eating, and weight loss: A systematic review. *Eating Behaviors*, *15*(2), 197–204. https://doi.org/https://doi.org/10.1016/j.eatbeh.2014.01.005

Keatley, D. A., Clarke, D. D., Ferguson, E., & Hagger, M. S. (2014). Effects of pretesting implicit self-determined motivation on behavioral engagement: evidence for the mere

measurement effect at the implicit level. *Frontiers in Psychology*, *5*. https://doi.org/10.3389/fpsyg.2014.00125

Koehler, K., Beckford, S. E., Thayer, E., Martin, A. R., Boron, J. B., & Stevens, J. R. (2021). Exercise Shifts Hypothetical Food Choices toward Greater Amounts and More Immediate Consumption. *Nutrients*, *13*(2), 347. https://doi.org/10.3390/nu13020347

Kolomitro, K., & MacKenzie, L. (2019). Using Think-Alouds to Explore Problem-Solving Procedures for Anatomy Students. *The FASEB Journal*, *33*(S1). https://doi.org/10.1096/fasebj.2019.33.1_supplement.604.7

Kumanyika, S., Afshin, A., Arimond, M., Lawrence, M., McNaughton, S. A., & Nishida, C. (2020). Approaches to Defining Healthy Diets: A Background Paper for the International Expert Consultation on Sustainable Healthy Diets. *Food and Nutrition Bulletin*, *41*(2_suppl), 7S-30S. https://doi.org/10.1177/0379572120973111

Kupis, J., Johnson, S., Hallihan, G., & Olstad, D. L. (2019). Assessing the usability of the automated self-administered dietary assessment tool (Asa24) among low-income adults. *Nutrients*, *11*(1). https://doi.org/10.3390/nu11010132

Lally, P., & Gardner, B. (2013). Promoting habit formation. *Health Psychology Review*, *7*(sup1), S137–S158. https://doi.org/10.1080/17437199.2011.603640

Larsen, J. K., & Hollands, G. J. (2022). Targeting automatic processes to reduce unhealthy behaviours: a process framework. *Health Psychology Review*, *16*(2), 204–219. https://doi.org/10.1080/17437199.2021.1876572

Legault, L., & Sago, A. (2022). When body positivity falls flat: Divergent effects of body acceptance messages that support vs. undermine basic psychological needs. *Body Image*, *41*, 225–238. https://doi.org/10.1016/j.bodyim.2022.02.013

Lemacks, J. L., Adams, K., & Lovetere, A. (2019). Dietary intake reporting accuracy of the bridge2u mobile application food log compared to control meal and dietary recall methods. *Nutrients*, *11*(1), 199. https://doi.org/10.3390/nu11010199

Leung, S.-O. (2011). A Comparison of Psychometric Properties and Normality in 4-, 5-, 6-, and 11-Point Likert Scales. *Journal of Social Service Research*, *37*(4), 412–421. https://doi.org/10.1080/01488376.2011.580697

Liddelow, C., Mullan, B., & Boyes, M. (2021). Understanding the predictors of medication adherence: applying temporal self-regulation theory. *Psychology & Health*, *36*(5), 529–548. https://doi.org/10.1080/08870446.2020.1788715

Lim, S. S., Vos, T., Flaxman, A. D., Danaei, G., Shibuya, K., Adair-Rohani, H., AlMazroa, M. A., Amann, M., Anderson, H. R., Andrews, K. G., Aryee, M., Atkinson, C., Bacchus,

L. J., Bahalim, A. N., Balakrishnan, K., Balmes, J., Barker-Collo, S., Baxter, A., Bell, M. L., … Ezzati, M. (2012). A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. *The Lancet*, *380*(9859), 2224–2260. https://doi.org/10.1016/S0140-6736(12)61766-8

Livingstone, M. B. E., & Black, A. E. (2003). Markers of the Validity of Reported Energy Intake. *The Journal of Nutrition*, *133*(3), 895S-920S. https://doi.org/10.1093/jn/133.3.895S

Lovibond, S. H., & Lovibond, P. F. (1995). Manual for the Depression Anxiety Stress Scales. In *Psychology Foundation of Australia* (Vol. 56).

Lucassen, D. A., Lasschuijt, M. P., Camps, G., van Loo, E. J., Fischer, A. R. H., de Vries, R. A. J., Haarman, J. A. M., Simons, M., de Vet, E., Bos-de Vos, M., Pan, S., Ren, X., de Graaf, K., Lu, Y., Feskens, E. J. M., & Brouwer-Brolsma, E. M. (2021). Short and Long-Term Innovations on Dietary Behavior Assessment and Coaching: Present Efforts and Vision of the Pride and Prejudice Consortium. *International Journal of Environmental Research and Public Health*, *18*(15), 7877. https://doi.org/10.3390/ijerph18157877

Ludwig, V. U., Brown, K. W., & Brewer, J. A. (2020). Self-Regulation Without Force: Can Awareness Leverage Reward to Drive Behavior Change? *Perspectives on Psychological Science*, *15*(6), 1382–1399. https://doi.org/10.1177/1745691620931460

Lumer, C. (2017). Automatic actions: Agency, intentionality, and responsibility. *Philosophical Psychology*, *30*(5). https://doi.org/10.1080/09515089.2017.1291928

Mackenzie, K. M., Kerr, D. A., Whitton, C., Talati, Z., McCaffrey, T. A., & Mullan, B. A. (2022). Predicting Perceived Problems in Self-Administered 24-Hour Dietary Recalls: A Quantitative Think-Aloud Study Comparing Automated Self-Assisted 24-Hour Dietary Assessment Tool (ASA24®) and INTAKE24© in University Students. *Nutrients*, *14*(20), 4281. https://doi.org/10.3390/nu14204281

Marchese, L., Livingstone, K. M., Woods, J. L., Wingrove, K., & Machado, P. (2022). Ultra-processed food consumption, socio-demographics and diet quality in Australian adults. *Public Health Nutrition*, *25*(1), 94–104. https://doi.org/10.1017/S1368980021003967

McAlpine, T., & Mullan, B. A. (2022). The role of environmental cues in sugar-sweetened beverage consumption using a temporal self-regulation theory framework. *Appetite*, *169*, 105828. https://doi.org/10.1016/j.appet.2021.105828

McCambridge, J., Witton, J., & Elbourne, D. R. (2014). Systematic review of the Hawthorne effect: New concepts are needed to study research participation effects. *Journal of Clinical Epidemiology*, *67*(3), 267–277. https://doi.org/10.1016/j.jclinepi.2013.08.015

Michie, S., Abraham, C., Whittington, C., McAteer, J., & Gupta, S. (2009). Effective techniques in healthy eating and physical activity interventions: A meta-regression. *Health Psychology*, *28*(6), 690–701. https://doi.org/10.1037/a0016136

Miller, C., Braunack-Mayer, A., Wakefield, M., Roder, D., O'Dea, K., Dono, J., & Ettridge, K. (2020). "When we were young, it really was a treat. *Health Promot J Austr*, *31*(1), 47–57. https://doi.org/10.1002/hpja.257

Mishra, G. D., Schoenaker, D. A., Mihrshahi, S., & Dobson, A. J. (2015). How do women's diets compare with the new Australian dietary guidelines? *Public Health Nutrition*, *18*(2), 218–225. https://doi.org/10.1017/S1368980014000135

Monahan, T., & Fisher, J. A. (2010). Benefits of 'observer effects': lessons from the field. *Qualitative Research*, *10*(3), 357–376. https://doi.org/10.1177/1468794110362874

Morin, A., Duhnych, C., & Racy, F. (2018). Self-reported inner speech use in university students. *Applied Cognitive Psychology*, *32*(3), 376–382. https://doi.org/10.1002/acp.3404

Moshier, S. J., Landau, A. J., Hearon, B. A., Stein, A. T., Greathouse, L., Smits, J. A. J., & Otto, M. W. (2016). The Development of a Novel Measure to Assess Motives for Compensatory Eating in Response to Exercise: The CEMQ. *Behavioral Medicine*, *42*(2), 93–104. https://doi.org/10.1080/08964289.2014.955077

Mossavar-Rahmani, Y., Tinker, L. F., Huang, Y., Neuhouser, M. L., McCann, S. E., Seguin, R. A., Vitolins, M. Z., Curb, J. D., & Prentice, R. L. (2013). Factors relating to eating style, social desirability, body image and eating meals at home increase the precision of calibration equations correcting self-report measures of diet using recovery biomarkers: findings from the Women's Health Initiative. *Nutrition Journal*, *12*(1), 63. https://doi.org/10.1186/1475-2891-12-63

Murakami, K., & Livingstone, M. B. E. (2015). Prevalence and characteristics of misreporting of energy intake in US adults: NHANES 2003-2012. *The British Journal of Nutrition*, *114*(8), 1294–1303. https://doi.org/http://dx.doi.org/10.1017/S0007114515002706

National Health and Medical Research Council. (2013). *Australian Dietary Guidelines*.

National Health and Medical Research Council. (2020). *Eat for Health Australia*. https://www.eatforhealth.gov.au/guidelines

Obradovic, M., Nesic, G., Popovic, A., Bozic, P., Savic, Z., Kojic, F., & Djuric, S. (2021). Physical activity and eating habits of students of the University of Belgrade: An epidemiological study. *Vojnosanitetski Pregled*, *78*(12), 1273–1279. https://doi.org/10.2298/VSP200510056O

Ohtomo, S. (2017). Exposure to diet priming images as cues to reduce the influence of unhealthy eating habits. *Appetite*, *109*, 83–92. https://doi.org/10.1016/j.appet.2016.11.022

Orbell, S., & Verplanken, B. (2010). The automatic component of habit in health behavior: Habit as cue-contingent automaticity. *Health Psychology*, *29*(4), 374–383. https://doi.org/10.1037/a0019596

Osadchiy, T., Poliakov, I., Olivier, P., Rowland, M., & Foster, E. (2020). Progressive 24-Hour Recall: Usability Study of Short Retention Intervals in Web-Based Dietary Assessment Surveys. *J Med Internet Res*, *22*(2), e13266. https://doi.org/10.2196/13266

Papies, E. K. (2016). Health goal priming as a situated intervention tool: how to benefit from nonconscious motivational routes to health behaviour. *Health Psychology Review*, *10*(4), 408–424. https://doi.org/10.1080/17437199.2016.1183506

Parent, M. B., Higgs, S., Cheke, L. G., & Kanoski, S. E. (2022). Memory and eating: A bidirectional relationship implicated in obesity. *Neuroscience & Biobehavioral Reviews*, *132*, 110–129. https://doi.org/10.1016/j.neubiorev.2021.10.051

Patel, M. L., Hopkins, C. M., Brooks, T. L., & Bennett, G. G. (2019). Comparing Self-Monitoring Strategies for Weight Loss in a Smartphone App: Randomized Controlled Trial. *JMIR MHealth and UHealth*, *7*(2), e12209. https://doi.org/10.2196/12209

Peterson, D. J., & Mulligan, N. W. (2012). A negative effect of repetition in episodic memory. *Journal of Experimental Psychology: Learning Memory and Cognition*, *38*(6). https://doi.org/10.1037/a0028220

Pitt, A., Oprescu, F., Tapia, G., & Gray, M. (2018). An exploratory study of students' weekly stress levels and sources of stress during the semester. *Active Learning in Higher Education*, *19*(1). https://doi.org/10.1177/1469787417731194

Platania, M., Rapisarda, P., & Rizzo, M. (2016). Food and health habits of university students. Relationship to food consumption behaviour. *International Food Research Journal*, *23*(3).

Poggiogalle, E., Kiesswetter, E., Romano, M., Saba, A., Sinesio, F., Polito, A., Moneta, E., Ciarapica, D., Migliaccio, S., Suwalska, A., Wieczorowska-Tobis, K., Pałys, W., Łojko, D., Sulmont-Rossé, C., Feart, C., Brug, J., Volkert, D., & Donini, L. M. (2021).

Psychosocial and cultural determinants of dietary intake in community-dwelling older adults: A Determinants of Diet and Physical Activity systematic literature review. *Nutrition*, *85*, 111131. https://doi.org/10.1016/j.nut.2020.111131

Polivy, J., Herman, C. P., Trottier, K., & Sidhu, R. (2014). Who are you trying to fool: does weight underreporting by dieters reflect self-protection or self-presentation? *Health Psychology Review*, *8*(3), 319–338. https://doi.org/10.1080/17437199.2013.775630

Pollard, C. M., Miller, M. R., Daly, A. M., Crouchley, K. E., O'Donoghue, K. J., Lang, A. J., & Binns, C. W. (2008). Increasing fruit and vegetable consumption: success of the Western Australian Go for 2&5 ® campaign. *Public Health Nutrition*, *11*(3), 314–320. https://doi.org/10.1017/S1368980007000523

Prentice, R. L. (2018). Intake biomarkers and the chronic disease nutritional epidemiology research agenda. *The American Journal of Clinical Nutrition*, *108*(3), 433–434. https://doi.org/10.1093/ajcn/nqy206

Prinsen, S., de Ridder, D. T. D., & de Vet, E. (2013). Eating by example. Effects of environmental cues on dietary decisions. *Appetite*, *70*, 1–5. https://doi.org/10.1016/j.appet.2013.05.023

Prochaska, J. O., & Norcross, J. C. (2002). Stages of Change. In *Psychotherapy relationships that work: Therapist contributions and responsiveness to patients.* (pp. 303–313). Oxford University Press.

Qualtrics. (2005). *Qualtrics*.

Rao, M., Afshin, A., Singh, G., & Mozaffarian, D. (2013). Do healthier foods and diet patterns cost more than less healthy options? A systematic review and meta-analysis. *BMJ Open*, *3*(12), e004277. https://doi.org/10.1136/bmjopen-2013-004277

Raynor, H. A., & Vadiveloo, M. (2018). Understanding the Relationship Between Food Variety, Food Intake, and Energy Balance. *Current Obesity Reports*, *7*(1), 68–75. https://doi.org/10.1007/s13679-018-0298-7

Razali, Z. B., Kader, M. M. A., Affendi, N. S. S. R., & Daud, M. H. (2020). Think-aloud Technique in Assessing Practical Experience: A Pilot Study. *IOP Conference Series: Materials Science and Engineering*, *932*(1). https://doi.org/10.1088/1757-899X/932/1/012084

Reicks, M., Smith, C., Henry, H., Reimer, K., Atwell, J., & Thomas, R. (2003). Use of the Think Aloud Method to Examine Fruit and Vegetable Purchasing Behaviors among Low-Income African American Women. *Journal of Nutrition Education and Behavior*, *35*(3), 154–160. https://doi.org/10.1016/S1499-4046(06)60200-5

Rigby, R. R., Mitchell, L. J., Hamilton, K., & Williams, L. T. (2020). The Use of Behavior Change Theories in Dietetics Practice in Primary Health Care: A Systematic Review of Randomized Controlled Trials. *Journal of the Academy of Nutrition and Dietetics*, *120*(7), 1172–1197. https://doi.org/10.1016/j.jand.2020.03.019

Robson, C. (2002). *Real world research: A resource for social scientists and practitioner-researchers* (2nd ed.). Blackwell.

Robson, S. M., DeLuccia, R., Baker, S., Bodt, B., & Trabulsi, J. (2020). Qualitative Research on the Real-Time Decision Making of WIC Participants While Food Shopping: Use of Think-Aloud Methodology. *Journal of the Academy of Nutrition and Dietetics*, *120*(1), 111–119. https://doi.org/10.1016/j.jand.2019.05.009

Rodero, E. (2019). The Spark Orientation Effect for Improving Attention and Recall. *Communication Research*, *46*(7). https://doi.org/10.1177/0093650215609085

Rogiers, A., Merchie, E., & van Keer, H. (2020). What they say is what they do? Comparing task-specific self-reports, think-aloud protocols, and study traces for measuring secondary school students' text-learning strategies. *European Journal of Psychology of Education*, *35*(2), 315–332. https://doi.org/10.1007/s10212-019-00429-5

Schilling, T. M., Kölsch, M., Larra, M. F., Zech, C. M., Blumenthal, T. D., Frings, C., & Schächinger, H. (2013). For whom the bell (curve) tolls: Cortisol rapidly affects memory retrieval by an inverted U-shaped dose-response relationship. *Psychoneuroendocrinology*, *38*(9). https://doi.org/10.1016/j.psyneuen.2013.01.001

Schlegel, I., Carstairs, S. A., & Ozakinci, G. (2021). The influence of supraliminal priming on energy density of food selection: a randomised control trial. *BMC Psychology*, *9*(1), 48. https://doi.org/10.1186/s40359-021-00554-1

Schmidt, H., Brandt, D., Bischof, A., Heidbrink, S., Bischof, G., Borgwardt, S., & Rumpf, H.-J. (2022). Think-aloud analysis of commonly used screening instruments for Internet use disorders: The CIUS, the IGDT-10, and the BSMAS. *Journal of Behavioral Addictions*. https://doi.org/10.1556/2006.2022.00034

Schroé, H., van Dyck, D., de Paepe, A., Poppe, L., Loh, W. W., Verloigne, M., Loeys, T., de Bourdeaudhuij, I., & Crombez, G. (2020). Which behaviour change techniques are effective to promote physical activity and reduce sedentary behaviour in adults: a factorial randomized trial of an e- and m-health intervention. *International Journal of Behavioral Nutrition and Physical Activity*, *17*(1), 127. https://doi.org/10.1186/s12966-020-01001-x

Schüz, B., Bower, J., & Ferguson, S. G. (2015). Stimulus control and affect in dietary behaviours. An intensive longitudinal study. *Appetite*, *87*, 310–317. https://doi.org/10.1016/j.appet.2015.01.002

Sellahewa, D. A., & Mullan, B. (2015). Health behaviours and their facilitation under depletion conditions: The case of snacking. *Appetite*, *90*, 194–199. https://doi.org/10.1016/j.appet.2015.03.009

Senay, I., Albarracín, D., & Noguchi, K. (2010). Motivating goal-directed behavior through introspective self-talk: the role of the interrogative form of simple future tense. *Psychological Science*, *21*(4), 499–504. https://doi.org/10.1177/0956797610364751

Shim, J.-S., Oh, K., & Kim, H. C. (2014). Dietary assessment methods in epidemiologic studies. *Epidemiology and Health*, e2014009. https://doi.org/10.4178/epih/e2014009

Short, M. E., Goetzel, R. Z., Pei, X., Tabrizi, M. J., Ozminkowski, R. J., Gibson, T. B., Dejoy, D. M., & Wilson, M. G. (2009). How accurate are self-reports? Analysis of self-reported health care utilization and absence when compared with administrative data. *Journal of Occupational and Environmental Medicine*, *51*(7), 786–796. https://doi.org/10.1097/JOM.0b013e3181a86671

Simpson, E., Bradley, J., Poliakov, I., Jackson, D., Olivier, P., Adamson, A., & Foster, E. (2017). Iterative Development of an Online Dietary Recall Tool: INTAKE24. *Nutrients*, *9*(2), 118. https://doi.org/10.3390/nu9020118

Steinfeldt, L., Anand, J., & Murayi, T. (2013). Food Reporting Patterns in the USDA Automated Multiple-Pass Method. *Procedia Food Science*, *2*, 145–156. https://doi.org/10.1016/j.profoo.2013.04.022

Stok, F. M., de Vet, E., de Ridder, D., & de Wit, J. (2012). The influence of descriptive social norms on consumer behavior. A fruit consumption study. *Appetite*, *59*(2), 635. https://doi.org/10.1016/j.appet.2012.05.101

Stubbs, R. J., O'Reilly, L. M., Whybrow, S., Fuller, Z., Johnstone, A. M., Livingstone, M. B. E., Ritz, P., & Horgan, G. W. (2014). Measuring the difference between actual and reported food intakes in the context of energy balance under laboratory conditions. *The British Journal of Nutrition*, *111*(11), 2032–2043. https://doi.org/http://dx.doi.org/10.1017/S0007114514000154

Subar, A. F., Freedman, L. S., Tooze, J. A., Kirkpatrick, S. I., Boushey, C., Neuhouser, M. L., Thompson, F. E., Potischman, N., Guenther, P. M., Tarasuk, V., Reedy, J., & Krebs-Smith, S. M. (2015). Addressing Current Criticism Regarding the Value of Self-Report

Dietary Data. *The Journal of Nutrition*, *145*(12), 2639–2645. https://doi.org/10.3945/jn.115.219634

Subar, A. F., Kirkpatrick, S. I., Mittl, B., Zimmerman, T. P., Thompson, F. E., Bingley, C., Willis, G., Islam, N. G., Baranowski, T., McNutt, S., & Potischman, N. (2012). The Automated Self-Administered 24-Hour Dietary Recall (ASA24): A Resource for Researchers, Clinicians, and Educators from the National Cancer Institute. *Journal of the Academy of Nutrition and Dietetics*, *112*(8). https://doi.org/10.1016/j.jand.2012.04.016

Tabachnick, B. G., & Fidell, L. S. (2019). *Using multivariate statistics* (7th ed.). Pearson.

Tahmassebi, J. F., & BaniHani, A. (2020). Impact of soft drinks to health and economy: a critical review. *European Archives of Paediatric Dentistry*, *21*(1), 109–117. https://doi.org/10.1007/s40368-019-00458-0

Tam, R., Yassa, B., Parker, H., O'Connor, H., & Allman-Farinelli, M. (2017). University students' on-campus food purchasing behaviors, preferences, and opinions on food availability. *Nutrition*, *37*. https://doi.org/10.1016/j.nut.2016.07.007

Thompson, F. E., Kirkpatrick, S. I., Subar, A. F., Reedy, J., Schap, T. E., Wilson, M. M., & Krebs-Smith, S. M. (2015). The National Cancer Institute's Dietary Assessment Primer: A Resource for Diet Research. *Journal of the Academy of Nutrition and Dietetics*, *115*(12), 1986–1995. https://doi.org/10.1016/j.jand.2015.08.016

Tooze, J. A., Subar, A. F., Thompson, F. E., Troiano, R., Schatzkin, A., & Kipnis, V. (2004). Psychosocial predictors of energy underreporting in a large doubly labeled water study. *American Journal of Clinical Nutrition*, *79*(5). https://doi.org/10.1093/ajcn/79.5.795

Tulving, E., & Schacter, D. L. (1990). Priming and Human Memory Systems. *Science*, *247*(4940), 301–306. https://doi.org/10.1126/science.2296719

Turner-McGrievy, G. M., Dunn, C. G., Wilcox, S., Boutté, A. K., Hutto, B., Hoover, A., & Muth, E. (2019). Defining Adherence to Mobile Dietary Self-Monitoring and Assessing Tracking Over Time: Tracking at Least Two Eating Occasions per Day Is Best Marker of Adherence within Two Different Mobile Health Randomized Weight Loss Interventions. *Journal of the Academy of Nutrition and Dietetics*, *119*(9), 1516–1524. https://doi.org/10.1016/j.jand.2019.03.012

Tyner, B. C., & Fienup, D. M. (2015). A comparison of video modeling, text-based instruction, and no instruction for creating multiple baseline graphs in Microsoft Excel. *Journal of Applied Behavior Analysis*, *48*(3). https://doi.org/10.1002/jaba.223

Tyng, C. M., Amin, H. U., Saad, M. N. M., & Malik, A. S. (2017). The influences of emotion on learning and memory. In *Frontiers in Psychology* (Vol. 8, Issue AUG). https://doi.org/10.3389/fpsyg.2017.01454

van Breukelen, G. J. P. (2013). ANCOVA Versus CHANGE From Baseline in Nonrandomized Studies: The Difference. *Multivariate Behavioral Research*, *48*(6), 895–922. https://doi.org/10.1080/00273171.2013.831743

van Dillen, S. M. E., Jan Hiddink, G., Koelen, M. A., de Graaf, C., & van Woerkum, C. M. J. (2007). Exploration of possible correlates of nutrition awareness and the relationship with nutrition-related behaviours: results of a consumer study. *Public Health Nutr*, *11*(5), 478–485. https://doi.org/10.1017/S1368980007000754

van Genugten, L., Dusseldorp, E., Webb, T. L., & van Empelen, P. (2016). Which Combinations of Techniques and Modes of Delivery in Internet-Based Interventions Effectively Change Health Behavior? A Meta-Analysis. *Journal of Medical Internet Research*, *18*(6), e155. https://doi.org/10.2196/jmir.4218

vanDellen, M. R., Isherwood, J. C., & Delose, J. E. (2016). How do people define moderation? *Appetite*, *101*, 156–162. https://doi.org/10.1016/j.appet.2016.03.010

Vandenbosch, L., Fardouly, J., & Tiggemann, M. (2022). Social media and body image: Recent trends and future directions. *Current Opinion in Psychology*, *45*, 101289. https://doi.org/10.1016/j.copsyc.2021.12.002

Vaudin, A., Wambogo, E., Moshfegh, A., & Sahyoun, N. R. (2021). Awareness and use of nutrition information predict measured and self-rated diet quality of older adults in the USA. *Public Health Nutrition*, *24*(7), 1687–1697. https://doi.org/10.1017/S1368980020004681

Vereecken, C., Covents, M., Maes, L., & Moyson, T. (2014). Formative evaluation of the dietary assessment component of Children's and Adolescents' Nutrition Assessment and Advice on the Web (CANAA-W). *Journal of Human Nutrition and Dietetics*, *27*(SUPPL.1). https://doi.org/10.1111/j.1365-277X.2012.01290.x

von Philipsborn, P., Stratil, J. M., Burns, J., Busert, L. K., Pfadenhauer, L. M., Polus, S., Holzapfel, C., Hauner, H., & Rehfuess, E. (2019). Environmental interventions to reduce the consumption of sugar-sweetened beverages and their effects on health. *Cochrane Database of Systematic Reviews*. https://doi.org/10.1002/14651858.CD012292.pub2

Voss, A., Rothermund, K., Gast, A., & Wentura, D. (2013). Cognitive processes in associative and categorical priming: A diffusion model analysis. *Journal of Experimental Psychology: General*, *142*(2). https://doi.org/10.1037/a0029459

Wallace, R., Lo, J., & Devine, A. (2016). Tailored nutrition education in the elderly can lead to sustained dietary behaviour change. *The Journal of Nutrition, Health & Aging*, *20*(1), 8–15. https://doi.org/10.1007/s12603-016-0669-2

Wansink, B. (2004). ENVIRONMENTAL FACTORS THAT INCREASE THE FOOD INTAKE AND CONSUMPTION VOLUME OF UNKNOWING CONSUMERS. *Annual Review of Nutrition*, *24*(1), 455–479. https://doi.org/10.1146/annurev.nutr.24.012003.132140

Weger, U., Wagemann, J., & Meyer, A. (2018). Introspection in Psychology. *European Psychologist*, *23*(3), 206–216. https://doi.org/10.1027/1016-9040/a000296

Wehling, H., & Lusher, J. (2019a). People with a body mass index ⩾30 under-report their dietary intake: A systematic review. In *Journal of Health Psychology* (Vol. 24, Issue 14, pp. 2042–2059). https://doi.org/10.1177/1359105317714318

Wehling, H., & Lusher, J. M. (2019b). Cognitive and Emotional Influences on Eating Behaviour: A Qualitative Perspective. *Nutrition and Metabolic Insights*, *12*. https://doi.org/http://dx.doi.org/10.1177/1178638819855936

Werle, C. O. C., Wansink, B., & Payne, C. R. (2011). Just thinking about exercise makes me serve more food. Physical activity and calorie compensation. *Appetite*, *56*(2), 332–335. https://doi.org/10.1016/j.appet.2010.12.016

Whatnall, M. C., Patterson, A. J., Ashton, L. M., & Hutchesson, M. J. (2018). Effectiveness of brief nutrition interventions on dietary behaviours in adults: A systematic review. *Appetite*, *120*, 335–347. https://doi.org/10.1016/j.appet.2017.09.017

Whitehead, A. E., Taylor, J. A., & Polman, R. C. J. (2015). Examination of the suitability of collecting in event cognitive processes using Think Aloud protocol in golf. *Frontiers in Psychology*, *6*. https://doi.org/10.3389/fpsyg.2015.01083

Whitehead, A., Montgomery, C., Swettenham, L., & Robinson, N. J. (2022). The Effect of Think Aloud on Performance and Brain Oxygenation During Cycling – An Exploratory Study. *Perceptual and Motor Skills*, *129*(4), 1115–1136. https://doi.org/10.1177/00315125221104769

Whitton, C., Healy, J. D., Dhaliwal, S. S., Shoneye, C., Harray, A. J., Mullan, B. A., McVeigh, J. A., Boushey, C. J., & Kerr, D. A. (2022). Demographic and psychosocial correlates of measurement error and reactivity bias in a 4-d image-based mobile food record among adults with overweight and obesity. *British Journal of Nutrition*, 1–12. https://doi.org/10.1017/S0007114522001532

WHO. (2020). *No Title*.

Wicklund, R. A., & Duval, S. (1971). Opinion change and performance facilitation as a result of objective self-awareness. *Journal of Experimental Social Psychology*, *7*(3), 319–342. https://doi.org/10.1016/0022-1031(71)90032-1

Wiedemann, A. U., Lippke, S., & Schwarzer, R. (2012). Multiple plans and memory performance: results of a randomized controlled trial targeting fruit and vegetable intake. *Journal of Behavioral Medicine*, *35*(4), 387–392. https://doi.org/10.1007/s10865-011-9364-2

Winne, P. H. (2020). Commentary: A proposed remedy for grievances about self-report methodologies. In *Frontline Learning Research* (Vol. 8, Issue 3). https://doi.org/10.14786/flr.v8i3.625

Wood, W., & Rünger, D. (2016). Psychology of Habit. *Annual Review of Psychology*, *67*(1), 289–314. https://doi.org/10.1146/annurev-psych-122414-033417

World Health Organization. (2022). *Noncommunicable diseases progress monitor 2022.*

Wulff, A. N., & Thomas, A. K. (2021). The Dynamic and Fragile Nature of Eyewitness Memory Formation: Considering Stress and Attention. In *Frontiers in Psychology* (Vol. 12). https://doi.org/10.3389/fpsyg.2021.666724

Yerkes, R. M., & Dodson, J. D. (1908). The relation of strength of stimulus to rapidity of habit-formation. *Journal of Comparative Neurology and Psychology*, *18*(5). https://doi.org/10.1002/cne.920180503

Yu, Z., Sealey-Potts, C., & Rodriguez, J. (2015). Dietary Self-Monitoring in Weight Management: Current Evidence on Efficacy and Adherence. *Journal of the Academy of Nutrition and Dietetics*, *115*(12), 1931–1938. https://doi.org/10.1016/j.jand.2015.04.005

Zhang, S., Paul, J., Nantha-Aree, M., Buckley, N., Shahzad, U., Cheng, J., DeBeer, J., Winemaker, M., Wismer, D., Punthakee, D., Avram, V., & Thabane, L. (2014). Empirical comparison of four baseline covariate adjustment methods in analysis of continuous outcomes in randomized controlled trials. *Clinical Epidemiology*, 227. https://doi.org/10.2147/CLEP.S56554

Appendices

Appendix A

Creature of Habit Scale (Ersche et al., 2017)

Routine Subscale	
Habit_R_11	I generally cook with the same spices/flavourings
Habit_R_12	I normally buy the same foods from the same grocery store
Habit_R_15	In a restaurant, I tend to order dishes that I am familiar with
Habit_R_13	I always follow a certain order when preparing a meal
Habit_R_14	I generally eat the same things for breakfast every day
Automaticity Subscale	
Habit_A_5	I often find myself finishing off a packet of biscuits just because it is lying there
Habit_A_1	I often find myself opening up the cabinet to take a snack
Habit_A_10	When walking past a plate of sweets of biscuits, I can't resist taking one
Habit_A_7	Television makes me particularly prone to uncontrolled eating
Habit_A_2	I often find myself eating without being aware of it
Habit_A_11	I am prone to eating more when I feel stressed
Habit_A_9	Eating crisps or biscuits straight out of the packet is typical of me
Habit_A_6	Whenever I go into the kitchen, I typically look in the fridge
Habit_A_8	I usually treat myself to a snack at the end of the workday
Habit_A_3	I often take a snack while on the go (e.g., when driving, walking, down the street, or surfing the web)

Removed items (not related to food consumption)	
Routine Subscale	
Habit_R_1	I tend to like routine
Habit_R_2	I find comfort in regularity
Habit_R_3	I rely on what is tried and tested rather than exploring something new
Habit_R_4	I quite happily work within my comfort zone rather than challenging myself
Habit_R_5	I tend to stick with the version of the software packages that I am familiar with for as long as I can
Habit_R_6	I tend to do things in the same order every morning (e.g., get up, go to the bathroom, have a coffee…)
Habit_R_7	I always try to get the same seat in places such as on the bus, in the cinema, or in church
Habit_R_8	I always like to park my car or bike always in the same place
Habit_R_9	I am one of those people who get really annoyed by last minute cancellations
Habit_R_10	I tend to go to bed at roughly the same time every night
Habit_R_16	I usually sit at the same place at the dinner table
Automaticity Subscale	
Habit_A_4	I often find myself running on autopilot, and then wonder why I ended up in a particular place or doing something that I did not intend to do

Appendix B

Mindfulness Eating Questionnaire (Clementi et al., 2017)

Awareness Subscale	
Mind_A_1	Before I eat, I take a moment to appreciate colours and smells of food
Mind_A_2	I taste every bite of food I eat
Mind_A_3	I appreciate the way my food looks on my plate
Mind_A_4	I notice when foods and drinks are too sweet
Mind_A_5	I notice subtle flavours in the food I eat
Mind_A_6	I notice when I am eating from a dish of candy just because it is there
Mind_A_7	I notice when the food I eat affects my emotional state
Mind_A_8	When I eat a big meal, I notice if it makes me feel heavy or sluggish
Mind_A_9	When eating a pleasant meal, I notice if it makes me feel relaxed
Mind_A_10	I recognise when food advertisements make me want to eat
Mind_A_11	I recognise when I am eating and not hungry
Recognition Subscale	
Mind_R_1	If there is good food at a party, I will continue eating even after I am full
Mind_R_2	if there are leftovers that I like, I take a second helping even though I am full
Mind_R_3	When I eat at ‘all you can eat buffets’, I tend to overeat
Mind_R_4	When I am eating one of my favourite foods, I do not recognise when I have had enough
Mind_R_5	If it does not cost much more, I get the larger size of food or drink, regardless of how hungry I am
Mind_R_6	I snack without noticing I am eating
Mind_R_7	At a party with a lot of good food, I notice when it makes me want to eat more than I should
Mind_R_8	When a restaurant portion is too large, I stop eating when I am full
Mind_R_9	I stop eating when I am full even when eating something I love

Appendix C

Systems Usability Scale (Bangor et al., 2008)

SUS_1	I think that I would like to use this system frequently
SUS_2R	I found the system unnecessarily complex
SUS_3	I thought the system was easy to use
SUS_4R	I think that I would need the support of a technical person to be able to use this system
SUS_5	I found the various functions in the system were well integrated
SUS_6R	I thought there was too much inconsistency in the system
SUS_7	I would imagine that most people would learn to use this system very quickly
SUS_8R	I found the system very awkward to use
SUS_9	I felt very confident using the system
SUS_10R	I needed to learn a lot of things before I could get going with this system

Item 8's wording of 'cumbersome' modified to 'awkward'. Even items are reversed coded.

Appendix D

Perceived Problems Checklist (Mackenzie et al., 2022).

Problems with remembering	Tally	
What was eaten: *Participant may stumble, tut, say 'ummm' or question 'what did I eat' when inputting their item. E.g.:* ☐ Unsure what was eaten/ or if they ate ☐ Unsure if that's all they had to eat/ amount eaten ☐ Hesitation or long contemplation time on remembering what was eaten ☐ Prompt on the screen or task reminding them what they forgot		
Problems with remembering	**Tally**	
Item's portion: *Participant may stumble, tut, say 'ummm' or 'how much did I have' or 'what ingredients were in it'. Often associated with pre-bought/machine made or restaurant meals E.g.:* ☐ Unsure on ingredients of a meal ☐ Unsure of the portion due to machine, pre-packaged ☐ Unsure on portion due to meal made for more than one serve ☐ Correcting later or contradicting food item ☐ Unsure if/when they ate		
Problems with remembering	**Tally**	
Unsure on items specifically: *Participant may stumble, tut, say 'ummm' or 'what was it called' or 'what was the brand'. Often associated with pre-bought items E.g.:* ☐ Unsure where the item was from ☐ Unsure on the name or brand of the item ☐ Unsure of how it was commercially cooked		
Problems with remembering	**Tally**	
Guessing: *E.g.:* ☐ Guessing the time frame ☐ Guessing the amount eaten ☐ Guessing food due to missing item/Unsure on food item replacement		
Problem with program	**Tally**	
Inputting item into program: what is it? *Unsure what the program is asking from the participant. This can sound like confusion and is often associated with questioning themselves about what the program wants. E.g.:* ☐ Unsure when to search for an item ☐ Unsure where to search an item ☐ Unsure whether to add an item or not ☐ Unsure if program wanted it input separate or together ☐ Unsure what the program was asking (i.e., how much was left or how much drank) ☐ Unsure whether to put item as abbreviation or full name ☐ Unsure on the time of day recalling food from		

Appendix D

Perceived Problems Checklist (continued; Mackenzie et al., 2022).

Problem with program	Tally	
Inputting item into program: where is it? *Unsure where to find something on the program. Participants may speak aloud something like 'where is or what do I add it as…' and can be followed by incorrect item or amount being input. E.g.:* ☐ Can't find the food item on the program ☐ Unsure what to do when can't find item in the system ☐ Unsure what the food is called in the system ☐ Unsure what kind the item is categorised under		
Problem with program	**Tally**	
Individual problems: *E.g.:* ☐ Issues with correct spelling ☐ Exotic food, doesn't know the name/spelling ☐ Measurement of portion size is guessed or measured as more than on portion size ☐ Chose wrong day on the program		
Emotional problems	**Tally**	
Individual frustration: *A participant is sounding frustrated by the study. This is sometimes recognised as a large sigh, grunt or sometimes swear-word (if the context assumes frustration). E.g.:* ☐ Frustrated at the specificity of the program ☐ Frustrated putting every item in instead of an overall meal ☐ Frustrated at how long it's taking to recall everything or the length of the program		
Emotional problems	**Tally**	
Individual confusion: *A participant is sounding confused this can be when they are unaware of what the question asks or how to answer it. Voice generally heightens in pitch and questions themselves (not the program). E.g.:* ☐ Unsure what qualifies for mealtime of day ☐ Unsure what qualifies as a meal ☐ Unsure on why the program skipped and had to refill something in ☐ Struggles to find something on the program ☐ Confused with how to use the program ☐ Unsure on the unit of measurement		
None	**Tally**	
No problems arise *E.g.:* ☐ Participant chooses not to speak or has no problems arise in the study		

PROGRAM:

UNIQUE IDENTIFICATION CODE:

PARTICIPANT NUMBER:

Instructions. Within the left column are categories for perceived problems (Problems with remembering, problems with the program, emotion problems, and none) that provide descriptions and examples for what may be perceived as a problem during recall. Each time a problem in the category arose, a tally mark would go in the opposite box. All tallies should be summed for each category and subcategory. [Remembering (rows 1-4), Program (rows 5-7), Emotion (rows 8-9), None (row 10)].

Appendix E

Social Media Advertisements for Study 2 (Chapter 3).

Participants Needed!

For my Master of Research, I am recruiting participants to better understand Australian individuals' food awareness. The study will take approximately 40 minutes over a week (separated into 3-parts) and will ask questions surrounding your typical food consumption. If you are interested in taking part, please click the link below for more information on the study aims and requirements.

https://curtin.au1.qualtrics.com/jfe/form/SV_cC6jfUR044BS7ga

Curtin University Human Research Ethics Committee (HREC) has approved this study [HREC Number HRE2022-0251]

Appendix F.

Nutritional Awareness Scale (van Dillen et al., 2007).

NA_1	The healthiness of food has little impact on my food choices.
NA_2R	I am very particular about the healthiness of the food I eat.
NA_3	I eat what I like, and I do not worry much about the healthiness of food.
NA_4R	It is important for me that my diet is low in fat.
NA_5	I always follow a healthy and balanced diet.
NA_6R	It is important for me that my daily diet contains a lot of vitamins and minerals.
NA_7	The healthiness of snack makes no difference to me.
NA_8	I do not avoid foods, even if they may raise my cholesterol.
NA_9	I do not want to ask myself all the time whether the things I eat are good for me.
NA_10R	I am prepared to leave ***out*** a lot, to eat as healthy as possible.
NA_11R	I think it is important to know how to eat healthy.
NA_12	I have the impression that other people pay more attention to healthy eating than I do.
NA_13R	I think it is important to eat two pieces of fruit and 200g of vegetables a day.
NA_14	I pay attention that I do not eat too much.
NA_15R	I take care that I eat a balanced diet.
NA_16R	I take care that I eat regularly.
NA_17R	I pay attention that I do not use too much sugar.

Question 10 has been slightly changed from the original scale, after pilot feedback. R means the question scoring has been reversed.

Appendix G.

Short Food Frequency Questionnaire (Diet Quality Measure; Cleghorn et al., 2016).

Please tick how often you eat at least ONE portion of the following foods and drinks over the past week. (*a portion includes: a handful of grapes, an orange, a serving of carrots, a side salad, slice of bread, or one glass of beverage*)								
	Rarely/ Never	Less than once a week	Once a week	2-3 times a week	4-6 times a week	1-2 times a day	3-4 times a day	5+ times a day
Fruit (tinned of fresh)								
Fruit Juice (not cordial or flavoured drinks)								
Salad (not garish or added to a sandwich)_								
Vegetables (tinned/frozen/fresh but NOT potatoe**s)**								
Chips/fried potatoes								
Beans or pulses (baked beans, chickpeas, dahl)								
Fibre-rich breakfast cereal (weetabix, porridge, muesli etc.)								
Wholemeal bread (or chapattis)								
Cheese or yoghurt								
Potato chips or savoury snacks								
Sweets (biscuits, cakes, chocolate or lollies)								
Ice-cream or cream								
Non-alcoholic fizzy drink (not sugar free or diet)								
	Rarely/ Never	Less than once a week	Once a week		2-3 times a week	4-6 times a week	7+ times a week	
Whole meat (Beef, Lamb, Pork, Ham, Steaks, Roasts, Ribs, Mince or Chops)								
Whole meat (Chicken or Turkey, not in batter or breadcrumbs)								
Processed red meat (sausages, bacon, corned beef, meat pies/pasties or burgers)								
Processed white meat (chicken/turkey nuggets, burgers, pies or in batter or breadcrumbs)								
Fish (white fish in batter or breadcrumbs like fish and chips)								

White fish (not in batter or breadcrumbs)						
Oily fish (herrings, sardines, salmon, trout, mackerel, fresh tuna - not canned tuna)						

Items were asked as per above questions. Once scores were downloaded from Qualtrics (Qualtrics, 2005), *they were input manually into an Excel Spreadsheet to calculate overall Diet Quality Scores for each participant. The spreadsheet is available at: http://dx.doi.org/10.1017/S1368980016001099. Instructions on how to input and read the scores, is described within the spreadsheet. Not all questions provided in* Cleghorn et al.'s (2016) *Short-Form Food Frequency Questionnaire were necessary for analysis given the study's objectives. Those that were not analysed, were provided in Table 4b Frequencies table in Chapter 3.*

Appendix H.

Between and Within Group Differences in Scores for Diet Quality Items Across Time-point 1 and 2.

Diet Quality Items	Between group significance (Group Difference)		Within-group significance (Time Difference)	
	(p)			
	Time 1	Time 2	Group 1	Group 2
Fruit	.170	.243	.937	.622
Fruit Juice	.666	.560	.571	.736
Salad	.715	**.048***	.186	**.012***
Vegetables	.828	.738	.147	.736
Hot chips/fried potato	.336	.254	.338	.553
Beans or pulses	.653	.265	.856	.096
Fibre-rich breakfast cereals	.867	.831	.468	.337
Wholemeal breads or chapattis	.586	.804	.162	.084
Cheese or Yoghurt	.917	.899	.872	.898
Potato crisps/savoury snacks	.533	.878	**.030***	.393
Sweets and confectionary	.414	.471	.199	.377
Ice-cream or cream	.431	.460	**.037***	1.00
Non-alcoholic SSBs	.912	.660	1.00	.500
Whole red meat	.563	.658	**.044***	.472
Whole white meat	.641	.269	.128	1.00
Processed red meat	.422	.055	.185	.878
Processed white meat	.845	.186	.183	.711
Battered Fish	.198	.171	.226	.281
White fish	.554	.335	**.013***	.472
Oily Fish	.604	**.019***	**.012***	.520
Daily fruit portions	.994	.187	.486	.011
Daily vegetable portions	.889	.239	1.00	.159
Alcohol	.190	.366	.324	.262

*= Significance at a *p* value of .05.

Supplementary Materials

Supplementary Material 1

Chapter 2: Permission to Include Open-Access Copyrighted Manuscript in Thesis

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Supplementary Material 2

Chapter 2: Ethics Approval Letter

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Supplementary Material 3

Chapter 2: Participant Information Sheet

Curtin University

PARTICIPANT INFORMATION STATEMENT

HREC Project Number:	HREC2021-0295
Project Title:	Predicting Problems in 24hr Dietary Recall: A Quantitative Think-Aloud Study
Chief Investigator:	Professor Barbara Mullan
Co-researchers:	Professor Deborah Kerr and Clare Whitton, PhD Candidate
Student researcher:	Katlyn Mackenzie (Hons)
Version Number:	1.0
Version Date:	05/07/2021

What is the Project About?

Accurately measuring diet is important for government nutrition guidelines, following the populations eating behaviours and protecting public health. Unfortunately, self-report measures are not reliable, and can result in errors in measurement. These errors can impact nutrition-based decisions. To ensure better data, the study will look at what contributes to these errors. The study will sample up to 60 undergraduate university students at Curtin University. The aim of the study is to see if being mindful when eating and having routine eating habits, contributes to problems when recalling what has been eaten in the past 24 hours. We hope to add to existing literature, to help find the issues associated with both 24hr recall methods, to suggest improvements, and to work on improving nutrition guidelines and population intake.

Who is doing the Research?

The project is being conducted by Katlyn Mackenzie, supervised by Professor Barbara Mullan, Professor Deborah Kerr and PhD Candidate Clare Whitton. This research project is funded through Curtin University and will contribute to the completion of my Bachelor of Psychology degree (Hons). There will be no costs to you, and you will not be paid for participating in this project.

Why am I being asked to take part and what will I have to do?

You have been asked to take part because of mutual convenience. You are a university student that needs Sona credits, and the study is located at the Perl-C lab at Curtin University.

- If you choose to participate and consent for your data to be used, the study will be made by appointment times chosen by you on the Sona website.

- There is an online and face to face component of this study. You will be asked to do an online survey prior to attending the face-to-face study.
- The face-to-face component will take place over two time periods. When signing up, we ask that the time slots for the two time periods are at the same time and on the same day, the following week.
- If you choose to participate and consent for your data to be used, the study will be made by appointment times chosen by you on the Sona website.
- The online component will ask for demographic information, information on your food eating habits and mindfulness. This will take approximately 10 minutes.
- The face-to-face component will ask you questions about your food intake in the past 24 hours, such as what you ate and how much you ate. During the recall, your voice will be recorded. You will be asked on the usability of the online recall tool.
- The face-to-face component will be completed in 2 time slots, taking approximately 35 minutes to complete each time.
- The measures will be on the computer in the Perl-c lab. You will not need to return anything or bring anything with you.
- There will be no cost to you for taking part in this research and you will not be paid for taking part. We will give you 5 Sona points to go towards your units. To get the 5 Sona points, you will need to complete both time slots. Participants will receive 0 points if they only complete the first time slot.
- We will make a digital audio recording so we can observe what you have to say during food recall. After the recording we will make a checklist. Once the checklist is created, the recordings will be destroyed.

Are there any benefits' to being in the research project?

There may be no direct benefit to you from participating in this research. However sometimes, people appreciate the opportunity to discuss their opinions and feelings. I hope the results of this research will allow us to assist in better outcomes of 24hr food recalls, online measures and add to previous knowledge on diet.

Are there any risks, side-effects, discomforts or inconveniences from being in the research project?

There are no foreseeable risks from this research project.

- We have been careful to make sure that the questions in the survey do not cause you any distress. But if you feel anxious about any of the questions you do not need to answer them. If the questions cause any concerns or upset you, we can refer you to a counsellor.
- Apart from giving up your time, we do not expect that there will be any risks or inconveniences associated with taking part in this study.
- In relation to the COVID-19 pandemic, social distancing will be in place with participants sanitising before and after computer use. Benches and materials will also be wiped down between each participant. Masks are to be worn. Participants will be asked to reschedule if they show COVID symptoms. SafeWA app or government logging is mandatory.

Who will have access to my information?

The information collected in this research will be re-identifiable (coded). This means that we will collect data that can identify you but will then remove identifying information and replace it with a code when we analyse the data. Though we do not need to collect individual names, your data will have a code to match it to the timeslot two data. No one, not even the research team will be able to identify your information. The following people will have access to the information I collect in this research: the research team and, in the event of an audit or investigation, staff from the Curtin University Office of Research and Development.

- At the end of the second time slot, a link will be provided separate to the data to allow us to credit you Sona points to your account. This data will be identifiable to the university but will in no way be connected to your data.
- Electronic data will be password-protected, and audio recorded data will be in locked storage and password protected on devices.
- The information we collect in this study will be kept under secure conditions at Curtin University for 7 years after the research is published and then it will be destroyed. The results of this research may be presented at conferences or published in professional journals. You will not be identified in any results that are published or presented.

Page 4 of The Participant Information Sheet unable to be reproduced here due to privacy restrictions.

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Supplementary Material 4

Chapter 2: Participant Consent Form and SONA Consent

Predicting Problems in 24hr Dietary Recall

Curtin University

CONSENT FORM

HREC Project Number:	2021-0295
Project Title:	Predicting Problems in 24hr Dietary Recall: A Quantitative Think-Aloud Study
Chief Investigator:	Professor Barbara Mullan
Co-researchers:	Professor Deborah Kerr and Claire Whitton, PhD Candidate,
Student researcher:	Katlyn Mackenzie (Hons)
Version Number:	1.0
Version Date:	05/07/2021

- I have read the information statement listed above, and I understand its contents.
- I believe I understand the purpose, extent and possible risks of my involvement in this project.
- I voluntarily consent to take part in this research project.
- I voluntarily consent to be audio-recorded.
- I have had an opportunity to ask questions and I am satisfied with the answers I have received.
- I understand that this project has been approved by Curtin University Human Research Ethics Committee and will be carried out in line with the National Statement on Ethical Conduct in Human Research (2007).
- I understand I will receive a copy of this Information Statement and Consent Form.

Participant Name	
Participant Signature	
Date	

Declaration by researcher: I have supplied an Information Letter and Consent Form to the participant who has signed above.

Researcher Name	
Researcher Signature	
Date	

Curtin University

If you decide to take part in this research and understand your involvement, we will ask you to check the following consent box. By clicking this, it is telling us that you understand what you have read. Clicking the consent indicates that you agree to be in the research project and have your information used as described.

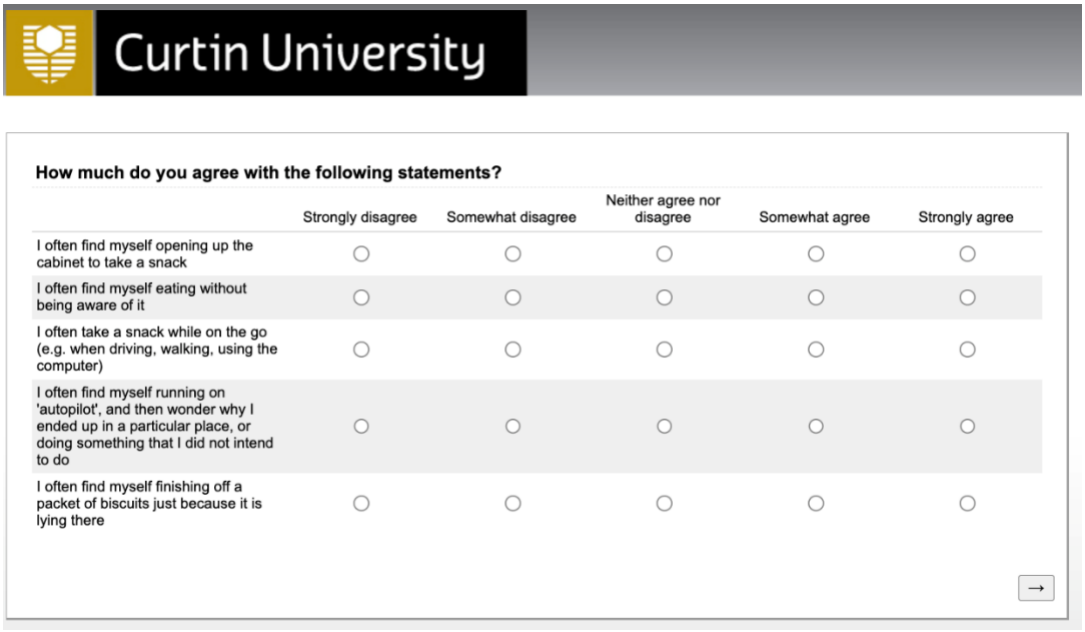
○ By ticking this box, I voluntarily consent to take part in this research.

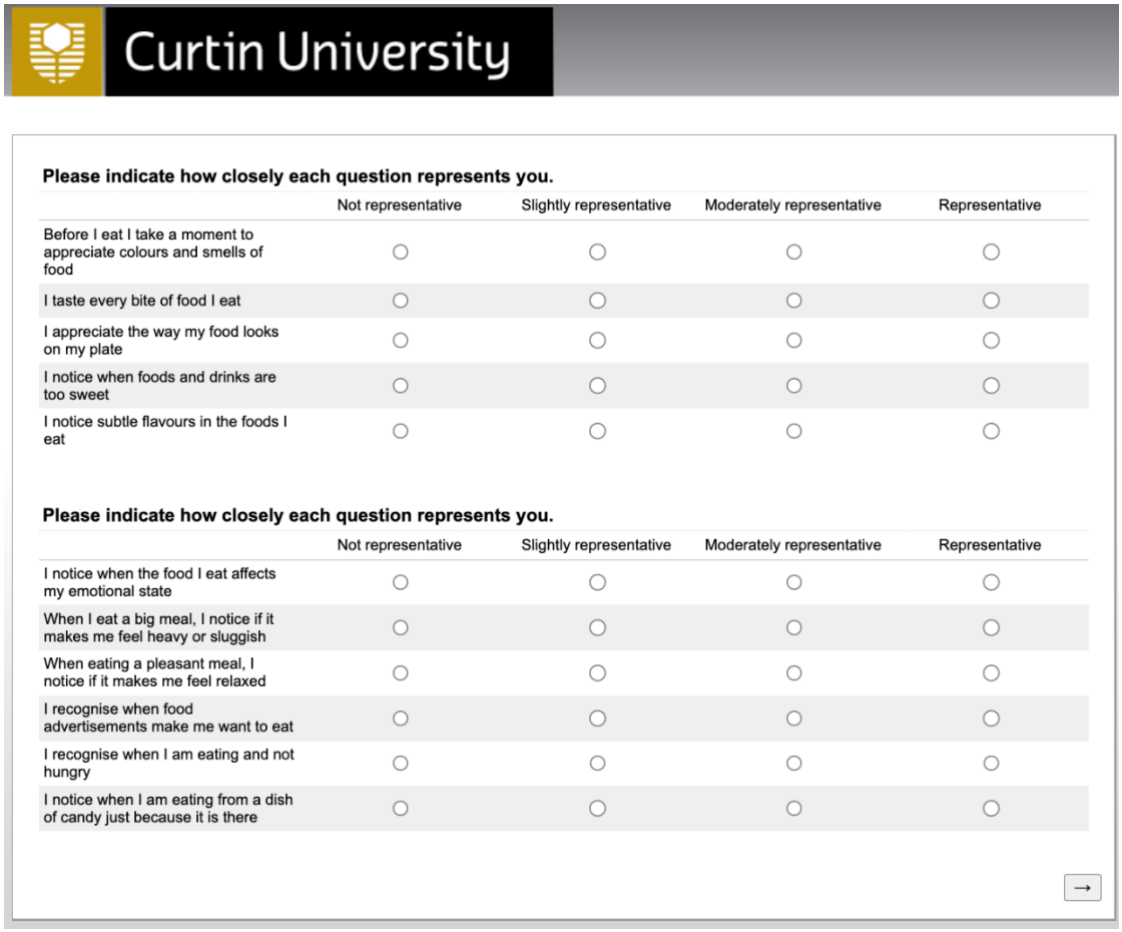
→

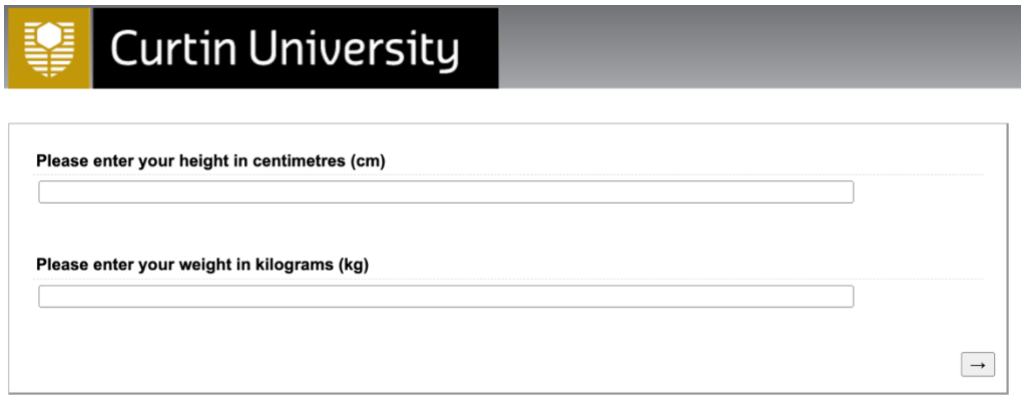
Supplementary Material 5

Chapter 2: Qualtrics Survey – Pre-Recall Part 1

Examples include the Creatures of Habit Scale, Mindfulness Eating Questionnaire and Demographic Questions



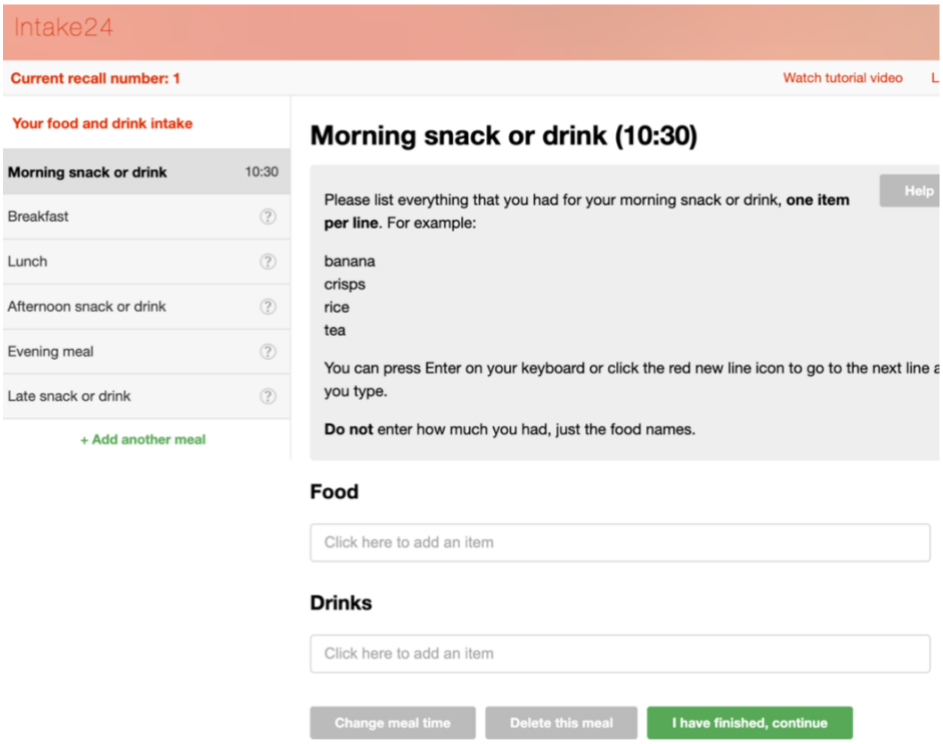


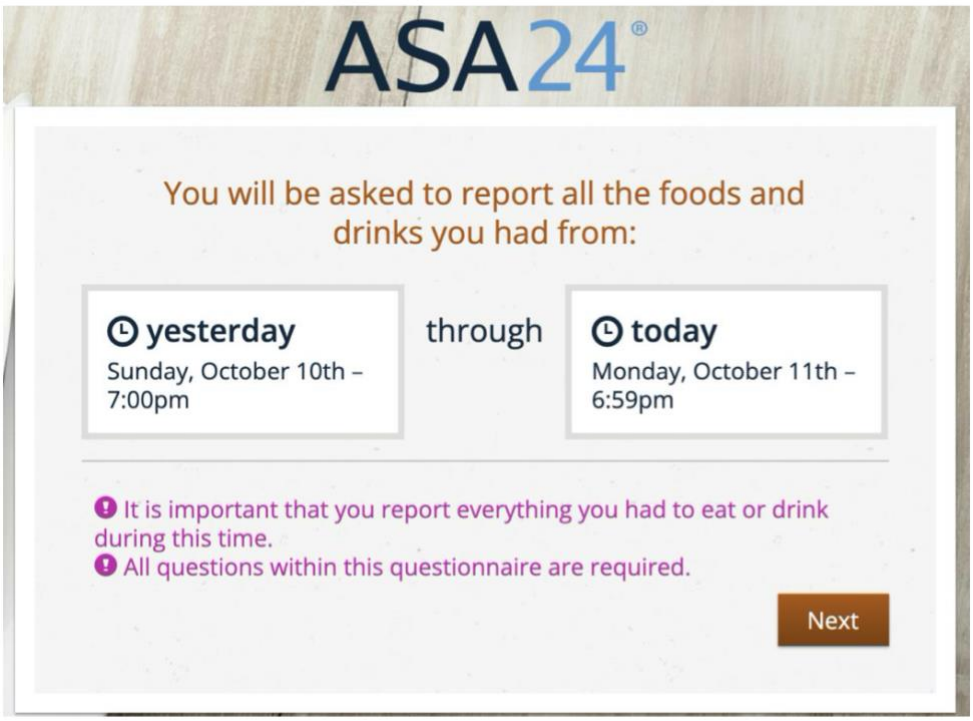

Curtin University
Please enter your height in centimetres (cm)
Please enter your weight in kilograms (kg)
→

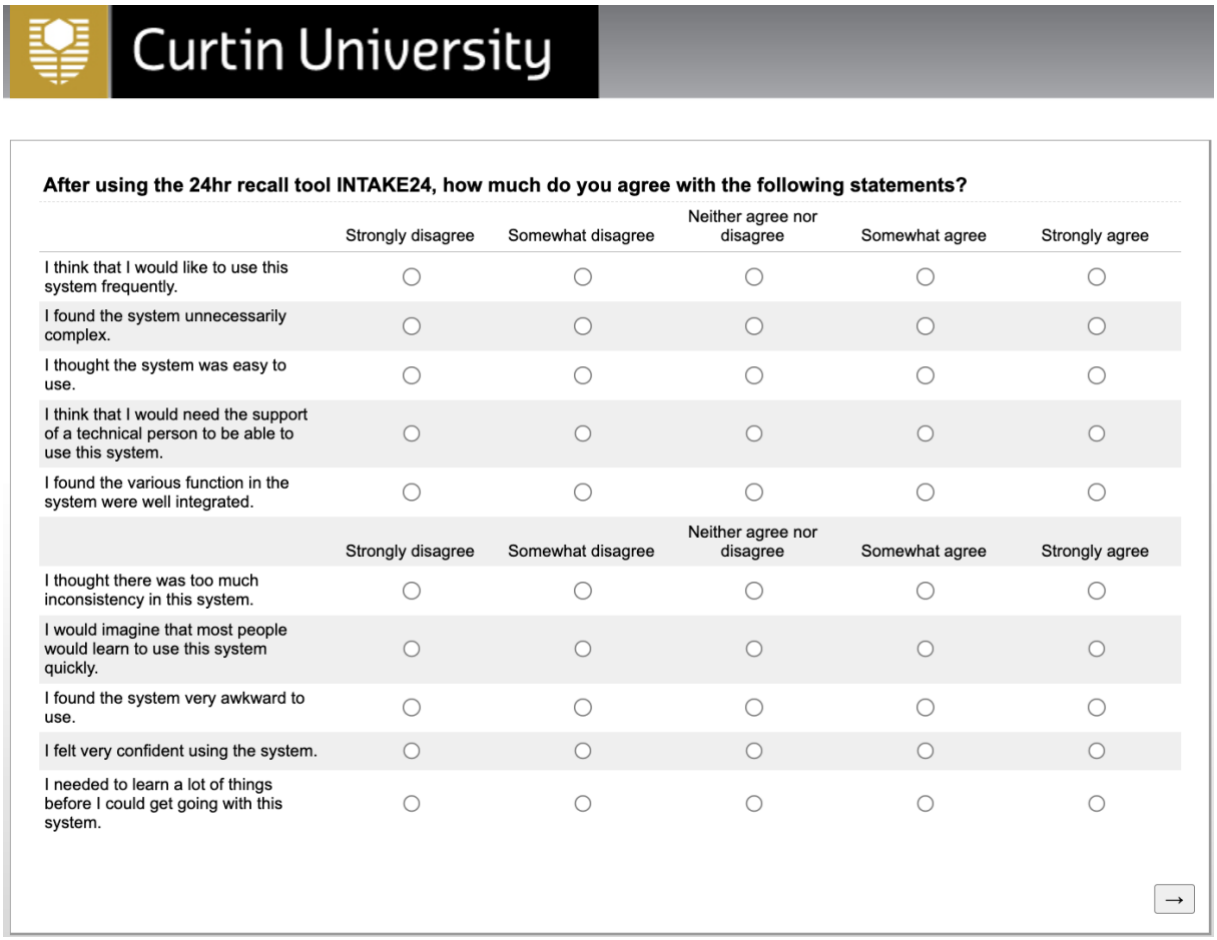
Supplementary Material 6

Chapter 2: Qualtrics Survey – Part 2 and 3

INTAKE24 and ASA24 Web Screenshot Accessed via External Link on Qualtrics. Both 24HR followed by Systems Usability Scale and Final Recall Followed by Preferred Program Question





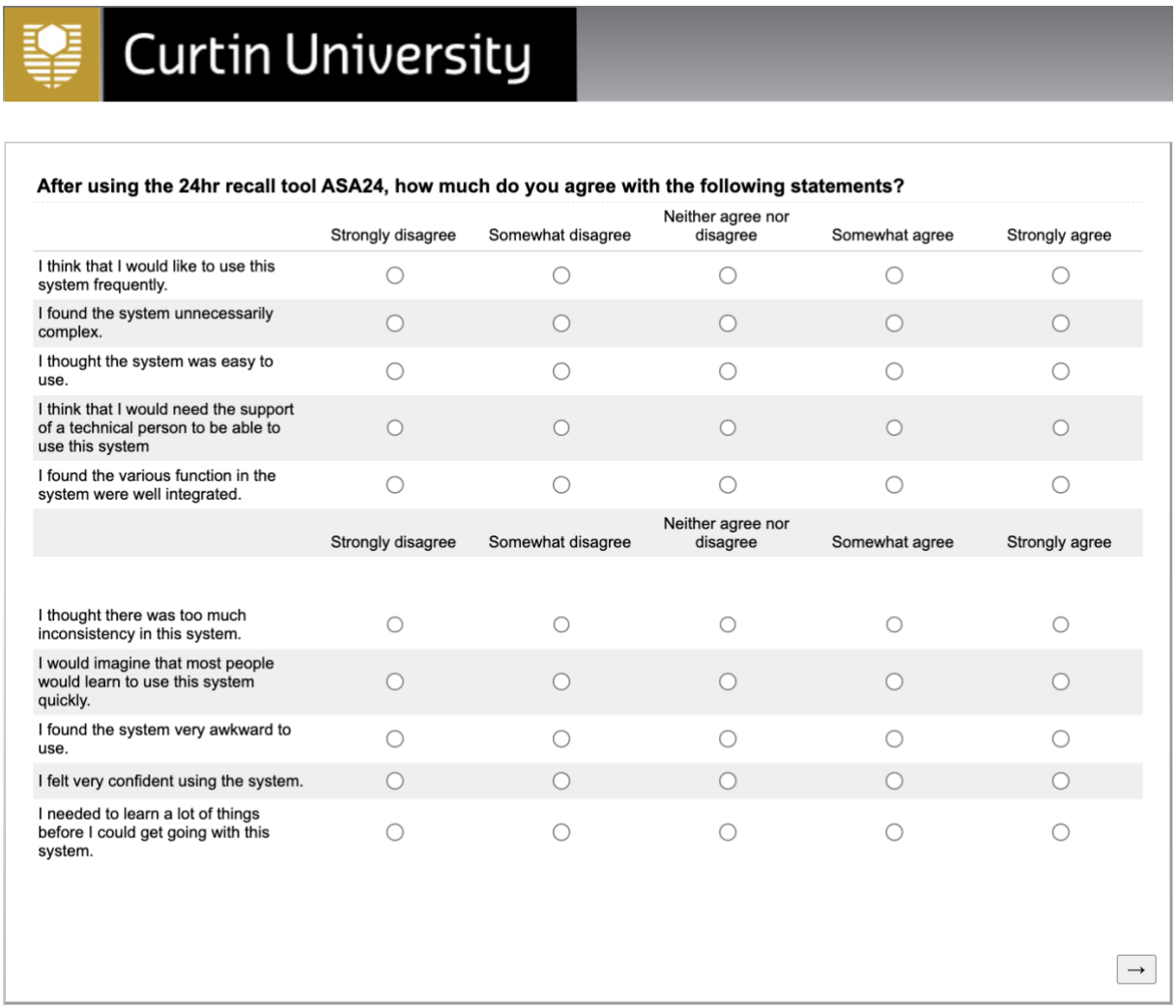


Curtin University

After using the 24hr recall tool INTAKE24, how much do you agree with the following statements?

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I think that I would like to use this system frequently.	○	○	○	○	○
I found the system unnecessarily complex.	○	○	○	○	○
I thought the system was easy to use.	○	○	○	○	○
I think that I would need the support of a technical person to be able to use this system.	○	○	○	○	○
I found the various function in the system were well integrated.	○	○	○	○	○
	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I thought there was too much inconsistency in this system.	○	○	○	○	○
I would imagine that most people would learn to use this system quickly.	○	○	○	○	○
I found the system very awkward to use.	○	○	○	○	○
I felt very confident using the system.	○	○	○	○	○
I needed to learn a lot of things before I could get going with this system.	○	○	○	○	○

→

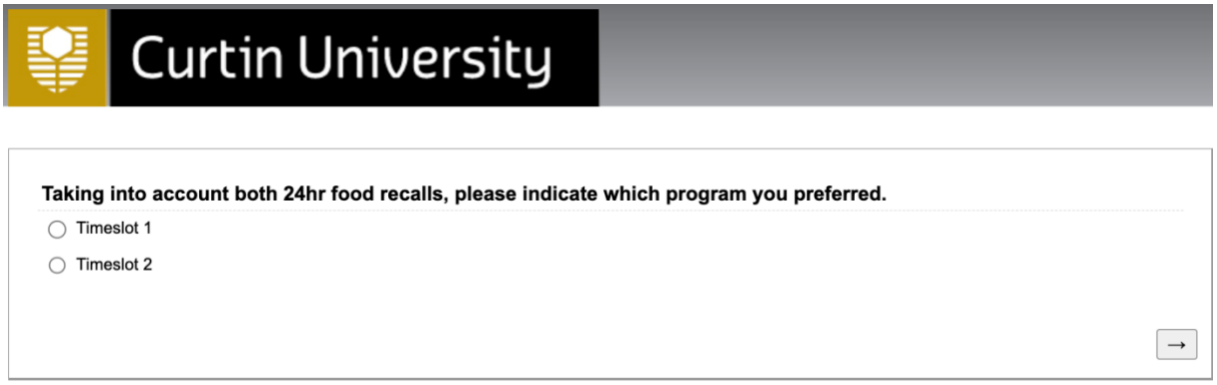


Curtin University

After using the 24hr recall tool ASA24, how much do you agree with the following statements?

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I think that I would like to use this system frequently.	○	○	○	○	○
I found the system unnecessarily complex.	○	○	○	○	○
I thought the system was easy to use.	○	○	○	○	○
I think that I would need the support of a technical person to be able to use this system	○	○	○	○	○
I found the various function in the system were well integrated.	○	○	○	○	○
	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I thought there was too much inconsistency in this system.	○	○	○	○	○
I would imagine that most people would learn to use this system quickly.	○	○	○	○	○
I found the system very awkward to use.	○	○	○	○	○
I felt very confident using the system.	○	○	○	○	○
I needed to learn a lot of things before I could get going with this system.	○	○	○	○	○

→


Curtin University
Taking into account both 24hr food recalls, please indicate which program you preferred.
Timeslot 1
Timeslot 2
→

Supplementary Material 7

Chapter 2: Participant Debrief Form

The Participant Debrief Form is unable to be reproduced here due to privacy restrictions.

Supplementary Material 8

Chapter 2: 24HR Webpage Links

Via Qualtrics, participants were transferred to these measures for their 24-hour food recall.

Each participant completed both programs which were counterbalanced.

INTAKE24: https://intake24.co.uk/

ASA24: https://asa24.nci.nih.gov/

Supplementary Material 9

Chapter 2: Quantifying the Think-Aloud Checklist

To test for the type of perceived problems associated when using ASA24 and INTAKE24 24-hour dietary recall programs, 4 Pilot audio recordings (from both programs) were transcribed, and a content analysis was conducted. The transcribed material was analysed by the main researcher, Katlyn Mackenzie, and cross analysed by a co-supervisor, Professor Deborah Kerr. Mid-way through analyses, both researchers met up and made sure they were following the same coding process. After separately analysing and creating a coded list of what each researcher believed was classed a type of problem, they cross-checked they got similar answers. After discussion an agreed checklist was created to quantify the frequency of perceived problems risen by participants during the dietary recall.
Each subcategory within the main category's (Remembering, Program, Emotion), were summed for an overall score for that problem type.

Remembering	Total	Program	Total	Emotion	Total	Overall Perceived problems
What = 5 Portion = 3 Item = 0 Guess = 9	17	What = 2 Where = 2 Individual = 1	5	Frustration = 4 Confusion = 1	5	27

Instructions from Appendix E. Within the left column, there are categories for perceived problems (Problems with remembering, problem with program, emotional problems, and none) that provide description and examples for what may be perceived as a problem during recall. Each time a problem in the category arose, a tally mark would go in the opposite box. All tallies should be summed for each category and subcategory. [Remembering (rows 1-4), Program (rows 5-7), Emotion (rows 8-9), None (row 10)].

Supplementary Material 10

Chapter 3: Ethics Approval Letter

The Ethics Approval Letter is unable to be reproduced here due to privacy restrictions.

Supplementary Material 11

Chapter 3: Participant Information Sheet

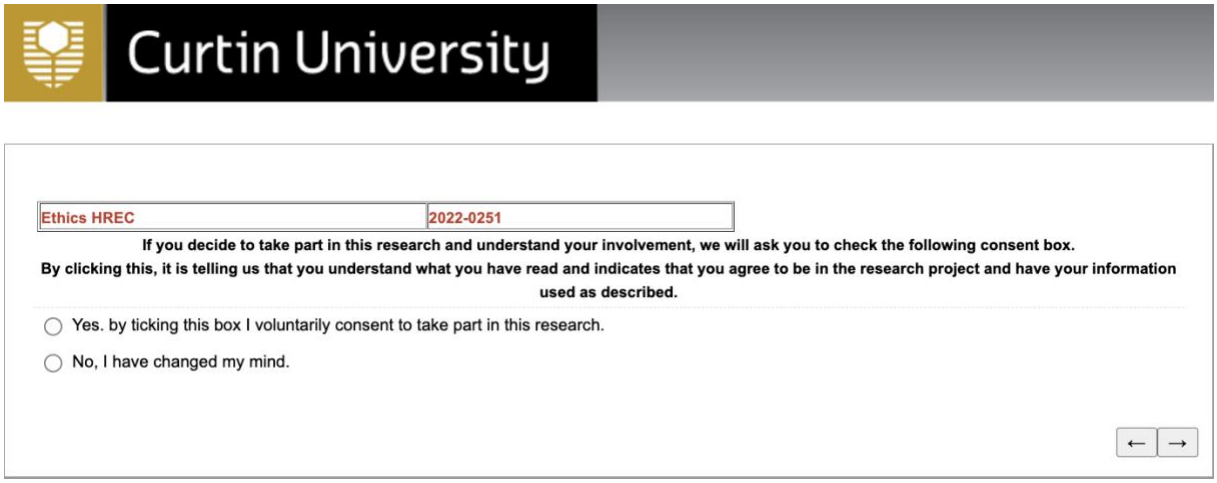
Social Media and SONA

The Participant Information Sheet is unable to be reproduced here due to privacy restrictions.

Supplementary Material 12

Chapter 3: Participant Consent Form

Social Media and SONA



Supplementary Material 13

Chapter 3: Qualtrics Survey – Pre-Recall Part 1

Examples include, Creatures of Habit Scale, Nutritional Awareness Scale, Short-Form Food Frequency Questionnaire and Demographic Questions

How much do you agree with the following statements

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I often find myself finishing off a packet of biscuits just because it is lying there	○	○	○	○	○
I often find myself opening up the cabinet to take a snack	○	○	○	○	○
When walking past a plate of sweets or biscuits, I can't resist taking one	○	○	○	○	○
Television makes me particularly prone to uncontrolled eating	○	○	○	○	○
I often find myself eating without being aware of it	○	○	○	○	○
I am prone to eating when I feel stressed	○	○	○	○	○
Eating crisps or biscuits straight out of the packet is typical of me	○	○	○	○	○
Whenever I go to the kitchen, I typically look in the fridge	○	○	○	○	○
I usually treat myself to a snack at the end of a workday	○	○	○	○	○
I often take a snack while on the go (e.g. when driving, walking, using the computer)	○	○	○	○	○
I often find myself running on 'autopilot', and then wonder why I ended up in a particular place, or doing something that I did not intend to do	○	○	○	○	○

How much do you agree with the following statements

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I tend to like routine	○	○	○	○	○
I find comfort in regularity	○	○	○	○	○
I rely on what is tried and tested rather than exploring something new	○	○	○	○	○
I quite happily work within my comfort zone rather than challenging myself	○	○	○	○	○
I tend to stick with the version of the software package that I am familiar with for as long as I can	○	○	○	○	○
I generally cook with the same spices/flavourings	○	○	○	○	○
I normally buy the same foods from the same grocery store	○	○	○	○	○
In a restaurant, I tend to order dishes that I am familiar with	○	○	○	○	○
I tend to do things in the same order every morning (e.g. get up, go to the bathroom, have a coffee...)	○	○	○	○	○
I always try to get the same seat in places such as a bus, in the cinema, or in class	○	○	○	○	○
I usually sit at the same place at the dinner table	○	○	○	○	○
I like to park my car or bike always in the same place	○	○	○	○	○
I always follow a certain order when preparing a meal	○	○	○	○	○
I am one of those people who get really annoyed by last minute cancellations	○	○	○	○	○
I tend to go to bed at roughly the same time every night	○	○	○	○	○
I generally eat the same things for breakfast everyday	○	○	○	○	○

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Please indicate your agreement with the following statements

	Strongly Agree	Agree	Neither	Disagree	Strongly Disagree
I have the impression that other people pay more attention to healthy eating than I do	○	○	○	○	○
I think it is important to eat 2 pieces of fruit and 200g of vegetables a day	○	○	○	○	○
I pay attention that I do not eat too much	○	○	○	○	○
I take care that I eat a balanced diet	○	○	○	○	○
I take care that I eat regularly	○	○	○	○	○
I pay attention that I do not use too much sugar	○	○	○	○	○

Please indicate your agreement with the following statements

	Strongly Agree	Agree	Neither	Disagree	Strongly Disagree
It is important for me that my daily diet contains a lot of vitamins and minerals	○	○	○	○	○
The healthiness of snacks makes no difference to me	○	○	○	○	○
I do not avoid foods, even if they may raise my cholesterol	○	○	○	○	○
I do not want to ask myself all the time whether the things I eat are good for me	○	○	○	○	○
To check your attention, please select 'Agree'	○	○	○	○	○
I am prepared to leave out a lot, to eat as healthy as possible	○	○	○	○	○
I think it is important to know how to eat healthy	○	○	○	○	○

Please indicate your agreement with the following statements

	Strongly Agree	Agree	Neither	Disagree	Strongly Disagree
The healthiness of food has little impact on my food choices	○	○	○	○	○
I am very particular about the healthiness of the food I eat	○	○	○	○	○
I eat what I like and I do not worry much about the healthiness of food	○	○	○	○	○
It is important for me that my diet is low in fat	○	○	○	○	○
I always follow a healthy and balanced diet	○	○	○	○	○

← →

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On average, how many portions of fruit do you eat a day?
(examples include a handful of grapes, an orange, a glass of fruit juice, a handful of dried fruits etc.)

On average, how much exercise do you do, if any?

- ○ I don't do any exercise
- ○ I do some light exercise (gentle walking, light housework)
- ○ I do some moderate exercise (fast walking, swimming, golf, heavy housework)
- ○ I do some vigorous exercise (running, team sports, hard swimming, gym session)

Please tick how often you eat at least ONE portion of the following foods and drinks in a 'typical' week.

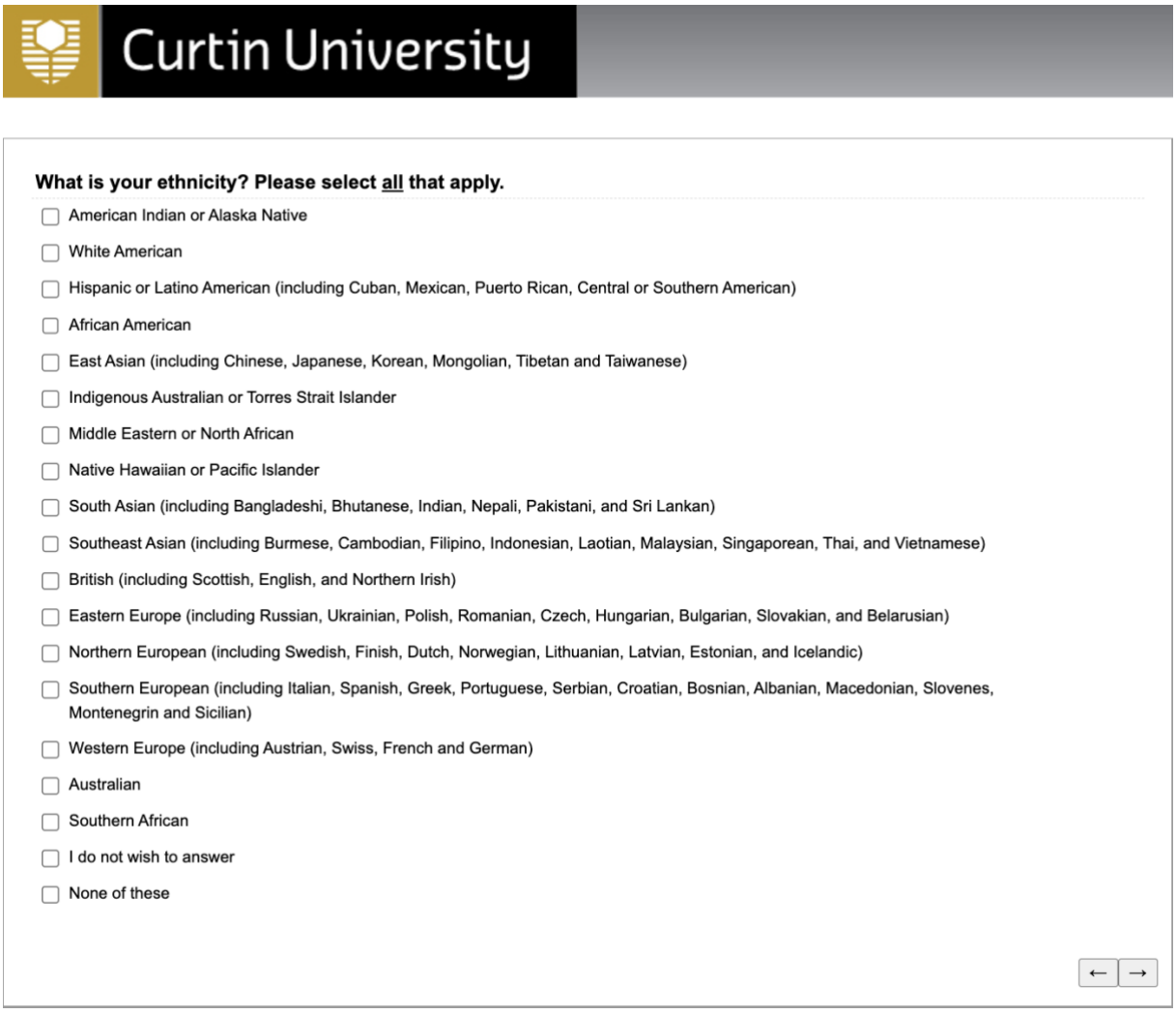
(a portion includes: a handful of grapes, an orange, a serving of carrots, a side salad, slice of bread or one glass of a beverage)

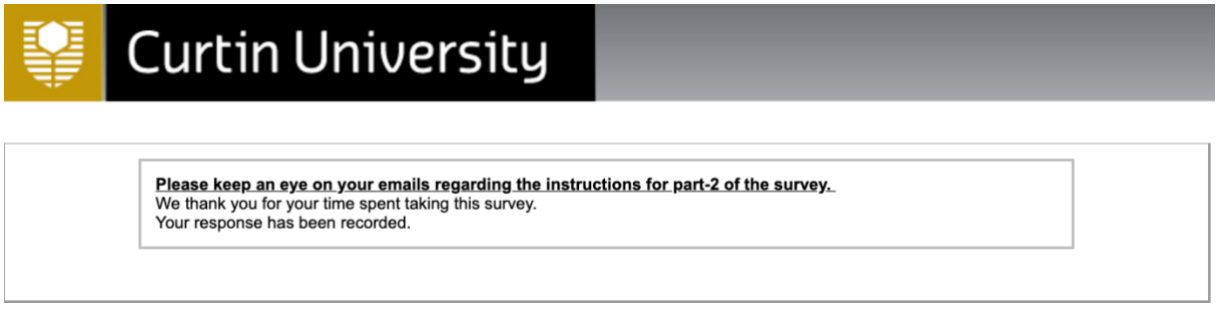
	Rarely/Never	Less than 1 a week	Once a week	2-3 times a week	4-6 times a week	1-2 times a day	3-4 times a day	5+ times a day
Fruit (tinned or fresh)	○	○	○	○	○	○	○	○
Fruit juice (not cordial or flavoured drinks)	○	○	○	○	○	○	○	○
Salad (not garnish or added to sandwich)	○	○	○	○	○	○	○	○
Vegetables (tinned/frozen/fresh but NOT potatoes)	○	○	○	○	○	○	○	○
Chips/fried potatoes	○	○	○	○	○	○	○	○
Beans or pulses (baked beans, chickpeas, dahl)	○	○	○	○	○	○	○	○
Fibre-rich breakfast cereal (weetabix, porridge, muesli etc.)	○	○	○	○	○	○	○	○
Wholemeal bread or chapattis	○	○	○	○	○	○	○	○

What milk do you usually use or drink, such as in hot or cold drinks or on cereal? (including tea, coffee, hot milk, protein shakes, cereals etc.)

- ○ Whole/full-fat milk
- ○ Skimmed milk
- ○ Semi-skimmed milk
- ○ Rarely/Never use milk
- ○ Other (please write)

On average, how many portions of vegetables do you eat a day?
(examples include 3 heaped tablespoons of carrots, a side salad, 2 spears of broccoli etc).


Curtin University
What is your ethnicity? Please select all that apply.
American Indian or Alaska Native
White American
Hispanic or Latino American (including Cuban, Mexican, Puerto Rican, Central or Southern American)
African American
East Asian (including Chinese, Japanese, Korean, Mongolian, Tibetan and Taiwanese)
Indigenous Australian or Torres Strait Islander
Middle Eastern or North African
Native Hawaiian or Pacific Islander
South Asian (including Bangladeshi, Bhutanese, Indian, Nepali, Pakistani, and Sri Lankan)
Southeast Asian (including Burmese, Cambodian, Filipino, Indonesian, Laotian, Malaysian, Singaporean, Thai, and Vietnamese)
British (including Scottish, English, and Northern Irish)
Eastern Europe (including Russian, Ukrainian, Polish, Romanian, Czech, Hungarian, Bulgarian, Slovakian, and Belarusian)
Northern European (including Swedish, Finish, Dutch, Norwegian, Lithuanian, Latvian, Estonian, and Icelandic)
Southern European (including Italian, Spanish, Greek, Portuguese, Serbian, Croatian, Bosnian, Albanian, Macedonian, Slovenes, Montenegrin and Sicilian)
Western Europe (including Austrian, Swiss, French and German)
Australian
Southern African
I do not wish to answer
None of these
←
→


Curtin University
Please keep an eye on your emails regarding the instructions for part-2 of the survey.
We thank you for your time spent taking this survey.
Your response has been recorded.

Supplementary Material 14

Chapter 3: Qualtrics Survey – Part 2

Unique INTAKE24 links followed by Nutritional Awareness Scale as advised via email instructions for Group 1 and Group 2. Qualtrics screenshots for the Nutritional Awareness Scale are as above, in Supplementary Material 13.

There are two links below. Please carefully read the instructions and ensure these are both completed.

Hello and thank you so much for completing the first part of my survey 3 days ago. Here are the links and instructions to part 2 of the study. If you can, please complete all steps in one sitting.

Step 1: Please have a separate phone or laptop device next to you that can capture audio recording. You can do this by starting a video recording next to you, with the camera facing the bench, or the voice recorder.

Step 2: Click the following link or copy and paste it into your browser. This link will take you to a website called INTAKE24. Here, you will be asked questions on the foods and drinks you have consumed in the last 24 hours. Whilst filling these questions out, we ask that you record yourself thinking aloud. This means, whilst you are completing the task, we want you to speak aloud all the thoughts that come into your mind. There is no right or wrong thing to say, it's just as if you are talking to yourself. Before you begin, please remember to start the audio recording.

http://intake24.com/surveys/CurtinThinkAloud?auth=dqHR4c7SU

Step 3: Please stop the audio recording **and send it via email** before completing the following link. This will have a smaller number of questions that are similar to the first survey. Please remember there will be one final survey in 3 days. Thank you.

https://curtin.au1.qualtrics.com/jfe/form/SV_9ZWCIBYQm0tc4K2

If you have any questions or issues, please respond to this email.

There are two links below. Please carefully read the instructions and ensure these are both completed.

Hello participant, just a friendly reminder to complete part 2 of my survey.

Thank you for completing the first part of my survey 3 days ago. Here are the links and instructions to part 2 of the study. If you can, please complete all steps in one sitting.

Step 1: Please click the following link. This link will take you to a website called INTAKE24. Here, you will be asked questions on the foods and drinks you have consumed in the last 24 hours.

http://intake24.com/surveys/CurtinThinkAloud?auth=rPqf2X7hp
Step 2: After step 1 is complete, please complete some questions on the following link.

https://curtin.au1.qualtrics.com/jfe/form/SV_8cyV0EHLrm9Kdym

Please remember there will be one final survey in 3 days.

If you have any questions or issues, please respond to this email.

Supplementary Material 15

Chapter 3: Qualtrics Survey – Part 3

Short-Form Food Frequency Questionnaire instructed via email 3 days completion of part 2.

Screenshots for the Short-Form Food Frequency Questionnaire are as above, in Supplementary Material 13.

Dear Participant,

Thank you for completing parts 1 and 2 of this research. Your responses are much appreciated.

Please click the following link for the final survey. This should take approximately 3 minutes.

https://curtin.au1.qualtrics.com/jfe/form/SV_bykNcoNp9Trz3ng

If you have any questions or wish to know more information, please feel free to contact the researchers.

Thank you for your time.

Supplementary Material 16

Chapter 3: Participant Debrief Email

The Participant Debrief Email is unable to be reproduced here due to privacy restrictions.

Supplementary Material 17

Chapter 3: Prize Draw Winners

Email Notification

The Prize Draw Winners Email is unable to be reproduced here due to privacy restrictions.