Uncovering the Decision-Making Process: An Empirical Investigation of Mouse-Tracking in a Discrete Choice Experiment

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Declaration

I confirm that this is my own work and the use of all material from other sources has been properly and fully acknowledged.

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Abstract

For many years, economic models have assumed that people make choices by paying full attention to all the information describing their choices. These economic models have offered a good approximation of individual decision-making and were shown to be successful at predicting people's choices. More recently, economists have come to agree that limitations in the domain of human attention are not only economically important but relevant in examining how people make choices. Recent technological advances that gather data about the information that people acquire during their decision-making have facilitated the incorporation of human cognitive limitations into economic models. A tool which has become available for economists is mouse-tracking technology. While arguably providing an important source of economic data, mouse-tracking has had a low uptake in the economic literature more generally and in the choice modelling literature more specifically. Consequently, little is known about its potential to enrich data coming from Discrete Choice Experiments. Moreover, mouse-tracking tools such as Mouselab have been criticized for potentially interfering with participants' behaviour due to their occluded design, but there is no direct empirical evidence to prove this. To address these gaps, this thesis investigates the potential of using mouse-tracking in economic research as a tool to gather additional insights into human behaviour. The specificities of Mouselab, which involve imposing a cognitive cost to participants, also provide the context to empirically examine the relevance of the Rational Inattention theory in the context of a hypothetical survey applied to nutritional labelling.

This thesis models the choices that people make under additional cognitive costs imposed by mouse-tracking. The data were collected using an online Discrete Choice Experiment (DCE) with embedded mouse-tracking technology. The DCE asked respondents to make choices between different food baskets as described by the UK's Traffic Light System for food labelling. Participants made their choices in two different and subsequent treatments: a classical DCE where all attributes were visible, and a mouse-tracked DCE where most attributes were hidden. Inference about the preference parameters of respondents was conducted using a Bayesian approach.

Key findings are that mouse-tracking does not appear to interfere in a significant way with choices made as part of a DCE. Willingness-to-Pay (WTP) estimates from the mouse-tracked DCE were correlated with WTP estimates in the classical DCE and a

model merging data from the classical and hidden experiments had a higher predictive validity than the models that treated each experiment separately. Mouse-tracking appears to provide additional and useful insights into human behaviour in a similar way to eye-tracking. However, limitations in relation to the size of mouse-tracking data and the complexity of a mouse-tracked experiment need to be recognised. Mouse-tracking data also appears to confirm previous research in relation to how consumers value and use nutritional information: the amount of attention spent on a nutrient is weakly related to how that nutrient is valued. Therefore, while tools that register and quantify attention can contain useful information about people's preferences, such methods should be used cautiously when attempting to make a connection between attention and value.

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List of abbreviations and acronyms

ANA	Attribute non-attendance
AOI	Areas of Interest
CSS	Cascading Style Sheets
DCE	Discrete Choice Experiment
HMC	Hamiltonian Monte-Carlo
HTML	Hyper Text Markup Language
HTTPS	Hypertext Transfer Protocol Secure
JSON	JavaScript Object Notation
MCMC	Markov Chain Monte Carlo
MXL	Mixed Logit Model
NUTS	No-U-Turn-Sampler
RI	Rational Inattention
RUM	Random Utility Model
Sat	Saturates
Sug	Sugar
TLS	Traffic Light System
WTP	Willingness-to-Pay

1 Background

1.1 Introduction

Attention is a key component of our lives. Hardly any decision we take is made without paying some degree of attention to the object of the decision. When buying a product, we first notice it, look at it, and then decide whether to buy it or not. We might decide to dwell on it for a long time if unsure whether to buy it, or we might dwell on it for a few seconds if we are reasonably convinced that we want to buy it. Irrespective of the length of time we spend looking at something, attention is an integral component of our decisions.

Allocating attention towards a product is a necessary step in considering a product and plays an active role in deciding whether that product will be ultimately chosen (Orquin and Mueller Loose, 2013). However, most of the time attention is not full. In most situations, individuals decide what to pay attention to and what to ignore. Just as limited time and income, limited attention is an important constraint that individuals face in their daily lives.

Despite attention being recognized as limited, past economic models have assumed that individuals pay attention to all the information describing the choices they are making. These models have provided useful approximations of economic behaviour. However, recent years have seen a noticeable push towards incorporating data on the extent of individual attention into economic models. Recent economic research has started to incorporate measures of visual attention by using eye-tracking technologies. While quite a lot is known about the benefits of incorporating eye-tracking data into economic research, less is known about other tools with the potential to track visual attention. One of these tools is mouse-tracking which enables researchers to track individual mouse movements. However, little is known about how mouse-tracking could be used as a technology in economic research and the extent to which mouse-tracking data could provide insights into economic behaviours.

This thesis seeks to better understand the potential that mouse-tracking technologies hold for economic research and their likely impact on respondent behaviour.

By collecting mouse-tracking data as part of a Discrete Choice Experiment applied to the UK's Traffic Light System for nutritional labelling, this thesis also seeks to understand the role of attention in nutritional labelling use.

This chapter sets out the background and significance of this study, identifies the research gap and outlines the objectives and research questions. Section 1.2 starts by describing the general significance of attention while Section 1.2.1 and 1.2.2 examine its links with individual decision-making processes such as consumer choice and nutritional label use. Section 1.3 provides a brief review of how the field of economics has dealt with the issue of attention over the years and the recent advancements which have recently been made in relation to measuring and incorporating measures of attention into economic modelling. Section 1.4 describes the objectives of this research and its associated research questions and hypotheses. The last two sections describe the contributions made by this thesis and provide an overview of the thesis structure.

1.2 The significance of attention

Attention is a key concept and crucial area of research in psychology. William James, considered to be one of the founding fathers of psychology, defined attention in terms of selectively focussing on a specific item: "[Attention] *is the taking possession by the mind, in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought. Focalization, concentration, of consciousness are of its essence"* (James, 1918, p.404). He defined attention as both a sensorial activity which involves focussing on a stimulus (*visual attention*) and as an intellectual activity whereby the focus of attention are ideas and representations (*intellectual attention*). There are many interpretations of the concept of attention. Attention has been interpreted as both a voluntary and active process whereby attention is directed by the individual goals and motivations (also called *top-down attention*), and as involuntary and passive whereby attention is caught by attractive stimuli which stand out in an environment (also called *bottom-up attention*) (Egeth and Yantis, 1997; Connor, Egeth and Yantis, 2004).

One of the most important aspects of attention is that it is a limited resource. Attention is limited because human capacity to cognitively process information is limited. Psychological research investigating the causes of limited attention has shown that attention might include a filtering process aimed at selecting the stimuli that will be attended (Broadbent, 1958). In other words, the information will never be fully attended because of a bottleneck in the flow of information from the moment the stimulus is received to the moment it is processed.

Because attention is both limited and important in decision-making, finding ways to attract it is considered a worthwhile effort. Attracting customers' attention towards products and services are key concerns in marketing. Similarly, attracting consumers' attention towards the health aspects of food is an objective of front of pack nutritional labelling. The links between attention and consumer choice and the links between attention and nutritional label use will be discussed in Section 1.2.1 and 1.2.2.

1.2.1 Attention in consumer choice

Attention plays a key part in consumer choice. Many of the decisions consumers make depend to a large extent on the degree of visual attention towards the products they buy. Consumers use their attention to look for products in supermarkets and to make decisions about these products. For a product to be chosen, it first needs to be noticed. Allocating attention towards a product is thus a first necessary step in considering a product and plays an active role in deciding whether that product will be ultimately chosen (Orquin and Mueller Loose, 2013). Along time and income, attention is one of the resources consumers have at their disposal when shopping.

The links between attention and consumer choice have been investigated for many years. The literature agrees there is an important link between attention and choice, especially in relation to food decisions. Grebitus, Roosen, & Seitz (2015) find in a choice experiment that visual attention is strongly linked to food choice. Pieters and Warlop (1999) find that the longer we fixate on a particular brand, the more likely we are to choose it. This is confirmed by Gidlöf *et al.* (2017) who find attention to food products to be the most important predictor of purchase. In general, the empirical literature finds evidence of both top-down and bottom-up attention in food choice. Attention is drawn to items that are more important to individuals or more visually salient (Orquin and Mueller Loose, 2013). Milosavljevic *et al.* (2012) find that when consumers need to make quick decisions, the visual saliency of food products is strongly linked to final choices. Van Loo, Caputo, Nayga, & Verbeke (2014) find that consumers who attach more importance to sustainability also spend more time looking at sustainability labels.

Nutritional labels are one element which can attract consumers' attention and that can play a part in consumer choice. The links between attention and nutritional labels will be further discussed below.

1.2.2 Attention in nutritional label use

Labels are an important factor in consumer food choice. Nutritional labels are key vehicles through which consumers can be informed about the nutritional contents of their food. However, for nutritional labels to have an impact on consumer choice, they first need to be seen.

The literature has been concerned with understanding the drivers of attention to labels in an effort to examine consumer use of labels. The literature has examined these drivers from both a bottom-up and top-down perspective on attention. In general, it has been found that colour-coded labelling is better understood and more likely to impact consumer choice than more extensive text-based information (Bialkova *et al.*, 2014; Becker *et al.*, 2015) potentially because their simplified format allows for quick comparisons of product attributes (Bix *et al.*, 2015). Given competition with other visual stimuli on food packages, nutritional labels also need to be sufficiently large and centrally positioned to facilitate consumer use (Graham, Orquin and Visschers, 2012). However, label use is not only influenced by the properties of the labels, but also by the goals, motivations, and attitudes of the consumers themselves. Health goals and motivations have been shown to drive consumer attention towards nutritional labels (Visschers, Hess and Siegrist, 2010; Hess, Visschers and Siegrist, 2012). Similarly, familiarity with labels has been found to be another driver of consumer attention to labels (Bialkova and van Trijp, 2010).

Consumer attention to nutritional labels is important if labels are to have an impact on consumer behaviours, since the very existence of labels does not necessarily guarantee that they are going to be looked at (Lusk and Marette, 2012; Buttriss, 2018). Attention to labels is therefore a first and important step in the processing of label information particularly in food purchasing contexts where several other elements such as brands, prices, promotions, might be competing for consumers' limited attention. However, attention to labels has been less of a concern in the nutritional labelling literature. This thesis tries to fill this gap by examining the role of attention in the context of consumer use of UK's Traffic Light System for food labelling.

1.3 Attention in economics

While the concept of attention has been a key area of research for psychologists for many decades, in economics, attention and its links to economic outcomes has been a less investigated topic (Festré and Garrouste, 2015). This can be partly explained by the traditional focus of economic models on final outcomes rather than on the cognitive processes that led to that outcome (Caplin, 2016). One of the first attempts at incorporating cognitive processes into economic theory is the work of Stigler into the economics of information (Stigler, 1961, 1962). Stigler's work was one of the first to emphasize the role of information search in explaining economic outcomes. At the same time, Herbert Simon was one of the first economists to emphasize the links between information and limited attention: "*What information consumes is rather obvious: it consumes the attention of its consumers. Hence a wealth of information creates a poverty of attention and a need to allocate that attention efficiently among the overabundance of information sources that might consume it*" (Simon, 1971, pp.40-41). Simon's subsequent ideas and research became instrumental to the development of a new branch of economics which aimed to incorporate more psychological realism into economics: behavioural economics.

The different ways in which attention has been incorporated in economic models by the neoclassical and behavioural economics literature will be briefly described in Section 1.3.1 and 1.3.2 below.

1.3.1 Attention in neoclassical economics

Traditionally, economic models of behaviour have assumed that individuals pay full attention to all the information describing a choice. The assumption of perfect attention to information has arguably been a reasonable assumption overall and a necessary simplification for modelling economic behaviour. The choice modelling literature has been one of the main economic strands assuming full attention to all available information. More specifically, the estimation of choice models has often been based on the assumption that the attributes presented to individuals in the context of a Discrete Choice Experiment are fully taken into account. Some economists have attempted to incorporate the fact that respondents might have ignored some parts of the information offered to them. In discrete choice modelling, this has been done via debriefing questions which directly asked respondents to state whether they ignored any DCE attribute. More recently, the choice modelling literature has started to incorporate measures of attention extracted from unconventional data sources such as eye-tracking technologies (Uggeldahl *et al.*, 2016; Vass *et al.*, 2018; Ballco, De-Magistris and Caputo, 2019; Yegoryan, Guhl and Klapper, 2019). Another source of individual attention data is mouse-tracking. However, this data source has not been incorporated so far into choice models. This study attempts to fill in this gap by collecting mouse-tracking data from a Discrete Choice Experiment and examining its relevance in understanding individual behaviour.

By attempting to incorporate proxies of attention, the choice modelling literature has made important links to another branch of economics, Behavioural Economics, which will be briefly described below.

1.3.2 Attention in behavioural economics

A key recognition in Behavioural Economics is that human processing capacity is limited. Individuals are assumed to be rational but within the boundaries of their cognitive capacities and the time they have available, hence the term of "*bounded rationality*" (Simon, 2000; Kahneman, 2003b). One of these boundaries is the limited attention span that humans have. Acknowledging this limited attention and incorporating it into economic models of human behaviour are key concerns for some parts of the behavioural economics literature.

Several economics models of attention are known in the literature. One model is the salience model of Bordalo (Bordalo et al., 2013; Bordalo et al., 2012) which assumes that individuals pay attention to those elements that are more salient according to an individual-specific reference level. Drift diffusion models assume that individuals accumulate evidence in favour of different alternatives while fixating, and stop when they have reached a certain threshold (Krajbich *et al.*, 2012; Caplin and Martin, 2016; Tavares, Perona and Rangel, 2017). The sparsity model of Gabaix (Gabaix, 2014) explains that individuals allocate their attention according to a personal sparsity model.

Another prominent model is the Rational Inattention (RI) model. The RI model recognizes the cognitive burden of paying full attention to a choice problem and assumes that individuals allocate their attention *rationally* towards those features of a decision problem which are most important to them (Sims, 2003, 2006; Dean and Neligh, 2017). The RI theory is linked to the ecological rationality literature which assumes that individuals manage their attention by choosing a few decision rules or heuristics which guide their attention towards the heuristic-relevant aspects of a decision (Mackowiak, Matejka and Wiederholt, 2018). For instance, an individual might choose to use the price of food as a decision rule or heuristic which meaning they will be paying more attention to the price attribute at the expense of other. Despite applications in the field of macroeconomics (Bartoš *et al.*, 2016; Acharya and Wee, 2019; Corradin, Fillat and Vergara-Alert, 2019; Maccuish, 2019; Bertoli, Moraga and Guichard, 2020), the RI theory has been less examined in the field of consumer choice and nutritional labelling. This thesis will address this gap by empirically testing the validity of the RI theory in the context of a DCE applied to colour-coded nutritional labelling.

1.3.3 Measurements of attention

As briefly discussed in Section 1.3.1, recent years have seen a noticeable interest among economists in enriching economic models with measures of individual attention (Caplin, 2016; Caplin *et al.*, 2016). A large part of the economic literature has started to incorporate measures of visual attention through the use of eye-tracking technologies. While we know quite a lot about the value of incorporating eye-tracking data into economic research, other tracking tools with potential to track visual attention have started to emerge.

One of these tools is mouse-tracking, which enables researchers to track individual mouse movements. But there is little research which uses mouse-tracking within a DCE context. Moreover, there are concerns linked to the interference of mouse-tracking with choice modelling estimates given the occluded design that Mouselab imposes (Rigby, Vass and Payne, 2020). As a result, little is known about how mouse-tracking could be used as a technology in economic research and the extent to which mouse-tracking data could provide insights into economic behaviours. This thesis tries to address this gap by using mouse-tracking within a DCE to understand the scope of mouse-tracking participants. Given the occluded design imposed by using Mouselab to track mouse movements, this thesis also examines respondent attendance in the context of a cognitively costly survey.

1.4 Research design synopsis

This Section offers a brief summary of the research design used in this thesis. Section 5.3.2 provides further details on the design behind this research.

Data for this study were collected through an online Discrete Choice Experiment (DCE) with embedded mouse-tracking capability (MouselabWeb2.0). The DCE was designed around UK's Traffic Light System (TLS) for food labelling which aims to inform consumers about the levels of Salt, Sugar, Fat and Saturates in processed food. Respondents were asked to choose between three food baskets described by the TLS and Price or to choose none of the baskets. Respondents faced 24 choices as follows. Twelve choices were shown in Hidden Treatment which implied that the information related to two of the three food baskets was hidden behind a box. Respondents were able to see the basket description only if they hovered their mouse cursor over each attribute level (Salt, Sugar, Fat, Saturates and Price). As soon as the mouse cursor left the nutrient box, the information about the nutrient level became again hidden. The same twelve choices were shown to respondents in Open Treatment, which is similar in design to a classical DCE in that all attributes are clearly visible. An illustration of the two treatments can be found in Section 5.3.3.

By hiding the attribute information behind a box and requiring respondents to hover their mouse cursor over it for the information to be visible, the Hidden Treatment introduced a cognitive cost for respondents. Hiding the information was a requirement for tracking mouse movements. This setup was needed because MouselabWeb 2.0, the mouse-tracking tool used in this research, can only track mouse movements as long as the information that is tracked is hidden behind a box. By comparing participants' choices in the Hidden (with mouse-tracking) and Open Treatment (without mouse-tracking), it is thus possible to examine the degree of interference of Mouselab with choice modelling estimates. By collecting mouse movement data in the Hidden Treatment, it is also possible to examine respondent engagement with a cognitively costly task.

1.5 Objectives, research questions and hypotheses

This study draws on the gaps identified above and in the Literature Review (Chapter 2) and is structured around three main objectives. These objectives are:

- ***Objective 1: To understand the potential of mouse-tracking as a source of individual-level data in stated preference research and the extent to which it can provide insights into individual behaviour.***

- ***Objective 2: To understand the impact of a cognitively costly survey on respondent engagement.***

- ***Objective 3: To understand consumer engagement with colour-coded nutritional labels.***

These three objectives have several research questions and hypotheses associated. These are further detailed below.

Objective 1: To understand the potential of mouse-tracking as a source of individual-level data in stated preference research and the extent to which it can provide reliable insights into individual behaviour.

The first objective will evaluate to what extent mouse-tracking can provide insights into people's decision-making behaviour in the context of Discrete Choice Experiments. Research questions that will be investigated are:

<u>*Q1: To what extent does Mouselab interfere with choices in a Discrete Choice Experiment?*</u>

Conducting a choice experiment with Mouselab imposes a cognitive constraint on respondents. In order to extract data related to the attributes looked at by respondents, the attribute information needs to be hidden behind a box. It is therefore necessary to understand to what extent this choice layout influences participants' choices. Understanding whether Mouselab interferes with choices is important if future researchers want to use this tool to extract data about respondent's valuation of and attention to attributes. This research will therefore attempt to understand the extent to which Mouselab interferes with respondents' behaviour in a choice experiment. Given preliminary evidence that Mouselab appears to provide similar insights to eye-tracking technologies (Meissner, Scholz and Decker, 2010), the hypothesis associated with this research question is the following:

H1: Mouselab does not interfere substantively with participants' inferred preferences.

Q2: Is there a relationship between eye-tracked data and mouse-tracked data?

Recent years have seen an increasing interest in using eye-tracking data to gather more information about respondents' behaviour. These studies have found a link between eye movements and choice behaviour and data about eye movements has been shown to incorporate additional information beyond attribute information(Chen *et al.*, 2015; Danner *et al.*, 2016; Van Loo, Grebitus, *et al.*, 2018; Yang, Toubia and de Jong, 2018). However, these studies have been limited in terms of small samples and high costs. In contrast, mouse-tracking software has the potential to gather data on larger samples than eye-tracking and at a relatively lower cost. Understanding the extent to which eye-tracking and mouse-tracking can provide similar data will therefore help future researchers who wish to use measures of attention in their economic experiments.

Objective 2: To understand the impact of a costly survey on respondent engagement.

As described in section 1.4, conducting a DCE while mouse-tracking participants necessarily imposes a cognitive cost to respondents. This is because mouse movements can only be collected if the information is hidden behind a box. This specific layout makes it relatively challenging for respondents to engage with the survey. However, this also provides the opportunity to examine respondent engagement with a cognitively costly survey for which there are no real consequences. This objective links therefore to the wider debate amongst economists in relation to whether non-consequential surveys provide a useful approximation of behaviour in real circumstances (Irwin, McClelland and Schulze, 1992). To this end, the following research question will be investigated:

Q3: What is the impact of a mouse-tracked DCE on respondents' overall attention to the DCE?

Objective 3: To understand consumer engagement with colour-coded nutritional labels

Previous research in the field of nutritional labelling has examined the role of labels in capturing attention. In relation to the Traffic Light System for food labelling, there is evidence that consumers have a strong preference towards avoiding food baskets dominated by red (Balcombe, Fraser, Williams, & McSorley, 2017). However, the links between how consumers allocate their attention and their valuation of nutrients have not been examined. Similarly, the links between heuristics and consumer attention have not been examined. This research will attempt to fill in this gap by examining consumers' attention not only for different nutrients, but also in terms of the links between attention and nutrient valuations. This analysis will be carried out from the perspective of the Rational Inattention theory. The RI theory predicts that that the degree of attention is associated with how much something is valued. It also predicts that attention is linked to the heuristics used in decision-making. The research questions and associated hypotheses that will be investigated are:

Q4: Is there any evidence of RI in nutritional label use?

H2: Participants who spent more time (in relative terms) looking at an attribute in relative terms valued it more relative to other individuals.

H3: Participants who looked more often (in relative terms) at an attribute in relative terms valued it more relative to other individuals.

H4: At a collective level, if an attribute receives more attention it means it is more valued than other attributes.

Q5: What are the links between heuristics and attention patterns?

H5: Using cheapest basket as a heuristic is associated with higher attention on the Price attribute.

1.6 Intended contribution

The insights gained from this research contribute to several different fields. First, this research brings a methodological contribution to the literature on stated preference research and Discrete Choice Experiments by incorporating and examining a new data source: mouse-tracking data. Second, by incorporating mouse-tracking data in a choice experiment applied to the Traffic Light System, this thesis brings new insights into the relationship between consumer attention to nutrients and valuation of nutrients. Third, this research brings a contribution to the ever-growing empirical literature on Rational Inattention. These contributions are further detailed below.

1.6.1 A methodological contribution

This study examines how the use of mouse tracking data could deepen current understanding of decision-making within the framework of a choice experiment. By investigating the feasibility of collecting mouse movements data, this research tries to address currents gaps in relation to new ways of collection individual-level data. Drawing from the experience of implementing a DCE with mouse-tracking software, this research will provide suggestions and future avenues for using mouse-tracking data to complement classical choice experiment data or other types of economic experiments. This will inform future research in the area of applied economic analysis and more specifically will inform future researchers who wish to use mouse-tracking data as a complement to traditional economic data.

Insights from conducting a choice experiment while collecting mouse data will be used to inform future stated preference research. The practicalities of using mouse-tracking software in terms of programming an experiment, the costs associated with running it, the data outputted, and its analysis will be presented to show the potential of Mouselab in future research. Conclusions about whether mouse-tracking could potentially be a valuable data source in choice experiments and in economic experiments more broadly will be drawn.

1.6.2 A contribution to the food labelling literature

As shown in Section 1.2.2 above, it is still not very well understood how people use nutritional information and the role that attention plays in this use. Understanding how consumers use their attention when using the TLS is a key factor in understanding engagement with nutritional labels. The outcomes of this research will further our understanding of the link between attention and heuristics and between attention and valuation in nutritional label use. By investigating the links between heuristics and patterns of attention in food choice this research aims to contribute to the ongoing nutritional labelling literature.

1.6.3 A contribution to the Rational Inattention literature

As shown in Section 1.3.2 above, applications of the Rational Inattention theory have received a lot of attention from economists. However, few applications have come from the field of discrete choice experiments or nutritional labelling. By examining the empirical validity of the Rational Inattention theory in the context of nutritional label use, this thesis is one of the first attempts to test for Rational Inattention in a DCE and nutritional labelling context.

1.7 Thesis outline

This thesis seeks to better understand the potential that mouse-tracking technologies hold for economic research and their potential impact on respondent behaviour. By collecting mouse-tracking data as part of a Discrete Choice Experiment applied to UK's Traffic Light System for food labelling, this thesis also seeks to understand the role of attention in nutritional labelling use.

This thesis is structured as follows. Chapter 2 provides a review of the literature in relation to the economics of attention, choice experiments and attention in nutritional labelling. It describes the different methods and models which have been used in these literatures to measure or estimate individual attention. Based on the reviewed literature, this chapter also outlines several research gaps which this thesis will address. Chapter 3 outlines the conceptual framework used for this research. More specifically, the bounded rationality and the attention economics literature within which this research sits as well as the Rational Inattention framework are described. Chapter 4 describes the methods used in this thesis. It describes the motivation for using discrete choice models and their theoretical basis. This chapter also describes how the discrete choice model employed in this research has been estimated using Bayesian inference. Chapter 5 describes how the primary data for this research has been gathered using an online Discrete Choice Experiment and embedded mouse-tracking capability and provides an overview of mouse-tracking data as well as a descriptive statistic of the final sample. Chapter 6 presents the results of the choice model employed for this research and several analyses linked to understanding whether mouse-tracking interferes with participants' behaviour (Objective 1). Chapter 7 presents the results from analysing the mouse-tracking data gathered as part of the Discrete Choice Experiment. The chapter reports several analyses to understand respondent engagement such as mouse-tracking measures of attention, attribute attendance and the relationship between WTP measures and heuristics. Findings from this chapter contribute mostly to Objective 2 and 3. Chapter 8 discusses the potential that mouse-tracking data might hold in examining individual behaviours and decision-making (Objective 1). It discusses the value of using mouse-tracking data in the context of a Discrete Choice Experiment as well as the impact of a mouse-tracked DCE on respondent overall engagement with the DCE survey (Objective 2). It also discusses the strengths and limitations of mouse-tracking data in relation to eye-tracking data. Chapter 9 combines findings from Chapter 6 and 7 and discusses these in relation to consumer engagement with the Traffic Light System for food labelling (Objective 3). It examines the relevance of the Rational Inattention model and the links between attention and heuristics in the context of nutritional label use. Chapter 10 offers a summary discussion of this thesis, discusses its limitations, and suggests areas for future research.

2 Literature Review

2.1 Introduction

This chapter reviews the literature in relation to the economics of attention, Discrete Choice Experiments, and the role of attention in nutritional labelling. It describes the different ways in which the economics literature has attempted to incorporate measures of attention within economic models, how attention has been measured, as well as the different economic models which have attempted to make sense of how individuals allocate their attention during decision-making. This chapter also describes the Rational Inattention Model which has been chosen for this research, its applications in the literature and its overall implications.

This chapter is structured as follows. Section 2.2 introduces the concept of limited attention as a resource in decision making and the different research programmes that have examined this human limitation. Section 2.3 reviews the concept of limited attention in the context of the choice modelling literature and describes the different methods used in this literature to measure or infer individual attention. Section 2.4 reviews the role of attention in the context of nutritional labelling and the contributions made by the choice modelling literature in this respect. Section 2.5 describes several economic models of attention that have been used in the literature to explain how individuals use their limited attention. Section 2.6 describes in more detail one of these economic models – the Rational Inattention Model – which underpins this research. Building on the reviewed literature, Section 2.7 outlines the research gaps that this thesis will address.

2.2 Attention as a Limited Resource in Decision-Making

For many years, economic models have assumed that when confronted with a decision, individuals will seek to maximize their utility in the following way: after carefully considering all the alternatives in a choice set, they choose the alternative with the highest utility. Individuals were assumed to be rational, have stable preferences and to take account of all the information at their disposal in reaching a decision (Becker, 1993; Sen, 1994; McFadden, 2001) These economic models, also known as rational choice models, have proven to be popular amongst economists because they provided a useful approximation of reality and were good at explaining individual choices and final outcomes. By assuming that individuals have access to and consider all the available information, these economic models made an implicit assumption. They assumed that individuals had seen and used this information when making their choices.

More recently, economists have agreed that limitations in relation to the information that is being used when reaching a decision are important and that economic models need to incorporate cognitive limitations faced by individuals (Kahneman, 2003; Kahneman & Thaler, 2006; Sims, 2011). Agreement that these cognitive limitations are important from an economic point of view has led to the development of the behavioural economics literature. A central concept in this literature is that of bounded rationality which assumes that rationality is bounded by several constraining factors such as limited cognitive and information-processing abilities, information complexity and uncertainty. Given these limitations, individuals are assumed to satisfice rather than optimize (Simon, 1972; 2000). Two different yet interrelated lines of research have emerged in the behavioural economics literature that seek to explain these human limitations: the biases and heuristics literature advanced by Kahneman & Tversky (Tversky and Kahneman, 1974; Kahneman, Knetsch and Thaler, 1991; Kahneman, 2003b) and the ecological literature advanced by Gigerenzer et al (Gigerenzer and Goldstein, 1996; Todd and Gigerenzer, 2000; Hutchinson and Gigerenzer, 2005; Gigerenzer, 2008, 2011; Gigerenzer and Brighton, 2009). Sections 2.2.1 and 2.2.2 below discuss these two strands from the perspective of food decisions.

2.2.1 The biases and heuristics research programme

One main strand of the behavioural economics literature examines bounded rationality through the lens of cognitive biases (Tversky and Kahneman, 1974, 1981; Thaler, 1980; Shefrin and Thaler, 1981; Kahneman, 2003; Thaler, Sunstein and Balz, 2010). A large part of this literature has brought important insights into the cognitive biases that seem to play a role in people’s food decisions. For example, we know from this literature that sometimes food choices are susceptible to default effects or the propensity to stick to a default option (Choi *et al.*, 2003; Downs, Loewenstein and Wisdom, 2009; Campbell-Arvai, Arvai and Kalof, 2014). We also know that, contrary to standard economic assumptions, some consumers allocate their money for food according to mental budgets or to the labels attached to it, thus violating money fungibility (Smith *et al.*, 2016; Abeler and Marklein, 2017). We also know that how much we eat is heavily influenced by the size of our portions (Diliberti *et al*, 2004; Levitsky & Youn, 2004; Rolls *et al*, 2006) presumably because portions act as a consumption anchor (Marchiori, Papies and Klein, 2014) or because of a unit bias (belief that one unit is the appropriate amount) (Geier, Rozin and Doros, 2006). There is also evidence of a bias towards visually salient items especially in situations where individuals need to take rapid decisions (Milosavljevic *et al.*, 2012; Peschel, Orquin and Mueller Loose, 2019). Food consumption decisions are also affected by the degree of loss aversion (Karle, Kirchsteiger and Peitz, 2015) while food purchasing decisions have been shown to be influenced by projection bias (De-Magistris and Gracia, 2016) and anchoring (Marchiori, Papies and Klein, 2014). It has also been found that hyperbolic discounting or the bias towards the present is associated with unhealthy behavioural choices and outcomes (Shapiro, 2005; Ikeda, Kang and Ohtake, 2010; Richards and Hamilton, 2012; Story *et al.*, 2014; Kang and Ikeda, 2016; Smith *et al.*, 2016; Tórtora and Ares, 2018). There are a wide range of other cognitive biases that have been shown to explain how people make food choices (Just, Mancino, Wansink, 2007).

2.2.2 The ecological rationality research programme

A different line of research in the behavioural economics literature is to examine when and how heuristics are employed in decision-making. Heuristics are "fast and frugal" decision rules which allow a decision-maker to ignore part of the information and find good-enough rather than optimal solutions (Gigerenzer and Goldstein, 1996). This strand of research focuses on the mind as an "adaptive toolbox" (Gigerenzer, 2008) where different heuristics or rules of thumb are collected and used depending on the environment in which decisions are taken. The study of heuristics and their adaptability to different environments has given rise to the ecological rationality literature whose aim is to examine how people make decisions and "what environmental structures enable a given heuristic to be successful, and where it will fail" (Todd and Gigerenzer, 2007, p.168). While the bounded rationality literature focuses on deviations from rational choice models (Kahneman, 2003b), the ecological rationality literature examines heuristics as an "essential cognitive tool for making reasonable decisions" (Todd and

Gigerenzer, 2000, p.739) and their adaptability to the decision-making environment. For researchers in ecological rationality the environment or the context matters more than the violations of rational choice theory.

We know from the ecological rationality literature that decision-making relies on simple heuristics which limit search and use limited rather than more analytical strategies (Schulte-Mecklenbeck *et al.*, 2013). Several heuristics have been shown to play a role in food decisions. For example, a simple lexicographic heuristic which takes into account only one important factor as opposed to several factors was found to be as good at predicting a person's food choice as a more computationally complex strategy which assigns weights to different attributes, sums them up and then chooses the one with the highest score (Scheibehenne, Miesler and Todd, 2007). Another documented heuristic is colour variety which people use to determine the healthiness of a dish (König and Renner, 2018). The conjunctive heuristic which involves elimination of options which do not reach a certain subjective threshold has also been documented in a retail context (Laroche, Kim and Matsui, 2003). There are other heuristics that have been documented in relation to food choices such as the negativity heuristic which allows people to easily recall the nutrients they should avoid or the availability heuristic which enables people to make nutritional judgements based on the information that has recently caught their attention (Gomez, 2013; Kalnikaite, Bird and Rogers, 2013).

2.2.3 The role of attention in explaining cognitive biases and heuristics

Both the biases and heuristics literature and the ecological rationality literature share a common understanding of human behaviour as being limited by processing capacity. Both strands assume that individuals use mental shortcuts or heuristics rather than more computationally intensive decision-making strategies. In this sense, they are opposed to the neoclassical economics assumption of an individual that takes decisions based on full access to and use of all available information. One important cognitive limitation that has been recognized in the behavioural economics literature is that humans have limited amounts of attention and thereby might ignore some features of the decision problem.

Many of the biases and heuristics documented in the literature can be explained by the fact that human capacity for attention is limited. For instance, the visual saliency bias has been shown to occur because people pay less attention to things that are not visually salient and noticeable, which happens especially when people are under time and cognitive constraints (Armel, Beaumel and Rangel, 2008; Dolan *et al.*, 2011; Milosavljevic *et al.*, 2012; Peschel, Orquin and Mueller Loose, 2019). Loss aversion has been explained by human tendencies to pay more attention to negative facts whilst ignoring positive ones (Meyerowitz and Chaiken, 1987). Projection bias can be explained by the tendency to pay exaggerated attention to the current state (Loewenstein, O'Donoghue and Rabin, 2003) and hyperbolic discounting has been attributed to "attentional myopia" (Mann and Ward, 2007) or limited attention to the future (Gabaix, 2017).

Limited attention can also explain why people use heuristics in decision-making at the expense of more cognitively demanding methods. Heuristics are useful because they reduce cognitive effort and allow attention to be allocated only to the most important cues. For instance, a gaze heuristic (fix the gaze and run so that the angle of gaze is constant) allows a player that needs to catch a ball to focus his attention to only one variable rather than undertaking more complex calculations which take into account variables such as speed and wind direction (Todd and Gigerenzer, 2000). Similarly, the take-the-best heuristic allows a decision-maker to discriminate against options and come to a decision based on a single cue rather than paying attention to a whole range of cues (Todd and Gigerenzer, 2007). Anchoring-and-adjustment bias occurs partly because people pay attention to the anchor at the expense of other pieces of information which could have been used in decision-making (Wilson *et al.*, 1996).

Limited attention is therefore a concept that unifies under a common framework the heuristics and biases literature and the ecological rationality literature. Models accounting for this limited attention have started to emerge in the economics literature in recognition of the role that limited attention might play in economic decisions (Sims, 2003, 2006; DellaVigna, 2009; Weber and Johnson, 2009; Gabaix, 2014; Caplin, Dean and Leahy, 2019). These models attempt to incorporate attention as a resource which people have at their disposal during decision-making and which they deplete. Several economic models of attention are discussed in Section 2.5.

2.3 Attention in the context of Discrete Choice Experiments (DCE)

The choice modelling literature has been one of the literature strands that have assumed that decision-makers pay full attention to all the information describing a choice situation. This assumption lies behind the Random Utility Model (RUM) which is the theoretical basis for modelling consumer behaviour in a DCE. RUM assumes that the preference of an individual among a set of alternatives is described by a utility function which is composed of an observed component and an unobserved (or random) component. Individuals choose the alternative that gives them the highest utility upon careful examination of all alternatives which are described by a set of attributes (a more detailed description of the RUM framework can be found in Section 4.2.3). Respondents are thus assumed to make trade-offs between all attributes describing the choice alternatives (Hensher, Rose and Greene, 2015). The RUM framework has been useful in modelling economic decisions, predicting consumer choices, valuing non-market goods and informing new product development over several decades (McFadden and Train, 2000; McFadden, 2001).

2.3.1 Use of heuristics in DCEs

Increasing concerns have been raised around the validity of the assumption of full attention to information within a DCE. These concerns are based on the fact that limited cognitive and processing capacities might impede individuals to attend to all attributes that they are presented with in a choice set. The choice modelling literature has documented a range of heuristics or decision shortcuts that individuals use to deal with the complexity of making a choice in the context of a DCE. In the choice modelling literature, these heuristics are also known under the name of attribute processing strategies or APS (Hensher, Rose and Greene, 2005; Hensher and Collins, 2011; Hensher, 2014). For instance, one of the heuristics identified in this literature is the majority of confirming dimensions which involves participants choosing the alternative with the highest number of best attribute levels (Leong and Hensher, 2012). Another heuristic is the reference point revision which respondents use to compare the desirability of one option in terms of a previously chosen alternative which is used as a reference point (Hensher and Collins, 2011). There are other heuristics that have been documented in the context of DCEs. A major concern in the choice modelling literature is that some heuristics might lead to inadequate WTP estimates. Arguably, one of these heuristics is attribute non-attendance whereby respondents ignore one or several attributes. This will be further discussed below.

2.3.2 Attribute non-attendance (ANA)

For many years, the choice modelling literature has been concerned with the possibility of respondents not attending all attributes within a DCE (Hensher, Rose and Greene, 2012; Kehlbacher, Balcombe and Bennett, 2013; Scarpa *et al.*, 2013). This type of behaviour is known in the literature as attribute non-attendance or ANA. ANA is believed to occur not as a result of respondents having zero utility for the attributes ignored but potentially because of task complexity (Hensher, 2006) or because the attribute might not relevant enough to be attended. There is evidence to suggest that accounting for ANA leads to differences in willingness to pay and improvements in model fitness and predictive validity (Hole et al., 2013a; Sandorf et al., 2017; Scarpa et al., 2009).

The choice modelling literature has dealt with ANA in several different ways. Three main approaches to measuring ANA are known in this literature: the *inferred* approach, whereby attention to DCE attributes is inferred from participants' data, the *revealed* approach, whereby ANA is extracted directly from respondents' data and the *stated* approach, whereby respondents are explicitly asked to state whether they paid attention to the different DCE attributes. These three approaches are discussed in Sections 2.3.3 and 2.3.4 and 2.3.5 below.

2.3.3 Stated approach

A large part of the choice modelling literature uses stated measures of ANA. This approach mostly involves directly asking respondents to state which DCE attributes they have ignored when choosing between the different sets. These approaches, known in the literature as stated attribute non-attendance or stated ANA, have been quite popular in the choice modelling literature (Caputo et al., 2018; Börger, 2016; Balcombe et al., 2015; Hole et al., 2013b; Kehlbacher et al., 2013; Scarpa et al., 2013a) due to concerns that respondents might not attend to all the features of the choice alternatives they are presented with. The most common way is to ask the stated attendance question as part of a set of debriefing questions after individuals have stated their preferences for the choice sets (usually known as serial ANA). In cases where there is a reason to believe that participants might attend differently depending on the choice card in question, then stated ANA questions are asked after each choice card, an approach known as choice task ANA (Scarpa et al., 2010).

A slightly different method of measuring stated attendance has been to ask respondents how much attention they usually pay to different attributes in real life, as opposed to just in the DCE context. For example, Leard (2018) measures attention to fuel costs in a choice experiment by asking respondents the extent to which they considered these costs in past car purchases. This method arguably provides a more realistic understanding into the extent of attention that is normally paid to features of a choice in a real-world setting.

Another method providing insights into the attention paid to a DCE is the think-aloud approach. The think-aloud approach allows respondents to express their thought processes during their decisions (Ryan, Watson and Entwistle, 2009) or just after it (Tanner, McCarthy and O'Reilly, 2019). For instance, Vass, Rigby and Payne (2019) use the think-aloud method to understand how women use risk information when choosing between breast cancer screening programmes while Cheraghi-Sohi *et al.* (2007) use it to understand how respondents interpret attributes in a DCE. In two other DCE studies (Ryan, Watson and Entwistle, 2009; Whitty *et al.*, 2014) the think-aloud approach is used to test whether the DCE method is empirically valid and whether the behaviour of respondents violates utility theory.

The stated approach provides insights into which attributes were considered and which were ignored by the respondent when making a decision. While this approach can provide a useful approximation of a participant's level of engagement with the attributes in a choice set, they are nevertheless imperfect measures. Some participants might not be able to adequately recall whether they attended certain elements describing a choice, while some others might interpret the stated attendance question as referring to things that played a minor role in their decisions (Balcombe *et al.*, 2016; Yegoryan, Guhl and Klapper, 2019). In other cases, it might be that participants paid only partial attention to the attribute in question. At the same time, there is evidence that despite reporting not to have attended a specific piece of information, some individuals have still paid attention to that particular information (Balcombe, Fraser and McSorley, 2015; Balcombe *et al.*, 2017).

2.3.4 Inferred approach

A second approach to measuring ANA in the literature is the inferred approach, whereby attention is inferred from participants' data. This approach has been referred to as endogenous because it relies on observed choices only (Yegoryan, Guhl and Klapper, 2019). This strand of literature has measured ANA by using specific econometric models that allow estimation of the probability of non-attendance. One such econometric model is the latent class model where the different classes reflect the degree to which different attributes have been considered. For instance, a semi-compensatory class might reflect attendance to two out of three attributes, while a lexicographic class might reflect attendance to one out of three attributes (Scarpa *et al.*, 2009; Yegoryan, Guhl and Klapper, 2019). Other econometric tools that have been used in the literature include stochastic attribute selection (Scarpa *et al.*, 2009) and mixed logit models with discrete and continuous mixtures of coefficients conditional on the observed pattern of choice (Scarpa *et al.*, 2013).

2.3.5 Revealed approach

A third approach to measuring ANA in the literature is the revealed approach, whereby attention is directly extracted from the DCE. Within this approach, two methods are known in the literature: the eye-tracking method and the mouse-tracking method.

2.3.5.1 Eye-tracking methods

More recently, the choice modelling literature has seen a considerable uptake in eye-tracking methods that allow researchers to track respondents' attention to attributes. Eye-tracking allows researchers to monitor the foveal vision of respondents as they take part in a computer-based survey. Researchers usually separate specific Areas of Interest (AOI) which correspond to the DCE attributes (Lahey and Oxley, 2016; Spinks and Mortimer, 2016). The eye movement measures that are collected include fixations (number of times someone has fixated on a specific AOI), pupil dilations, saccades (how participants move their eyes between different AOIs) and dwell time (how much time they allocate to fixating AOIs) (Rebollar *et al.*, 2015; Fenko, Nicolaas and Galetzka, 2018; Peschel, Orquin and Mueller Loose, 2019). Because they allow researchers to monitor participants' eye movements in a relatively non-obtrusive way and without the need for attendance self-reporting, eye-tracking methods are considered to be relatively precise and more objective measurements of attendance than stated measures (Graham, Orquin and Visschers, 2012).

The eye-tracking method of inferring attention to DCEs has been shown to bring in additional and useful insights into respondent behaviour within the framework of surveys and Discrete Choice Experiments (Balcombe, Fraser and McSorley, 2015; Van Loo *et al.*, 2015; Ryan, Krucien and Hermens, 2018; Van Loo, Nayga, Campbell, H. S. Seo, *et al.*, 2018; Peschel, Orquin and Mueller Loose, 2019). In addition, it has been suggested that eye-tracking methods could be useful during the design and piloting stage of DCEs by identifying situations when DCEs are too complex for consumers to process them fully and thereby prone to ANA (Spinks and Mortimer, 2016; Balcombe *et al.*, 2017). However, eye-tracking methods are also claimed to be expensive and time-consuming and only suitable for use in controlled laboratory experiments (Graham, Orquin and Visschers, 2012).

2.3.5.2 Mouse-tracking methods

Recent tools which have become available for researchers interested in decision-making and attention involve the use of mouse-tracking technology. For instance, MouseTracker and Open Sesame are tools that that can track and record a participant's mouse trajectory (*x* and *y* coordinates) in real time (for more information see Freeman and Ambady, 2010 and Kieslich *et al.*, 2019). Another mouse-tracking tool which has been recently adopted in the literature is Mouselab. Mouselab captures whether specific information has been inspected as well as the length and the frequency with which it has been inspected. This is usually done with a survey whereby the attribute information is hidden behind a box so that measures of attention can be captured (Willemsen and Johnson, 2011).

Despite its potential to uncover cognitive processes behind decision-making, the take-up of Mouselab in the economics literature more generally and in the stated preference literature more specifically has been quite limited. In the economics literature, Gabaix, Laibson, Moloche, & Weinberg (2006) use Mouselab to study how individuals acquire information in a lab experiment. The mouse movements allow the authors to put to test different attention models. They find evidence that individuals behave in line with a model of directed cognition rather than the fully rational actor model. This model of directed cognition implies that at each decision stage, individuals behave as if their next search was the last one, hence why the model is also called a partially myopic model because individuals calculate the benefits and costs of their decision at each decision stage. In the psychological literature, Schulte-Mecklenbeck et al. (2013) use Mouselab to examine whether heuristics can predict food choices as good as more deliberate strategies. In a laboratory experiment, they study the decision strategies that respondents use when choosing between two lunch options with varying nutritional information (Calorie, Salt content, Protein, Fat, Price, etc). They distinguish between compensatory strategies (where all available information is integrated to reach a decision) and heuristics (which are decision strategies that involve using a limited set of information without any computation or trade-offs). They compare different heuristic strategies to more analytical strategies and find that the former better describes the decision-making process in relation to food. Using a software similar to Mouselab, Bartoš et al. (2016) collect data on how much information about different job candidates recruiters acquire during their hiring process as well as about how much information landlords obtain about their future tenants. They collect this data by sending emails with hyperlinks and monitoring the extent to which landlords and recruiters acquire more information about the future tenant or candidate. They find that recruiters tend to spend more time inspecting information about candidates coming from a majority ethnicity and less time on minority candidates, while they find the opposite for landlords who acquire more information about minority ethnics. This finding allows them to test discrimination theories. Meissner, Scholz and Decker (2010) compare consumer preferences for coffee machines when using both eye-tracking and mouse-tracking in the framework of a choice experiment. They find that mouse-tracking only marginally interfered with marginal utilities derived from a DCE.

While the revealed approach to estimating participants' attention provides important insights into the information that is looked at, this strand of literature relies on a very important assumption. The eye-mind assumption implies that what is looked at is also what is mentally processed (Just and Carpenter, 1980). These methods therefore track what is known in the psychological literature as overt attention. Overt attention refers to the shifts in our physical or spatial attention (eye or mouse movements) while the covert orientation of attention refers to the mental shift of attention without the eye movements. There is some evidence that these two types of attention can be rather distinct (Hunt & Kingstone, 2003). In addition, while eye movements might offer an insight into the cognitive processes that are happening in the mind of an individual, they might not tell the whole story behind these processes (Kok and Jarodzka, 2017). These limitations are important since it might mean, that in certain situations, a physical shift of the eyes towards a particular object or attribute, might not necessarily also imply a mental shift of attention.

2.3.6 Attention in hypothetical surveys

The previous sections have reviewed the different ways in which the choice modelling literature has inferred or measured attribute non-attendance. The concern that some respondents might not attend all attributes in a survey is also linked to the wider debate in stated preference research about the necessity to make hypothetical surveys consequential or incentive-compatible. This concern is motivated by a belief that respondents might not engage sufficiently with a survey if the choices they make are not consequential. For instance, the contingent valuation literature is particularly concerned with ensuring that respondents reveal their true preferences (Carson and Groves, 2007). There is also a belief in the risk preference literature that respondents should face some degree of consequentiality when their risk preferences are elicited. For instance, one way to ensure consequentiality is by making one of the choices made by respondents have a real payoff (Tanaka, Camerer and Nguyen, 2010).

2.4 Attention in the context of nutritional labelling

Attention to and use of nutritional labels are important research topics in the nutritional labelling literature. How people use, process and interact with nutritional labels has been one of the concerns of a large portion of the choice modelling literature over the past years (Balcombe, Fraser and Di Falco, 2010; Barreiro-Hurle, Gracia and de-Magistris, 2010; Scarborough *et al.*, 2015). Discrete choice models are suited to investigating engagement with nutritional labels because they allow the researcher to treat labels as part of the set of attributes offered to the respondent and therefore allow estimation of how much consumers value the information provided by the label. In recent years, to better understand the use of labels, researchers have tried to incorporate measures of participant attention discussed in Section 2.3 such as stated measures of attribute attendance or eye movements (Jones and Richardson, 2007; Ortega *et al.*, 2011; van Herpen and Trijp, 2011; Bialkova, Grunert, Juhl, Wasowicz-Kirylo, Stysko-Kunkowska and van Trijp, 2014; Turner *et al.*, 2014; Bix *et al.*, 2015; Reale and Flint, 2016; Van Loo *et al.*, 2017; Peschel, Orquin and Mueller Loose, 2019b). Within this literature, an avenue of research has been to examine how respondents understand and interact with the UK's Traffic Light System (TLS) for nutritional labelling which assigns a colour to each nutrient depending on its levels (low, medium or high) (Balcombe, Fraser and Di Falco, 2010; Scarborough *et al.*, 2015). The existing literature has investigated consumer attention to nutritional labels from either a *bottom-up* approach or a *top-down* approach to attention. *Bottom-up* approaches are concerned with understanding the extent to which different aspects of the label are able to attract consumers' attention. *Top-down* approaches are concerned with understanding the individual level factors that might contribute to using and paying attention to nutritional labels. These two approaches are discussed in Section 2.4.1 and 2.4.2 below.

2.4.1 Bottom-up approaches to examining attention to nutritional labels

Part of the literature investigating attention to nutritional labels has been concerned with examining the way in which the appearance of labels could be modified to attract attention and be used by consumers. It has been found that label features such as size, position and colour scheme are key drivers of consumer attention to labels (Bialkova and van Trijp, 2010). Colour-coded labelling has been shown to be better understood by consumers than monochrome labelling (Borgmeier and Westenhoefer, 2009) or textual information (Becker *et al.*, 2015). Colour-coded labelling has been found to attract consumer attention and processing and to discourage consumers from purchasing products with high level of harmful nutrients (Balcombe, Fraser and Di Falco, 2010; Scarborough *et al.*, 2015). There is also evidence to suggest that colour-coded labelling leads in some cases to a bigger impact on product choice than more extensive ingredient information (Becker et al., 2015; Bialkova et al., 2014a).

Different recommendations as to how these nutrition labels could be improved to help consumer use have been put forward in terms of size, position, and salience of the label. For instance, it has been found that consumers are able to make more effective use of labels when these are positioned centrally, are visually salient through the use of colours and through surface size and when simplifying heuristics are incorporated

(Graham and Jeffery, 2011; Graham, Orquin and Visschers, 2012). At the same time, there is also evidence to suggest that attention to nutritional labels might decrease if there are other additional packaging elements competing for attention (Bialkova, Grunert and van Trijp, 2013).

2.4.2 Top-down approaches to examining attention to nutritional labels

The literature summarized above shows a large interest in the bottom-up effects that food labels have in general on consumers. But attention is also endogenous to the individual that pays attention and therefore depends on individual level factors that are outside the stimulus in question. The literature examining attention to nutritional labels from a top-down perspective has found that the use of nutritional labels appears to be driven by either individual health motivations or by a combination between motivations and the label in question. Visschers et al. (2010) find in an eye-tracking study that both consumers' health goals and the package design drive consumers' attention towards nutritional information. This is confirmed by another eye-tracking study by van Herpen & Trijp (2011) that finds that the impact of nutritional labels is enhanced when consumers already have a health goal in mind. In another study, people who are mainly motivated by taste, spend less time looking at nutritional information (Turner *et al.*, 2014). This finding is contradicted by Bix et al. (2015) who find that even people who did not have a health goal in mind increased their attention to nutrition information when exposed to a front-of-package nutritional label. Familiarity with the labels is another key determinant of attention to labels (Bialkova and van Trijp, 2010). However, even if the label is attended, this does not necessarily mean that the information will be acted upon because consumers might not deem it relevant for their decisions (Tanner, McCarthy and O'Reilly, 2019).

The literature examining label use from a top-down attention perspective looks at consumer heterogeneity in relation to food labels from a motivation and ability point of view. However, what is less investigated in this literature is the heterogeneity of label use and the different levels of attention that different individuals might allocate to the information provided by the nutritional label. The Rational Inattention Model which will be discussed in Section 2.6 provides a useful framework to examine this heterogeneity in label use.

2.5 Economic Models of Limited Attention

Section 2.3 has reviewed the different ways in which individual attention has been measured or estimated using stated, inferred, and revealed approaches while Section 2.4 has reviewed the links between nutritional labels and attention. This section describes the different ways in which the economics literature has attempted to model how individuals allocate their scarce attentional resources. Multiple economic models of attention are used in the literature and this section will present only a selected few, while acknowledging that the attention economics literature is an ever-growing field. In general, economic models of attention fall into two broad categories: *bottom-up models* which assume that attention is exogeneous and driven by the decision-making environment and *top-down models* which assume that attention is driven by the individual's goals and motivations (Orquin and Mueller Loose, 2013).

The bottom-up category includes models such as the salience model of Bordalo (Bordalo et al., 2013; Bordalo et al., 2012) which assumes that individuals pay attention to those elements that are more salient according to an individual-specific reference level and the drift diffusion models which assume that individuals accumulate evidence in favour of different alternatives while fixating, and stop when they have reached a certain threshold (Krajbich *et al.*, 2012; Caplin and Martin, 2016; Tavares, Perona and Rangel, 2017). The top-down category include Bayesian approaches to attention that assume rational consumers are Bayesians and therefore model any departure from Bayesian inference as reflecting a form of inattention, the consideration sets models which assume individuals have a limited set of options that they consider at any point in time (consideration sets) which allow them to allocate attention in a differential way as well as the sparsity model (Gabaix, 2014) according to which individuals allocate their attention according to a personal sparsity model. These different approaches to modelling attention are explained in more detail in the rest of this section.

2.5.1 Bottom-up attention models

Bottom-up attention models start from the premise that individual attention depends on and is directed by the features of the environment and the choices individuals are facing at the decision-making moment. These models assume that individual attention is not an autonomous action but is a response to the context or the environment in which individuals find themselves. Attention is driven by the salience of a specific cue or stimulus available in the environment. Individuals are assumed to make use of the available stimulus to reach a decision.

A well-known bottom-up approach to modelling attention is the salience model proposed by Bordalo, Gennaioli, & Shleifer (2013). According to this model, consumers pay attention to the attributes that are more salient with respect to a consumer-specific reference level and in a particular context. The consumer reaches a decision by attributing larger weights to more salient attributes. The salience model can explain for instance, why the decision to buy a wine in the supermarket is different from the decision to buy the same one in a restaurant (Bordalo et al., 2013). If price is a more salient attribute in a supermarket it will be given a lot more weight than in the case of a restaurant where quality rather than price will be given more attention and weight. The salience model might also explain why consumers respond to price promotions: the percentage decrease in price shown at the point of purchase becomes more salient for the consumer and as a result is given more weight in the decision process.

The drift-diffusion model is another bottom-up attention model which has been used to explain the role of attention in decision-making (Krajbich and Rangel, 2011; Krajbich *et al.*, 2012; Tavares, Perona and Rangel, 2017). The drift-diffusion model assumes that individuals fixate on different alternatives and in doing so they accumulate information about the different alternatives, a process that stops when the individual has accumulated enough evidence to be able to come to a decision.

2.5.2 Top-down attention models

Top-down attention models assume attention comes from the individual and is therefore endogenous. In opposition to bottom-up attention models, top-down attention models assume that individuals have a set of internal goals, beliefs and motivations that shape what they choose to attend (Connor, Egeth and Yantis, 2004; Graham, Orquin and Visschers, 2012).

One strand of literature that assumes attention is endogenous considers attention as being similar to Bayesian inference (Knill and Richards, 1996). Individuals are assumed to perceive the reality around them based on their prior knowledge about the world. The environment in which individuals live provides the physical and sensory information. Individuals use their prior knowledge about the environment to make sense of this sensory, and often noisy information (Knill, 2007; Teufel, Subramaniam and Fletcher, 2013; Koenderink, 2014, 2016). Gabaix and Laibson (2006) use the Bayesian inference approach to explain why some individuals pay attention to add-on costs while others do not. They compare the behaviour of a Bayesian consumer, who always forms posteriors about add-on costs, to that of a myopic consumer who does not pay attention to add-on costs. They conclude that part of the reason why add-on costs are used by firms is because of a lack of attention by myopic consumers.

Another top-down attention model is Gabaix's sparsity model (Gabaix, 2017). In this sparsity model, individuals are assumed to attend to only a few pieces of information subject to a cost of attention. The model is called the sparsity model because individuals are assumed to allocate their attention according to a sparsity matrix that contains many variables that are ignored and only a few variables that are considered. Once they have decided the level of attention to different variables, individuals then choose the optimal course of action just as in neoclassical models in economics.

The consideration sets model is another top-down model of attention. In the consideration set literature, individuals are assumed to be paying attention according to a limited number of options (a consideration set) which is specific to each individual (Laroche, Kim and Matsui, 2003; Manzini and Mariotti, 2014). Alternatives within this consideration set are therefore being allocated attention while those outside the set are ignored.

2.5.3 Limitations of the two attention modelling approaches

Both the bottom-up and the top-down attention models provide useful frameworks for examining individual attention. These two approaches are equally used in the literature to investigate several different topics, most of which in the domain of consumer choice. Part of the consumer choice literature has used the bottom-up approach to investigate consumers' use of labels or the relationship between the visual stimulus and final choices (Armel, Beaumel and Rangel, 2008; Milosavljevic *et al.*, 2012; Bialkova *et al.*, 2014; Salle, 2014; Grebitus, Roosen and Seitz, 2015; Van Loo *et al.*, 2015, 2017; Peschel, Orquin and Mueller Loose, 2019). Another part of the literature has used the top-down approach to attention to examine the extent to which individual motivations goals drive attention patterns (Pieters and Warlop, 1999; Papies and Veling, 2013; Meissner, Musalem and Huber, 2016; Botelho *et al.*, 2019). While these two approaches have offered valuable methods to model individual attention, there is nevertheless evidence that attention is a more complex process that incorporates both bottom-up and top-down factors (Corbetta and Shulman, 2002; Haladjian and Montemayor, 2013). For instance, Visschers et al. (2010b) find in a laboratory experiment with eye-tracking that consumer attention to nutritional labels is driven by both individual health motivation and the package design, hence providing evidence that both bottom-up and top-down attention happen at the same time. Similarly, in a review of the literature on eye movements and choice, Orquin and Mueller Loose (2013) conclude that eye-movements are under the control of both bottom-up and top-down processes.

2.6 The Rational Inattention (RI) Model

The previous Section has briefly described several approaches to modelling limited attention which have been used in the economics literature. This Section describes one of the top-down models of attention which has been chosen for this research: The Rational Inattention Model. This Section only describes the RI Model, while Section 3.4 describe the reasons why this model was chosen for this research.

2.6.1 Description of the Rational Inattention Model

The RI model is based on the idea that attention is an important resource which individuals attempt to use in an optimal way in the decision-making process. Because attention is costly, individuals often cannot pay attention to everything. They need to make a trade-off between the costs of acquiring the information and the benefits that the acquired information might bring (Caplin and Dean, 2015b). Additionally, they need to decide which features of a task they need to focus their attention on, and which features they need to ignore or dedicate less attention to. This process of allocating their attention to different features of a choice set at different levels is rational, hence the name of *Rational Inattention* (Mackowiak et al., 2018; Sims, 2015; Wiederholt, 2010). For example, the large amounts of information on the Internet on a given topic might overwhelm someone attempting to understand that topic. Hence, the individual might rationally decide to only read a few trustworthy webpages as opposed to reading *all* the pages containing information on that topic. Similarly, when looking to buy a property on a website, a buyer might decide to filter search results based on attributes which are relevant, such as price, type of property, location, or number of bedrooms.

In the economics literature, Sims (2003, 2015) is considered as having laid the foundations for the rational inattention models as part of his efforts to understand macroeconomics phenomena. Sims based his model on the idea that economic agents are finite-capacity channels: although there is a lot of information they could pay attention to, economic agents will be limited by how much information they can actually process. Sims' model was based on Shannon's information theory (Shannon, 1948) and entropy understood as uncertainty. According to Shannon's information theory, information is defined in terms of how much uncertainty is reduced by the receipt of the message. For instance, if you were sure that the message was yes, and the message that you have received is yes, then the message did not bring any new information as there was certainty that the message was yes. Because attention is modelled as reduction in entropy, Sims' models are also called entropy-based models.

Sims' initial model has received attention among economists and has given birth to a considerable literature which assumes that information is chosen as a result of a cost-benefit analysis where the costs of acquiring information are weighed against its benefits (Caplin and Dean, 2013; Tutino, 2013; Civelli *et al.*, 2018; Fuster, Perez-Truglia and Zafar, 2018; Wang *et al.*, 2018; Corradin, Fillat and Vergara-Alert, 2019; Huettner, Boyacı and Akçay, 2019; MacCuish, 2019; Matejka and Tabellini, 2021). For instance, Mackowiak, Matejka, & Wiederholt (2018) further developed Sims' model by focusing on the decision strategies that individuals adopt to deal with the fact that their attention is limited. According to these authors, individuals are aware of their own cognitive limitations and will try to optimize their attention resources by making use of heuristics. The use of heuristics will be driven by economic conditions and will determine what type of mistakes they ultimately make. Their model describes an individual's allocation of attention as one of maximizing the utility of a decision minus the cost of information chosen to attend based on their prior beliefs. This strand of literature is linked to the ecological rationality literature which investigates the use of heuristics in decision-making and their suitability to the context in which they are used (Gigerenzer, Todd and ABC Research Group, 1999; Gigerenzer, 2008; Gigerenzer and Brighton, 2009; Gigerenzer and Gaissmaier, 2011).

Sims' theory is linked to Stigler's seminal work on the economics of information (Stigler, 1961). Stigler claimed that price variation for similar products which is observed in real markets is not only explained by transport costs but also by the costs of searching for information. According to his theory, an economic agent engages in a sort of cost-benefit analysis when seeking information about goods and services. This implies that the economic agent will continue to gather information until the benefits of acquiring more information are no longer higher than the costs of searching for that information. Sim's theory is also linked to the literature on consumer search which attempts to explain an individual's search process in relation to the search costs incurred (Mccall, 1970; Mortensen, 1970; Santos, Hortaçsu and Wildenbeest, 2012).

Rational Inattention models lie at the intersection between behavioural and neoclassical economics because they draw on behavioural observations about human cognitive limitations while also describing attention allocation as a process whereby people optimize their attention subject to the cost of attention. These models have therefore the advantage of reconciling the need for incorporating more psychological realism into economics with the empirical tractability of rational choice models.

2.6.2 Testing for Rational Inattention

Testing the validity of the Rational Inattention theory has been a concern of the empirical literature over the last years. A large part of the empirical literature has attempted to test the validity of RI by examining the trade-offs that people make in incentivized choice tasks where there is a cost to paying full attention.

One method used in the empirical literature is to collect a dataset known as state dependent stochastic choice (SDSC) data which is usually generated through laboratory experiments (Caplin and Dean, 2013; Dean and Neligh, 2017). In these experiments, respondents are presented with a screen of both red and blue balls and are being told they there is a 50% chance of either there being 49 red balls or 50% chance of there being 51 red balls. Through a series of questions and without being subject to any time constraints, respondents are then asked to say how many red balls there are, with incentives varying with different questions. The respondent can choose to count the red balls or go ahead without doing so and thereby making a trade-off between the cost of attention (counting the red balls) and the benefit of paying attention (the reward for being right). The researcher then infers the respondents' attention from their pattern of choices.

A related approach to testing for Rational Inattention has been to measure attention costs. Caplin et al. (2018) take inspiration from production theory to derive an individual psychometric curve which is similar to a firm's supply curve, in that attentional effort supplied by an individual to a particular choice task increases when the reward also increases. This approach also relates to that of de Oliveira *et al.* (2017) which propose using individual preferences over menus of information to uncover hidden information costs. There are other experimental ways to infer attention costs that are known in the literature. Some approaches infer attention costs based on the observed trade-off that individual make between effort and reward (Tutino, 2013; Civelli *et al.*, 2018) while other approaches examine whether individuals are rationally inattentive by examining their response to price changes (Wang *et al.*, 2018).

Despite recent efforts, measuring attention costs is an ongoing endeavour. Most of the efforts so far have centred on measuring the costs of attention by varying the level of reward and the level of task difficulty. In most cases, the experimenter knows the correct answer and looks at the amount of attention that participants invest in each task. This experimental setup allows the researcher to measure attention inputs relatively easy.

2.6.3 Applications of Rational Inattention in the literature

The RI theory has been applied to the study of a wide range of phenomena in economics. A large part of studies use the RI framework to study macroeconomic phenomena such as labour market decisions. Bartoš *et al.* (2016) show how hiring managers use the name of applicants as a heuristic which guides their attention when deciding which job applications to read. Because firms recruiting for candidates cannot gather more precise information about their job candidates, rationally inattentive firms accept fewer jobseekers during recessions in an effort to minimize losses from hiring unsuitable candidates (Acharya and Wee, 2019). Maccuish (2019) uses the RI framework to look at retirement decisions and finds that it can explain bunching of labour market exits and people's ignorance of their pension provision. Kacperczyk et al. (2016) examine the mutual fund sector as an information-rich environment where mutual fund managers use their attention rationally to deal with overwhelming amounts of information. Matejka and Tabellini (2016) look at the consequences of having rationally inattentive voters on subsequent policy-making decisions and find that voters pay more attention to things they care more. Dessein, Galeotti and Santos (2016) bring the Rational Inattention framework in the management literature and argue that a scarcity of attention should make organizations focus on a limited set of tasks while Bertoli, Moraga and Guichard (2020) examine migrations decisions when information about destinations is costly.

The RI framework has been said to describe very well repeated choice situations, such as in the field of consumer choice (Mackowiak, Matejka and Wiederholt, 2018). Wang et al. (2018) use a monthly panel dataset on residential water consumption and find evidence of rational inattention among water users with consequences for water conservation policies. They examine water user behaviour by using the bunching test which revolves around examining whether are disproportional increases in the vicinity of each increasing block prices kink (where the marginal price per unit of water increases). Leard (2018) also provides evidence of rationally inattentive consumers on the vehicle market: they find that households who travel less by car are less likely to pay attention to fuel costs. Salle (2014) also finds that Rational Inattention describes consumer choices on the automobile market: because of the cost and effort involved in processing information about a car's energy efficiency, rationally inattentive consumers will make choices based on incomplete information.

2.6.4 Implications of Rationally Inattentive Behaviours

The existing literature has found that rationally inattentive behaviours lead to a wide range of consequences. It has been found that rationally inattentive behaviours have important implications for markets such as the labour market, the housing market, and the durable goods market. Whether individuals are rationally inattentive also has methodological implications. These implications are described below in the rest of this section.

2.6.4.1 Implications for different markets

On the labour market, RI leads to discrimination against minority groups and ignorance of pension rights. For instance, Bartoš et al. (2016) find that rationally inattentive recruiters tend to discriminate against negatively stereotyped minority groups by paying less attention to their job applications while Maccuish (2019) finds that RI leads to people being unaware of their pension provisions. Matejka and Tabellini (2016) find that policy-making is impacted by rationally inattentive voters through an increased focus on attention-seeking policies such as targeted redistribution policies at the expense of less attention-seeking policies such as public goods provision. In the area of consumer choice, Salle (2014) find that car buyers experience small welfare losses by being rationally inattentive while Caplin et al. (2019) sees RI as an explanation for the formation of consideration sets. On the housing market, Corradin et al. (2019) find that due to the cost of acquiring information on the market value of their house, households will either overestimate or underestimate the value of their house over time with implications on households' future financial decisions, while Bartoš et al. (2016) find that RI makes tenant-seeking landlords more prone to discriminating against minority groups.

2.6.4.2 Methodological implications

Whether individuals are rationally inattentive also has methodological implications. The choice modelling literature assumes that all attributes describing a choice set are attended in one form or another. If, however, discrete choice models do not account for the fact that attendance of attributes might not be complete, then model estimates will be biased. This literature has tried to overcome these limitations by either inferring attention from participants' choices (Scarpa *et al.*, 2009, 2013; Yegoryan, Guhl and Klapper, 2019) or eliciting measures of stated attention (Brooks & Lusk, 2010; Caputo et al., 2018; Hole et al., 2013b; Scarpa et al., 2013) as described in Section 2.3. Additionally, whether overall, respondents pay reasonable attention to a hypothetical survey is important in the context of understanding respondent engagement with surveys where there is no incentive or consequentiality. For instance, there is a common practice in the risk and time preference literature to implement surveys where at least one of the choices respondents make has a real consequence (Holt and Laury, 2002; Richards and Hamilton, 2012). For instance, one version of the Becker–DeGroot–Marschak method is to draw one of the choices at random and make the respondent pay for that choice as stated in the experiment (Becker, DeGroot and Marschak, 1964). This method is believed to ensure that respondents reveal their true preferences. Accounting for the degree of attention in a hypothetical survey is therefore a valuable effort.

2.7 Research Gaps

There are several research gaps which this thesis tries to address. First, we do not fully understand the value of collecting mouse-tracking data in stated preference research and the extent to which this type of data is useful in examining individual behaviour and inferring attention. Second, we do not yet understand the implications of using mouse-tracking in the framework of a DCE in terms of model estimates and participant behaviour. Third, given that there is some evidence that the Rational Inattention model can explain behaviours in some contexts, it will be useful to know whether this also applies to a Discrete Choice Experiment and in the context of nutritional label use. Fourth, it is still not completely understood how consumers interact with colour-coded labelling information such as UK's Traffic Light System and the role of attention. These gaps are further explained below.

2.7.1 Understand the potential of mouse tracking data in examining individual behaviours

The choice modelling literature has made significant advances in recent years in terms of incorporating more insights into individual behaviours, such as stated or revealed measures of attention into econometric models (Peschel et al., 2019a; Scarpa et al., 2010; Scarpa et al., 2013b; Van Loo et al., 2015b). Using mouse tracking data as a source of revealed attention has been less of a concern in the literature, despite its potential to provide a novel source of data. This is an important gap given the recent push in economics to engineer new datasets that can document the processes behind choices as advocated by Caplin (2016) and Caplin and Dean (2015a, 2015b). It is therefore important to understand the potential (benefits or any associated shortcomings) of collecting such data in relation to examining individual choices as part of a Discrete Choice Experiment. More broadly, understanding respondent engagement with hypothetical experiments remains an important field of investigation. Mouse-tracking can play an important role in understanding this engagement.

2.7.2 Understand the implications of using mouse-tracking within a Discrete Choice Experiment

Because of a lack of research in relation to mouse-tracking, we do not know the implications of using mouse-tracking technology within a DCE in terms of model estimates. It is therefore important to understand whether the use of mouse-tracking technology interferes in any way with participants' behaviour or whether it changes participants' pattern of choices in any significant way. More specifically, it is important to understand whether using a mouse-tracking tool such as Mouselab in a DCE radically interferes with WTP estimates. This understanding is useful for discrete choice researchers that might be interested in using mouse-tracking data as part of their experiments. This understanding might also fit into a broader discussion about the role of tracking technologies in investigating economic behaviour and their potential limitations in terms of their interference with decision-making.

2.7.3 Understand the impact of a cognitively costly survey on respondent engagement

A major concern in the choice modelling literature is attribute non-attendance because it might lead to potentially biased WTP estimates (Hole, Kolstad and Gyrd-Hansen, 2013; Scarpa *et al.*, 2013; Caputo *et al.*, 2016, 2018; Rodríguez-Entrena, Villanueva and Gómez-Limón, 2019). There is some evidence that more complex choice designs lead to higher attribute non-attendance (Spinks and Mortimer, 2016) but this evidence is quite scarce. More evidence is therefore needed in terms of understanding respondent engagement with hypothetical DCEs and surveys that are costly from a cognitive point of view.

Collecting mouse movement data with Mouselab has a special feature: mouse movements can only be recorded if the attribute level information is hidden from respondents behind a box. This imposes a cognitive cost to respondents because they can only visualise one attribute at a time by hovering their mouse cursor on each individual attribute. At the same time, respondents do not have a direct incentive for hovering their mouse on each attribute, nor is there any consequence to their behaviour. Examining the extent to which respondents engage with the survey despite these costs also links to the wider debate in economics on whether surveys should be incentive-compatible and/or consequential (Grether and Plott, 1979; Irwin, McClelland and Schulze, 1992).

2.7.4 Understand consumer engagement with UK's Traffic Light System for nutritional labelling

The rationale behind nutritional labelling policies is that concentrated and simple health information lowers attention costs which makes it easier for consumers to access the nutritional information needed to make a healthy food choice. But, the implicit assumption is that consumers pay attention and process all labelling information, while, in reality consumers might allocate less attention to some aspects of the labels and more to others. Nutritional labelling represents a blanket approach to information provision because it assumes that all consumers will attend to and use this information. Nutritional labels can only work if they are adequately processed and used by consumers (Verbeke, 2005). But to be processed and used, nutritional labels first need to be seen and paid attention to. Understanding whether nutritional labels are not only attended to by consumers but also the extent of that attendance is therefore an important effort in examining label use. The Rational Inattention model provides a useful framework to examine this heterogeneity in attention to nutritional labels.

3 Conceptual Framework

3.1 Introduction

This chapter introduces the conceptual framework underpinning this thesis. Section 3.2 describes the general theoretical context of this research which is the bounded rationality and the economics of attention literature. Section 3.3 discusses the Rational Inattention framework which provides the theoretical underpinning of the DCE used in this research. Section 3.4 explains the motivation for choosing the Rational Inattention framework, while Section 3.5 describes more specifically how the RI framework is used in this research. Section 3.6 describes the theoretical links between attention and the use of heuristics.

3.2 Bounded rationality and the economics of attention in relation to Discrete Choice Experiments

This research is situated within the wider context of the bounded rationality literature. An important pillar of this literature is that individuals behave rationally subject to physiological and psychological constraints. These constraints refer to the individuals' own cognitive capacities as well as the complexity and uncertainty of the decision problem they are facing. Given these constraints, individuals are assumed to settle for satisfactory outcomes rather than exhaustively seek the best outcome (Simon, 1955, 1972). One significant constraint to individual decision-making is that attention is never full and therefore individuals will rarely pay attention to all the information describing a choice problem. Because attention is a finite resource, individuals will be forced to make adjustments in terms of which information to attend and which to ignore (Simon, 2000).

This research sits against the backdrop of costly attention. It takes the view that individuals have limited amounts of attention which they attempt to use in an optimal way. Because attention is costly, individuals cannot pay attention to everything. They therefore need to decide which features of a task they need to focus their attention on, and which features they need to ignore or dedicate less attention to. By emphasizing the role of attention in the acquisition of information, this research is closely connected with the literature on the economics of attention and the concept of 'attention economy' which reflects the idea that capturing attention has become a key objective of modern economies (Davenport and Beck, 2001).

One way in which individuals optimize their attention is by paying more attention to things that are more important to them. This process of optimizing attention to different features at different levels because full attention is costly is called *Rational Inattention* (Wiederholt, 2010; Sims, 2015; Mackowiak, Matejka and Wiederholt, 2018). The Rational Inattention literature is closely linked to the ecological rationality literature which has documented a range of heuristics or rules of thumb that individuals use to manage the complexity of the choices they are facing. This research therefore combines insights from the attention economics literature with insights from the ecological rationality literature to understand individual behaviour in a Discrete Choice Experiment. These two literature strands are described in more detail in the sections below.

3.3 The Rational Inattention framework

This research sets out to empirically test one of the theories of attention which have become popular in the macroeconomics literature: The Rational Inattention theory. The basis of the Rational Inattention framework has been put forward by Sims (Sims, 2003; Sims, 2015) and later by Mackowiak, Matějka and Wiederholt (2020). According to Sims, individuals are limited by how much information they can process at any given point and optimize their behaviour with respect to this information processing constraint. Information is represented as a reduction in uncertainty such that individuals will maximize their utility by choosing the amount and type of information they need. Further developing Sims' model, Mackowiak, Matějka and Wiederholt (2020) put forward a model which assumes that people are aware of their cognitive limitations in terms of how much information they can pay attention to and try to allocate their attention by making use of decision strategies or heuristics.

Their model can be described as follows. There is an unknown random state of the world (x) and the agent has a prior belief about this state of the world represented as a probability distribution function $g(x)$. There are three steps to the decision. First, the agent chooses what to pay attention to, or in other words, what information about x to process from the available information. This is described as the signal the agent gets to reduce the uncertainty in relation to the state of the world *(f_{sx} $(s|x)$).* Secondly, she receives the signal that she chose in the first step and forms a posterior belief $f_{xs} = f_{sx}(s|x)\, g(x) / p(s)$ where *p(s)* is the probability distribution function of the signals. Thirdly, the agent chooses an action *y* that maximizes the expectation of utility *U(y,x)* less the cost of information. The agent problem's is therefore:

$$\max \int U(y,x)\, f(y,x)\, dx\, dy - C(f) \quad (1)$$

subject to

$$\int f(y,x)dy = g(x), \qquad \forall x \quad (2)$$

where the first term in (1) is the expectation of *U* and *C(f)* is the cost of information. $C(f) = \lambda\, I\,(y;x)$ where *I (y;x)* is the Shannon mutual information between the random variables *y* and *x* which is measuring the reduction of entropy about *x* upon processing the information and choosing *y*.

The Rational Inattention framework models an agent's choice of information as a trade-off between the value of the information and the costs of acquiring it. One way in which people are assumed to manage their attention is to use heuristics or decision shortcuts. One such heuristic is to pay more attention to things that are more relevant to the decision that they are facing. In Sims's own words, "*We may prefer to obtain the costly bit if it is relevant to our decision problem, even though other bits are much cheaper*" (Sims, 2006, p.160) or, as Mackowiak, Matějka and Wiederholt (2020, p.4) put it: "*Rational Inattention builds on a natural assumption: agents cannot pay full attention to all available information, but can choose to pay more attention to more important things".*

3.4 Motivation for using the Rational Inattention Framework

There are two main arguments which make the Rational Inattention theory a suitable framework to test within this research. A first argument is that this theory emphasizes the role of costs to paying full attention. The choice experiment used in this research poses a cognitive cost to participants in that the information needed in decision-making is costly to acquire. A second argument is that the theory makes predictions in relation to how individuals will manage their attention in costly situations. These predictions can be empirically tested because the choice experiment used in this research allows to track participants' mouse movements which can be used as a proxy for attention.

3.5 How the Rational Inattention framework is used in this research

In the context of this research, the choice situation is represented by three different food baskets described in terms of their nutrients (Salt, Sugar, Fat and Saturates) and in terms of their Price. Individuals are asked to choose their preferred basket among three different baskets or to choose none of the baskets. However, most of the information related to the nutrient levels is obscured (hidden behind a box) and individuals must hover their mouse over the relevant box to be able to visualize the nutrient levels (which can be Red, Amber or Green). As soon as the mouse cursor leaves the box, the nutrient information becomes again hidden. Participants are therefore confronted with a cognitive cost when choosing their preferred food basket. They face a trade-off between the cost of acquiring the nutrient level information and the benefit that the information might bring to their decision. In the most extreme case, individuals could choose their preferred basket by not hovering their mouse at all on any nutrient as there is no obligation for them to look at any nutrient before choosing their baskets. Besides not knowing the attribute information, there is no consequence for the respondent for not hovering their mouse. An illustration of the choice situation faced by respondents is shown in Figure 1.

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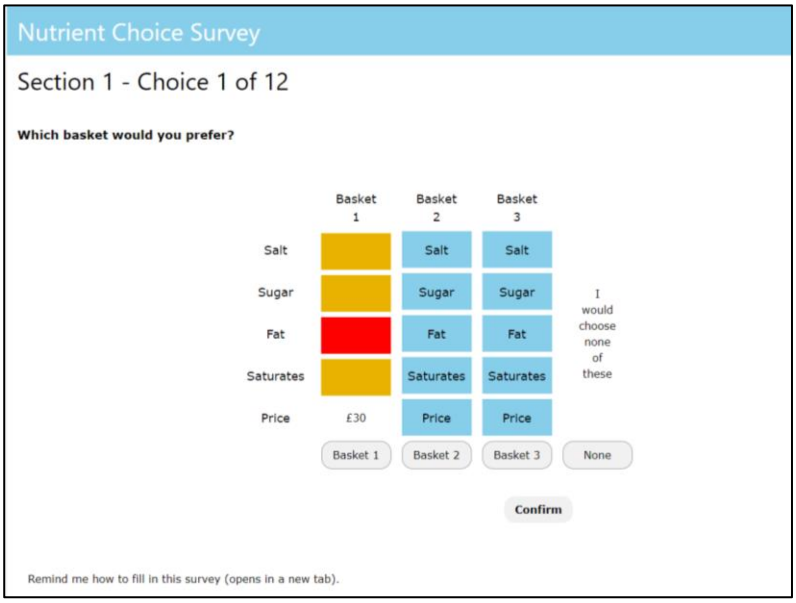
Figure 1 Sample choice card where the attribute information is obscured for two baskets



Taking the soft perspective of the RI theory, individuals will choose to uncover the nutrient level information if it is relevant for their decision. Following Mackowiak, Matejka and Wiederholt (2018), they will "*choose to pay more attention to more important things*". This experiment assumes that more important things are those nutrients that individuals value more, in other words, the nutrients for which they have a higher willingness-to-pay. For instance, this research assumes that individuals who value Salt will spend more time looking at the Salt attribute by hovering their mouse longer or more frequently on the Salt attribute. Taking the hard perspective of the RI theory, individuals will spend little time investigating the DCE attributes, since there is no incentive for them to pay full attention to all attributes.

3.6 The role of heuristics in attention

A strand of literature related to the Rational Inattention literature outlined above is the ecological rationality literature which has been described in Section 2.2.2. This literature assumes that individuals use a range of mental shortcuts or heuristics that help them deal with the complexity or uncertainty of a choice problem and with their own cognitive limitations. This strand of literature is linked to the Rational Inattention literature by its emphasis on heuristics that might direct attention to features of a choice at the expense of other features. These heuristics are used in an adaptive way, depending on the choice context, hence why the literature is also known as the 'ecological rationality' literature. This strand of literature argues that accounting for heuristics and shortcuts in certain situations can explain individual decisions better than more cognitively demanding strategies where all the available information is considered (Schulte-Mecklenbeck *et al.*, 2013).

Looking at this research from an ecological rationality perspective, participants might employ heuristics to deal with the cognitive effort required to investigate all attributes describing the food baskets. In the context of this choice experiment, participants using heuristics to decide between the three food baskets will make their decision by looking at some attributes to a lesser extent as opposed to looking at all the available attributes. This will necessarily entail that participants who use heuristics will also allocate less attention overall towards DCE attributes than participants who consider all the attributes.

The ecological rationality literature has also documented specific heuristics which are employed in decision-making to manage the uncertainty and complexity of a choice. For instance, one of the most identified heuristics in the choice modelling literature is attribute non-attendance (ANA) which allows participants to simplify the choice task by ignoring some attributes. Other heuristics have been described in more detail in section 2.2.2.

In the context of this choice experiment, a heuristic that could be used by participants in deciding between the three food baskets would be to only look at a few attributes (ANA). For instance, some participants might decide to choose the basket which is the cheapest and thereby will only be interested in the Price attribute. Taking the view of the ecological rationality literature, using the 'cheapest basket' as a heuristic would help participants in their decision-making process because it allows them to focus their attention on one piece of information only as opposed to all the information available. The 'cheapest basket' heuristic is closely related to what the ecological rationality literature calls 'lexicographic' (LEX) heuristic which implies choosing the options with the highest value on the most important attribute (Schulte-Mecklenbeck *et al.*, 2013).

4 Methods

4.1 Introduction

This chapter introduces the methods used in this thesis. Section 4.2 describes the use of discrete choice models, in relation to the motivation for employing these, their theoretical basis and how they are specified and estimated. Section 4.3 describes how model comparison has been carried out using Bayesian methods while Section 4.4. describes the Mixed Model used to examine mouse-tracking measures.

4.2 Discrete choice models

4.2.1 Motivation

Discrete choice models (DCMs) are a type of stated preference method. Discrete choice models allow modelling of choices when an agent (a consumer, a firm, government, etc.) faces a choice between several distinct alternatives. DCMs have been used so far to predict and explain choices made by economic agents in a whole range of different fields, such as marketing and consumer behaviour, transport, energy use, labour market participation, government policy, etc. In the consumer behaviour field, DCMs have been used to understand choices made by consumers when different competing brands or alternatives are available (Baltas and Doyle, 2001; Train and Winston, 2007; Train, 2009). The goal of DCMs is to understand an agent's choice by examining the preferences that might drive this choice. However, not all factors that might influence an outcome are observed by the researcher, and thus the unobserved factors are treated as random variables. The utility derived from an agent's choice is decomposed by the researcher into a deterministic component (a function of the observed variables and parameters that characterise preferences) and a stochastic component reflecting the unobserved variables that might affect choices.

4.2.2 The Components of a Discrete Choice Model

The general characteristics of a Discrete Choice model are as follows (Louviere, Hensher and Swait, 2000):

- Options are described as bundles of attributes (with differing levels of these attributes) usually including a monetary attribute.
- Respondents are required to choose between pre-specified ‘bundles’ of attributes.
    - A discrete choice experiment is usually characterized by requiring individuals to choose their most preferred option only.
    - Individuals may also be able to opt-out of all options, or the set of options may include a status-quo option.
- Respondents are required to complete a series of choice tasks involving different combinations of the attribute levels.
    - Having decided on the number of options, total number of tasks, attributes, and attribute levels, a superset of tasks is designed, usually using an optimal design criterion (e.g., d-optimality). The task superset is then usually divided into task subgroups and allocated to individuals.
- Utility is expressed as a weighted sum of the attributes (the weights being marginal utilities) as discussed in Section 4.2.3.
- Provided there is a sufficient sample, respondents’ preference parameters can be specific to an individual and be conditioned on socioeconomic and attitudinal variables and estimated econometrically as discussed in Section 4.2.4.1.
- Willingness to pay (or accept) can be calculated provided a monetary attribute has been included.

It is worth noting that the practical implementation of choice models, to a large extent, implicitly or explicitly recognises the cognitive costs of completing choice tasks. The widespread use of discrete choice itself is, arguably, because a full ranking of options (which would give more information) is difficult for respondents (Hensher, Rose and Greene, 2005). Additionally, to avoid excessive complexity, the number of attributes is generally limited to less than 10, and the number of options within a given task is generally less than 4 and more commonly 2 or 3 (Louviere, Hensher and Swait, 2000). Moreover, the fact that people are only required to do relatively few choice tasks (often between 4 and 12) is due to the fact that clearly people may pay less attention as the number of tasks increases, or even cease to complete them altogether. An example of a choice set used in this research is shown in Figure 2.

4.2.3 The Random Utility Model

The theoretical basis for estimating discrete choice models is underpinned by the Random Utility Model (RUM). The Random Utility Model (RUM) is rooted in Marschak's interpretation of Thurstone's law (Marschak, 1959) which relied on modelling the respondent's choices based on how they differentiated between different stimuli. Marschak brought this theory into economics by providing a method to derivate it from utility maximization. RUM assumes that when presented with a set of alternatives, individuals will choose the alternative that maximizes their stochastic utility. RUM was formally introduced in the choice modelling field by McFadden (1982).

RUMs are derived as follows. Let U_{nj} denote the random utility of person n from choosing alternative j. Because the person is utility-maximizing, she will choose the alternative that provides the highest level of utility. The model implies therefore that alternative j will be chosen if and only if the random utility of j is higher than the utility of all other options i:

$$U_{nj} > U_{ni} \qquad \forall\, i \neq j \quad (3)$$

However, the person n's utility is not known to the researcher. The researcher only observes a set of choices that describe this utility. The researcher therefore decomposes the utility as follows:

$$U_{nj} = V_{nj} + \varepsilon \qquad (4)$$

Where V_{nj} is the systematic utility, a function that relates the observed variables to the person's utility and ε captures the unobserved factors that affect utility. Plugging equation 4 into equation 3 we arrive at the following:

$$\begin{aligned} P_{nj} &= Prob\left(U_{nj} > U_{ni} \; \forall\, i \neq j\right) \\ &= Prob\;\left(V_{nj} + \varepsilon_{nj} > V_{ni} + \varepsilon_{ni} \; \forall\, i \neq j \right) \quad (5) \\ &= Prob\,(\varepsilon_{nj} - \varepsilon_{ni} < V_{ni} - V_{nj} \; \forall\, i \neq j) \end{aligned}$$

In other words, the probability of person *n* of choosing alternative *j* is the probability that each random term $\varepsilon_{nj} - \varepsilon_{ni}$ is below the observed quantity $V_{ni} - V_{nj}$. The researcher denotes the joint density of the unobserved variables as $f(\varepsilon_n)$ which allows for making probabilistic statements about the person's choice. Using this density, we can derive the integral form for equation (5):

$$P_{nj} = \int I(\varepsilon_{nj} - \varepsilon_{ni} < V_{ni} - V_{nj} \;\; \forall\, i \neq j)\; f(\varepsilon_n)\, d\,(\varepsilon_n) \quad (6)$$

where I is the indicator function which takes the value of 1 when the statement in brackets is true, and 0 when the statement is false. Equation (6) above is a multidimensional integral over the density of the unobserved portion of utility, $f(\varepsilon_n)$.

4.2.4 Specific models

The most common types of DCMs are variations upon the Logit, Generalized Extreme Value (GEV), Probit models. These models are derived under different specifications of the density of unobserved variables $f(\varepsilon_n)$. For instance, the Logit model assumes that the unobserved variables (ε) are 'extreme value' distributed, independent of the observed factors, and uncorrelated across individuals and alternatives. However, because the independence assumption could be considered an important limitation for some researchers, other models have been introduced that relax this assumption. GEV models allow for correlation in unobserved factors, while Probit models are based on a normal distribution of the unobserved factors.

The most basic model forms are based on the idea of a representative agent and assume that the parameters that characterise people's preferences are fixed across individuals. A popular variation of the standard (fixed parameter) Logit is the Mixed Logit, or its Bayesian equivalent, the Hierarchical Bayesian Logit (or Bayesian Mixed Logit). This model allows for the systematic utility to be specific to an individual, based on preference parameters that are stochastic. Another popular alternative to the Mixed

Logit is model is the Latent Class Logit, or its Bayesian equivalent, the Finite Mixture Logit. This approach also allows for individual preference parameters to be a weighted sum of a finite set of parameters that each represent a class (or group). However, this research has employed the Bayesian Mixed Logit exclusively and will therefore describe it further below.

4.2.4.1 The Mixed Logit Model

The Mixed Logit Model (MXL) has been referred to as being flexible enough to accommodate any RUM given appropriate specification and distribution of coefficients (McFadden and Train, 2000). Apart from having become relatively easy to estimate given the recent technological advances in simulation, the Mixed Logit Model is believed to have three main advantages over the standard (fixed parameter) Logit model: it allows for random taste variation, potentially unrestricted substitution patterns and correlation between preferences over time (Train, 2009). In other words, while in the standard Logit model the coefficients are the same for everyone, the MXL allows different coefficients (β) for each person (Akinc and Vandebroek, 2017).

In the MXL, the utility of person *n* from the *j*th option in *s*th choice set is:

$$U_{njs} = \beta_n x_{njs} + \varepsilon_{njs} \quad (7)$$

where x_{njs} represents the observed variables (attributes) that relate to the alternative and decision-maker and β_n is a vector of coefficients (marginal utilities) for these variables for person *n* representing that person's tastes. The unobserved factor ε_{njs} is 'extreme value' distributed, is independent of x_{njs} and uncorrelated across individuals and choices. The coefficients vary over decision-makers in the population with density $f\ (\beta\ |\theta)$:

$$\beta_n \sim f\ (\beta\ |\theta) \qquad (8)$$

where θ are the parameters of the distribution of β_n's over the population, such as the mean and variance of β_n.

The decision-maker knows the value of his own β_n and ε_{njs} and chooses alternative j if and only if $U_{nj} > U_{ni} \; \forall \, j \neq i.$ The researcher observes the choices along with x_{njs} but not β_n or ε_{njs}. Conditional on β_n, the probability that person n chooses alternative j,s is the standard logit formula:

$$L_{njs}(\beta_n) = \frac{e^{\beta_n x_{njs}}}{\sum_j e^{\beta_n x_{nis}}} \quad (9)$$

As illustration, consider the sequence of choices faced by decision makers in the DCE described in this thesis. The probability that a decision-maker makes a sequence of choices is the product of logit formulas:

$$L_{nj}(\beta_n) = \prod_s \left[\frac{e^{\beta_n x_{njs}}}{\sum_j e^{\beta_n x_{nis}}} \right] \quad (10)$$

Given that β_n is random and the researcher cannot condition on β, the unconditional choice probability is the integral of the formula above over all possible variables of β_n.

$$P_{nj} = \int L_{nj}(\beta) f(\beta) d\beta \quad (11)$$

where P_{nj} is the choice probability of decision-maker n of choosing alternative j, $L_{nj}(\beta)$ is the logit probability evaluated at parameters β, and $f(\beta)$ is a density function.

The researcher specifies a distribution for the coefficients and estimates the parameters of that distribution: $\beta \sim N\,(b, W)$ or $ln\,\beta \sim N\,(b, W)$ where b is the mean and W is the covariance matrix. The mixed logit probability is therefore a weighted average of the logit formula evaluated at different values of β, with the weights given by the density $f(\beta)$. By specifying this density appropriately, the researcher can then model any utility-maximizing behaviour by a mixed logit model (Train, 2009).

4.2.5 Bayesian inference

This research mainly adopts a Bayesian approach to inference. Bayesian inference allows the researcher to incorporate prior knowledge about the parameters which cannot be done if using a frequentist (or classical) approach to estimation. This information can be relatively diffuse, yet still aid in deriving estimates from models that are difficult or impossible to estimate by using a Classical (Maximum likelihood) approach.

The Bayesian approach is based on Bayes' theorem and the rules of probability. Given two random variables *A* and *B*, the rules of probability imply that:

$$p(A, B) = p(A|B)\, p(B) \quad (12)$$

Where $p(A, B)$ is the joint probability of *A* and *B* occurring, $p(A|B)$ is the probability of A occurring conditional on B having occurred (the conditional probability of *A* given *B*) and $p(B)$ is the marginal probability of *B*. By reversing the roles of *A* and *B*, an alternative expression for the joint probability of *A* and *B* can be written:

$$p(A, B) = p(B|A)\, p(A) \quad (13)$$

where the $p(B|A)$ is the probability of B occurring conditional on A having occurred (the conditional probability of *B* given *A*) and $p(A)$ is the marginal probability of *A*. By equating equations (12) and (13) above and rearranging, we derive the Bayes' rule which underpins the Bayesian approach to estimation:

$$p(B|A) = \frac{p(A|B)\, p(B)}{p(A)} \quad (14)$$

If one substitutes in equation (14) *A* with y and *B* with *θ,* where y is the matrix that constitutes the observed dependent data and *θ* is the matrix of parameters for the model that tries to explain *y*, (along with a set of covariates that we do not include for simplicity), then we can express Bayes' rule as follows:

$$p(\theta|y) = \frac{p\,(y|\theta)p(\theta)}{p(y)} \quad (15)$$

For the Bayesian econometrician, $p(\theta|y)$ is therefore of fundamental interest because it allows to answer the question "Given the data, what do we know about θ?". Because θ is of the main interest for the research, the denominator in equation (15) can be ignored because it does not involve θ, and Bayes' rule can be rewritten as follows:

$$p(\theta|y) \propto p(y|\theta)\, p(\theta) \quad (16)$$

where $p(\theta|y)$ is the posterior density (the probability density function for the parameters after observing the data), $p(y|\theta)$ is the likelihood function (the density of data conditional on the parameters of the model or the data generating process) and $p(\theta)$ is the prior density. In other words, the prior distribution expresses our uncertainty about the model parameters before seeing the data, while the posterior distribution expresses our uncertainty about the model parameters after seeing the data. Equation (16) can be also read as "posterior is proportional to likelihood times prior" and can be seen as an updating rule, whereby the posterior combines both data information and our prior views about the model parameters.

In Bayesian inference, the model parameters (θ) are treated as random variables and their probability distribution is used to quantify the amount of uncertainty. This allows the researcher to make probabilistic statements about the parameters in question. This is different from the frequentist approach which treats the model parameters as fixed non-random quantities.

4.2.6 Hierarchical Bayes estimation

The Mixed Logit model employed in this thesis, when estimated in a Bayesian way is equivalent to a Hierarchical Bayesian Logit. The individual-level parameters as well as the parameters describing the population distribution of the individual parameters are estimated.

Let the data y be represented by a model with parameter θ and θ is a sample from a common population distribution governed by some unknown parameter φ. Given that φ is unknown, then it has its own prior distribution, $p(\varphi)$ also known. The posterior distribution is therefore of the vector (φ, θ). The joint prior distribution is therefore:

$$p(\varphi, \theta) = p(\varphi)\, p(\theta|\varphi) \quad (17)$$

And the joint posterior distribution is:

$$p(\varphi,\theta\,|y)\ \propto p(\varphi,\theta)\,p(y\,|\varphi,\theta)$$
$$=\ p(\varphi,\theta)\,p\ (y\,|\theta) \qquad (18)$$

where the latter simplification holding because φ only affects y through θ. Replacing (17) in (18) gives us the following joint posterior distribution:

$$p(\varphi,\theta\,|y)\ \propto p(\varphi)\,p(\theta|\varphi)p(y\,|\theta) \quad (19)$$

Where *p(φ)* is the prior distribution for *φ*, $p(\theta|\varphi)$ is the conditional distribution for θ and $p(y\mid\theta)$ is the likelihood.

The hierarchical structure is therefore as follows (where θ_n is the parameter pertaining to the *n*th individual):

$$\textit{Stage 1: } y_n \mid \theta_n, \varphi \sim p(y_n \mid \theta_n, \varphi)$$
$$\textit{Stage 2}: \theta_n|\ \ \varphi \sim p(y_n \mid \varphi) \qquad (20)$$
$$\textit{Stage 3}: \varphi \sim p(\varphi)$$

In total, this study estimates nine parameters. These are: the means of the group WTP parameters, the scale parameters, and opt-out parameters together with their respective standard deviations, and the heterogenous (individual-level) WTP parameters, scale parameters and opt out parameters. The individual-level parameters are obtained from the group-level parameters as follows:

$$\beta_{nk} \sim N\left(\beta_k, \sigma_\beta^2\right);\ \beta_k \sim N\left(\mu_{\beta,}\, \sigma_\beta\right);\ \sigma_\beta^{-2} \sim G(a_\beta, b_\beta)$$
$$\alpha_j \sim N\ (\alpha, sigma\ \sigma_\alpha^{-2});\ \alpha \sim N(\mu_\alpha, \sigma_\alpha); \sigma_\alpha^{-2} \sim G(a_\alpha, b_\alpha) \quad (21)$$
$$\theta_n \sim N\left(\theta, \sigma_\theta^2\right);\ \theta \sim N(\mu_\theta, \sigma_\theta); \sigma_\theta^{-2} \sim G(a_\theta, b_\theta)$$

Where β_{nk} , α_n and θ_n denote the individual-level parameters for the WTP, the scale parameter and the opt-out parameter, β_k, α and θ denote the group-level parameters for the WTP, the scale parameter and the opt-out parameter, N (.) denotes a Normal distribution and G(.) denotes a Gamma distribution. See equation (25) for a description of the parameters. The exact hyper parameters used in the empirical model above were $(\mu_{\beta,} \sigma_{\beta}) = (0, \quad 0.1)$, $(\mu_{\alpha}, \sigma_{\alpha}) = (0, 0.25)$, $(\mu_{\theta}, \sigma_{\theta}) = (0, 10)$, $(a_{\beta}, b_{\beta}) = (1, 1)$, $(a_{\alpha}, b_{\alpha}) = (2, 1)$, $(a_{\theta}, b_{\theta}) = (1, 5)$.

Importantly, in interpreting the priors above, the Price variable was divided by 10 in estimation and the coding of the experiment was such that the WTP parameters represented a WTP to move from Red to Amber, or Amber to Green for each nutrient. Therefore, the mean WTP (μ_{β}) for each attribute which had a prior mean of 0, but the standard deviation of 0.1 equates to £1. Thus, the priors reflected that for a "representative consumer", the WTP for moving from Amber to Green or from Red to Amber, for any given nutrient, was unlikely to be more than £3 (three standard deviations from the mean of zero) or £6 to move from Red to Green. These are reasonable given that the total price range between the cheapest and most expensive basket within the experimental design was £15, and individuals could have WTPs much larger or smaller than the mean. Additionally, the WTP distributions were truncated so that the maximum WTP to move from Red to Green for any given nutrient was £10 for the "representative individual", and £20 pounds for any given individual. In this sense, some individuals were allowed to pay more than the total price variation in the experiment (£15) in order to go from Red to Green for just one nutrient. Thus, this restriction was not considered overly restrictive. The high prior standard deviation for the logged scale term ($\sigma_{\alpha} = 0.25$), and the status quo effect ($\sigma_{\theta} = 10$) reflected a wish to be largely uninformative about terms.

This hierarchical estimation was implemented in Pystan, a Python interface to Stan, a programming language used for Bayesian inference. The code used for estimation can be found in *Appendix H. Stan code for estimating Hierarchical Bayes Mixed Logit model*. Stan uses Hamilton Monte-Carlo (HMC) as sampling method. HMC is further described in Section 4.2.7 below. The number of iterations, burn-ins and retained posterior draws are reported in Section 6.2.

4.2.7 The Hamiltonian Monte-Carlo using Stan

Hamiltonian Monte-Carlo (HMC) was used to draw samples from the posterior distribution. HMC is a particular simulation method belonging to Markov Chain Monte Carlo (MCMC) which uses the derivative of the target density which is being sampled to generate efficient transitions (Stan Development Team, 2019). Compared to the basic MCMC methods such as the Gibbs sampler and Metropolis Hastings, HMC has the advantage of suppressing the random walk behaviour and moving more quickly through the target distribution (Gelman *et al.*, 2014). In practical terms this means that the draws using HMC are much less serially correlated than those obtained from other MCMC algorithms, which in turn means that less draws are required to adequately sample the posterior distribution.

HMC has proven to efficient when used in hierarchical models such as Hierarchical Bayes Mixed Logit by speeding up convergence towards the stationary distribution. HMC uses the gradient of the log probability function and two tuning parameters: the step size and the number of steps (Carmeci and Valeri, 2015). HMC can be further enhanced by employing algorithms that optimise the choice of the tuning parameters. The “No-U-turn-Sampler” (NUTS) is employed for this purpose and is the default method when using Stan software which was used to estimate the Bayesian models in this dissertation.

As with all MCMC algorithms, HMC requires that the initial parameters are chosen arbitrarily (for which Stan will choose automatically) followed by a warm-up (or ‘burn-in’) phase which is then followed by another phase where the sampler collects draws which will be used to summarise the posterior of the distribution. The warm-up phase for NUTS-HMC is used to find the optimal tuning parameters for the sampler along with ensuring that once this phase has ended the posterior is being sampled from a reasonably high-density region. The length of the warm-up phase is somewhat arbitrary but can be verified to be sufficient by examining the model diagnostics after estimation. Stan will give warnings if there appears to be poor convergence.

Finally, it is worth noting that unlike most other Bayesian Software, Stan compiles the code in C++. Thus, while the interface may be Python, R, Stata, or others, the sampler benefits from the speed advantages of C++ which are generally significant.

4.2.8 Model specification

The model was estimated as in what has been coined 'WTP space' (Train & Weeks, 2005). We start with the Utility specification in what has been described as the preference space:

$$U_{njs} = -\exp(\beta_{1n})x_{1ns} + \gamma_{2j}x_{2ns} + \cdots + \gamma_{kj}x_{kns} + \varepsilon_{njs} \quad (22)$$

where x_{1ns} is the Price attribute and has a coefficient that is exponentiated to ensure that the coefficient β_{1n} is negative and x_{kns} and ε_{njs} are the attributes that relate to the alternative and the decision-maker and the error term respectively which is 'extreme value' distributed as mentioned in Section 4.2.4.1. To derive directly the WTP estimates, equation (22) above is transformed into:

$$U_{njs} = \exp(\beta_{1n})\,(-x_{1ns} + \frac{\gamma_{2j}}{\exp(\beta_{1n})}x_{2ns} + \cdots + \frac{\gamma_{kj}}{\exp(\beta_{1n})}x_{kns}) + \varepsilon_{njs} \quad (23)$$

However, the ratio of the attribute coefficients to the Price coefficient are the WTP. Therefore, in equation (24), the $\beta_{2n}, \beta_{3n}, \dots \dots, \beta_{kn}$ are the WTP estimates.

$$U_{njs} = \exp(\beta_{1n})\,(-x_{1ns} + \beta_{2n}x_{2ns} + \cdots + \beta_{kn}x_{kns}) + \varepsilon_{njs} \quad (24)$$

The specification in equation (24) allows therefore for a direct estimation of WTPs while also avoiding having to set preference space priors that need to take into account of scale (Balcombe *et al.*, 2017).

Given the set of attributes used in this research (see Table 1), the econometric specification is as follows:

$$U_{njs} = \exp(\alpha_n)[\,-Price_{njs} + \beta_{2j}\,SaltGA_{njs} + \beta_{3j}\,SaltRA_{njs} + \beta_{4j}\,SugarGA_{njs} + \beta_{5j}\,SugarRA_{njs} + \beta_{6j}\,FatGA_{njs} + \beta_{7j}\,FatRA_{njs} + \beta_{8j}\,SatGA_{njs} + \beta_{9j}\,SatRA_{njs} + \theta_n\,OptOut_{njs}] + \varepsilon_{njs} \qquad (25)$$ [1]

where Price is the cost of the basket, Salt is Salt, Sugar is Sugar, Fat is Fat, Sat is Saturates and *OptOut* is the opt out parameter. For each of these nutrients, estimates have been obtained for the change from Amber to Green (G-A) and from Amber to Red (R-A). Thus, for example, *SaltGA* is 1 if Salt is Green, and 0 otherwise and *SaltRA* is 1 if Salt is Red and 0 otherwise. This means that Amber represents the base level from which comparisons are made. The notation *SaltGA*, *SaltRA* is therefore used to remind readers that estimates of WTP are to move away from Amber for Salt. Similar notation is used with respect to the other four nutrients.

4.3 Bayesian model comparison

Bayesian models can be compared in different ways. One commonly used method is to calculate the marginal likelihood for the models (e.g., Balcombe et al. 2015a), which corresponds to calculating $p(y)$ in equation (13). This is difficult to calculate and can be numerically unstable and can also be oversensitive to the priors used in the model. An alternative that has recently become increasingly popular is to estimate the prediction accuracy from a fitted Bayesian model using posterior simulations. Methods to estimate predictive accuracy are cross-validation and information criteria. The widely applicable or Watanabe-Akaike information criterion (WAIC) is one method used to estimate the pointwise out-of-sample prediction accuracy using the log-likelihood evaluated at the posterior simulations of the parameter values. WAIC is an improvement of the deviance information criterion (DIC) for Bayesian models and has the advantage of using the entire posterior distribution and is invariant to parametrization (Vehtari, Gelman and Gabry, 2017). The WAIC can be used/interpreted in the same way as other information criteria such as the Akaike, Schwarz-Bayes criteria that are commonly used in

[1] The author acknowledges that an additional alternative-specific constant could have been included in the model specification to reflect the fixed basket.

frequentist/classical analyses (Gelman *et al.*, 2014). However, the Bayesian approach calculates standard errors for these estimates also, and for one model to be considered superior (according to this criteria) to another it should be at least one standard deviation different from the alternative. A further complication is that when calculating whether there is a “significant” difference between the WAIC for two models of the same data, account must be taken of the correlation in predictions across models. This can be easily achieved as shown in Vehtari, Gelman and Gabry (2017). The WAIC is therefore used for model comparisons in this dissertation.

4.4 Mixed Model

Finally, to examine whether there is a time trend in attention as measured by mouse-tracking, a Mixed Model was estimated where the log of total fixations on the *k*th attribute on the *s*th choice card was regressed against the log of choice card number while allowing a random intercept and a random slope for each attribute. The estimated model was specified as follows:

$$\ln(Fix_{k,s}) = \theta_{1k} + \theta_{2k} \ln(Card.no) + \varepsilon_{ks} \quad (26)$$
$$\text{where } (\theta_{1k}, \theta_{2k}) \sim N((\theta_1, \theta_2), \psi)$$

5 Data

5.1 Introduction

This chapter describes the data that are used for this thesis and the data collection method. The data used in this research has been collected using an online survey. The first part of the survey consisted of a Discrete Choice Experiment with embedded mouse-tracking capability. The second part of the survey consisted of several socio-demographic and food shopping habits questions.

This chapter consists of seven main sections. Section 5.2 provides a general overview of the primary data collection process. Section 5.3 details how the data has been collected using an online survey and a Discrete Choice Experiment and describes the use of the mouse-tracking technology in recording respondents' mouse movements throughout the Hidden Treatment of the choice experiment. This section also includes details about the testing of the survey instrument and its calibration following feedback received during the testing stage. Section 5.4 describes the participant recruitment process while Section 5.5 details how the data have been cleaned. Section 5.6 offers an overview of how the mouse-tracking data has been retrieved and used to extract the mouse-tracking measures such as fixations and dwell time. Section 5.7 provides an overview of the final sample which has been used for this research using descriptive statistics.

5.2 Data source

The dataset for this research was collected through a primary data collection process which took place between March and April 2020 with two testing rounds taking place between July 2019 and February 2020. The primary data collection was implemented through an online survey which was composed of a Discrete Choice Experiment with an embedded mouse-tracking capability. A version of the questionnaire used during the online survey can be found in Appendix A. The survey with DCE and mouse-tracking (set 1A).

5.3 Online survey

The online survey used for data collection was hosted on a secure website (https://www.foodchoiceexperiment.com) designed specifically for this research and was composed of the following elements: 1) A Choice Experiment composed of 24 choice sets, 2) A MouselabWeb 2.0 table embedded in twelve of the 24 choice sets to allow mouse movements to be recorded in the Hidden Treatment and 3) Additional HTML webpages containing instructions on how to fill in the survey, a participant information sheet, as well as several socio-demographic and food shopping habits and lifestyle questions. These are further detailed below.

5.3.1 Webserver and website setup

A dedicated webserver and website were specifically set up for hosting the online survey. This website was hosted by DreamHost and was made HTTPS (Hypertext Transfer Protocol Secure). This meant that the integrity and confidentiality of the data between the participants' computer and the website was protected, encrypted to keep it secure from eavesdroppers, impossible to be modified or corrupted during transfer as well as protected against man-in-the-middle attacks.

The website consisted of a series of linked dynamic HTML webpages. The webpages were coded individually by making use of HTML and JavaScript language. All data generated by the research was saved on PHP scripts in a MySQL database. The website made use of Jquery and w3.css to ensure that participants were offered a visually attractive and responsive interface to the survey. The website designed specifically for hosting the online survey facilitated therefore the data collection process and enabled the participants to fill in the surveys from anywhere as long as they had a relatively recent Internet browser and did not require installation of specific software or plugins.[2]

[2] To see one of the survey versions, go to the survey webpage (active until 28/03/2022): https://www.foodchoiceexperiment.com/Set1Anew/Introduction.php

5.3.2 Choice experiment design

The purpose of the online survey was to implement the Discrete Choice Experiment (DCE). The DCE design used for this research was based on that of two previous studies that have already been tested: Balcombe, Fraser, & Di Falco (2010) and Balcombe, Fraser, & McSorley (2015) with some modifications. First, the design used in the two cited studies will be explained followed by the modifications brought by the DCE employed in this research.

5.3.2.1 DCE design employed by previous studies

The two studies referenced above employed a DCE designed around UK's Traffic Light System (TLS), a voluntary front-of-pack food and drink labelling initiative meant to inform food shoppers about the levels of Salt, Sugar, Fat, Saturates and Energy contained in their foods. In these two studies, participants were asked to choose their preferred food basket among three hypothetical food baskets which were described using the Traffic Light System in terms of their Salt, Sugar, Fat and Saturates content and in terms of their Price. Each nutrient was described as Green, Amber or Red depending on the nutrient amounts. That is, a basket had Green on Sugar if that basket contained high levels of Sugar, while Green would have meant that the basket had low levels of Sugar. Within each choice set, Basket 1 was always fixed (it had Amber on Salt, Sugar and Saturates and Red on Fat) while Basket 2 and 3 varied between choice sets. The composition of Basket 1 was decided based on 'an examination of current consumption activity and the levels of the various nutrients being consumed'(Balcombe, Fraser and Di Falco, 2010, p.216). A "don't know" option was also included in the choice set. The DCE employed a fractional factorial design which ensured balance across the attributes. This resulted in a total of twenty-four choice sets which were blocked into two sets of 12 in the study by Balcombe et al. (2015). The attributes and their levels are presented in Table 1. The study by Balcombe, Fraser and McSorley (2015) also collected data on eye-tracking to understand consumer visual attention and attribute non-attendance in Discrete Choice Experiments.

5.3.2.2 DCE design employed by this research

For this research, participants were presented with the same twenty-four choice sets in terms of basket composition used by the two studies above. That is, respondents were asked to choose between three different baskets described in terms of their Salt, Sugar, Fat and Saturates content, and Price. However, in contrast to the two studies, the prices of the baskets were increased by £10 to be more reflective of food prices for the year 2020. The author acknowledges that Saturates are a subset of Fat and this might have been confusing for some respondents. However, the author made the decision to keep these two nutrients as distinct since they are part of UK's nutritional labelling policy. As done in the previous two studies above, Basket 1 was always fixed (it had Amber on Salt, Sugar and Saturates and Red on Fat) while Basket 2 and Basket 3 varied across choices. The author of this research felt that the composition of Basket 1 used in the previous two studies (where no ingredient is Green) was still relevant at the time the research was conducted, and therefore the composition of Basket 1 was kept the same as the previous two studies cited above. In addition, a 'Neither of the baskets' option was included, while the previous two options included a 'Don't know' option. Also, this research not only collected data about participants' basket choices, but also recorded their mouse movements while participants were making their choices. Because data about a respondent's mouse movements can only be gathered if the relevant information is hidden, this choice experiment was designed to enable Basket 1 to be always visible. The information relating to the attributes describing Basket 2 and 3 was always hidden behind an opaque box and could only be uncovered if respondents hovered their mouse on the box. This is further explained in the mouse-tracking section below.

Table 1 Attribute and levels for the Discrete Choice Experiment design

Attribute	**Levels**
Salt	Green, Amber, Red
Sugar	Green, Amber, Red
Fat	Green, Amber, Red
Saturates	Green, Amber, Red
Price	£25, £28, £30, £35, £40

5.3.3 Mouse-tracking: procedures and implementation

In addition to collecting respondent's choices as is usually the case in a classical DCE, the DCE used in this research also collected participants' mouse movements as they were deciding between the baskets. These data were recorded with the help of MouselabWeb 2.0[3] (version August 2019). MouselabWeb 2.0 is an open-source software package that collects data about a user's mouse movements. In the decision-making literature, MouselabWeb 2.0 has been used to understand decision theories and is often referred to as a 'process-tracing tool' (Willemsen and Johnson, 2011). A typical MouselabWeb 2.0 page usually has a matrix appearance with each cell representing a specific type of information. This matrix appearance makes it suitable for use in a DCE. However, for MouselabWeb 2.0 to collect respondents' mouse movements in the DCE, the attribute information needs to be hidden behind an opaque box and can only be revealed if the mouse cursor is hovered over it. Once the mouse has left the box, the information becomes again hidden (Willemsen and Johnson, 2011). By using MouselabWeb 2.0 within a DCE to collect mouse movement data, respondents face an automatic cognitive cost: they can only see the attribute level information as long as their mouse cursor is hovered over the relevant box and this information becomes hidden again once the mouse cursor has left the box. Mouse movement data cannot be collected without this specific occluded design.

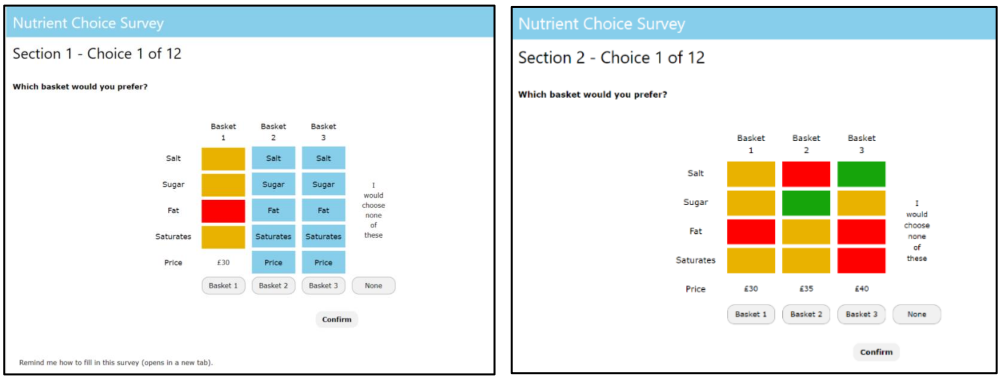
MouselabWeb 2.0 is based on jQuery and w3.css and uses a Json (Java Script Object Notation) definition file for the table where the mouse-tracked information is shown. Underlying a MouselabWeb 2.0 page are JavaScripts that contain the MouselabWeb 2.0 functionality and PHP scripts that store the data in a background MySQL database. MouselabWeb 2.0 pages can be linked to each other and can also contain other types of questions such as radio button questions or multiple-choice questions.

Because mouse movements can only be tracked if the information is occluded, the choice sets presented to the participants were modified to allow for this. This is referred to in this thesis as the Hidden Treatment (HT). Namely, Basket 2 and 3 were presented in a hidden format, which implied hiding the information about nutrient level

[3] The code and instructions to set up a mouse-tracking experiment and download the data can be found on the dedicated Github page: https://github.com/MCWillemsen/mouselabWEB20 (Accessed: 05/03/2021).

and price behind individual opaque boxes. To make the task manageable for the survey participants, Basket 1, which was also fixed, was always presented in "open format", that is nutrient and price information was always visible. For Basket 2 and 3, participants had to hover their mouse cursor on each individual attribute to see the nutrient and price information. Participants were also offered the possibility of choosing none of the three baskets.

Figure 2 Sample choice set used in Hidden Treatment (left panel) and Open Treatment (right panel).



Note: In the Hidden Treatment, the participant needs to hover their mouse on each individual blue box for the nutrient and price information to be revealed. The box shows the information as long as the mouse is hovered over it and goes back to being blue when the mouse leaves the box.

Apart from answering the survey in a Hidden Treatment, participants were also asked to make the same twelve choices in an Open Treatment (OT) where all nutrient and price information about all three baskets was visible. Participants did not know that these were the same choices. Examples of choice sets used in the Hidden Treatment and in the Open Treatment are presented in Figure 2 above. Every participant made 24 choices in total: twelve choices in Open Treatment and the same twelve choices in Hidden Treatment. To prevent unwanted effects of information display on participants' level of attention, approximately half of the sample first saw the Hidden Treatment followed by the Open Treatment, while the other half first saw the Open Treatment followed by the Hidden Treatment. This was to ensure that responses were robust to learning from the previous treatment.

Since the 24 choice sets were split into two sets of twelve, four versions of the survey were employed (see Table 2 below) with each participant facing one of these four versions. For analysis purposes, these survey versions were grouped by Choice Card number and by Treatment as follows. Set 1 refers to Choices 1 to 12 while Set 2 refers to

Choices 13 to 24. Set A refers to Choices 1 to 24 where the Hidden Treatment was seen first while Set B refers to Choices 1 to 24 where the Open Treatment was seen first. This thesis will therefore refer to these sets using this description.

Table 2 The four survey versions according to the choice cards used and the treatment order.

Survey version	**Choice cards**	**Treatment order**	**Set number acc. to choice card number**	**Set number acc. to Treatment Order**	**No. of respondents**
1A	Choices 1 to 12	Hidden Treatment followed by Open Treatment	1	A	55
1B	Choices 1 to 12	Open Treatment followed by Hidden Treatment	1	B	56
2A	Choices 13 to 24	Hidden Treatment followed by Open Treatment	2	A	58
2B	Choices 13 to 24	Open Treatment followed by Hidden Treatment	2	B	75

The data generated by MouselabWeb 2.0 can then be retrieved by using the Datalyser program for which a password must be set so that the experiment data is secure. The Datalyser allowed downloading of individual participants' data: their basket choice for each choice set, the number of times and the length of time each attribute within each of the two hidden baskets was hovered over and the order in which participants hovered over the attributes. The Datalyser also allowed downloading of participants' responses to questions about socio-demographic and lifestyle data. A more detailed description of the mouse-tracking data is offered in Section 5.6 below.

The survey was also accessible on smartphone devices, but participants were asked to fill it only from a desktop computer or a laptop. This was to ensure that the participants interacted in a similar way with the survey but also that the MouselabWeb 2.0 was tracking mouse movements as opposed to touch movements. Because the experiment differentiated between touch movements and mouse movements, it was possible to check if respondents followed the instructions.

5.3.4 Measurement of attitudinal variables

Additional HTML webpages with questions were designed to include introductory information about the survey and the research, as well as to capture more individual-level data relevant to the research. The first pages offered instructions for participants on how to fill in the survey, as well as information about the content of the survey and estimated time of completion. The following page asked the participants to insert a memorable word which they could quote after completion of the survey if they wanted to withdraw their responses from the research. The Traffic Light System was presented to participants using simple language and an example basket was shown. Next, participants were given a practice question based on a choice card. As part of this practice question, respondents were given explanations on how to hover their mouse on the individual boxes to see the information for Basket 2 and 3 and how to choose their preferred basket. Participants had to choose their preferred baskets in the practice question before moving on to the actual survey.

After responding to the choice experiment, participants were asked additional questions regarding: the attribute(s) they ignored when making their choices in both Hidden and Open Treatments (the stated non-attendance question), the heuristics or the decision rules they used in making their choices, how difficult they found the Hidden Treatment compared to the Open Treatment, their IT literacy, several diet and lifestyle questions inspired from the Food Choice Questionnaire by Steptoe, Pollard, & Wardle (1995) but adapted to a supermarket shopping scenario, several questions about their knowledge and use of the TLS as well as several socio-demographic questions. Finally, participants were asked to enter their email address if they wished to enter a lottery for a chance to win an Amazon voucher worth £50.

5.3.5 Survey testing

Prior to the data collection process, the online survey and embedded MouselabWeb 2.0 technology was subjected to several user testing sessions. Because this was the first time a choice experiment was used in conjunction with mouse-tracking technology, the objective of the user testing sessions was twofold. First, it was important to understand how users interact with the mouse-tracking instrument and whether they understand how to hover their mouse to inspect the basket information in the Hidden Treatment. Second, it was important to understand whether users experience any technical difficulties in terms of how they interact with the survey on their own personal computer and browser, as well as whether the survey instructions are self-sufficient.

5.3.5.1 First testing round

A first round of user testing sessions was conducted between July and October 2019 on an earlier version of the online survey. Fourteen participants were recruited and asked to fill in the web survey. The recruitment criteria were age 18 or over, UK consumer, responsible for own grocery shopping and being a supermarket shopper. During this first round of user testing sessions, priority was given to having participants from a variety of socio-demographic backgrounds and with different levels of IT literacy. Of the 14 participants, seven were aged between 25 and 34, three were aged 34 to 44, one was aged between 45 and 54, one was aged between 55 and 64 and two participants were over 75 years old. All fourteen participants had varying levels of IT literacy and only four of them played video games on a frequent basis. Nine of these participants were asked to take part in individual one-to-one user testing sessions.

The objective of this first round of user testing sessions was to observe how participants interact with the survey instrument (especially the Hidden Treatment), understand whether they experience difficulties of any nature and make necessary adjustments. The one-to-one sessions were conducted following usability testing methodologies for websites and web applications which are normally used in the IT industry (Krug, 2014). A usability test script guided the format of these sessions and was drafted to ensure all individual sessions were conducted in a standardized manner. The usability test script was adapted from the methodology proposed by Krug (2009). The usability test script included information about the objective of the testing session and questions about the profile of the participant (level of IT literacy, frequency of computer usage, etc.) as well as questions about the visual presentation of the website and wording of survey instructions. Throughout the session, participants were encouraged to think out loud and voice any concerns or difficulties related to filling in the survey or using their mouse to uncover basket information. The sessions were audio-recorded to ensure that participant feedback was adequately recorded. The computer screen used by participants to respond to the survey was also recorded using screencast technology. Prior to the start of the session, participants were informed about the objectives of the session and were asked to sign a consent form agreeing to their screen and conversation to be recorded. A copy of the consent form can be found in *Appendix C User testing recording consent form* and a copy of the usability test script which guided the user testing sessions can be found in *Appendix D. Usability test script for online survey*.

In addition to the nine in-person user testing sessions, five participants were sent the link to the web survey by email and were asked to fill in the survey on their own and answer a shortened version of the questions included in the usability test script. The goal was to test the web survey on different computers and web browsers and understand how participants interact with the survey in their own environment (home, office, etc) reflecting how the actual participants might fill in the survey.

5.3.5.2 Second testing round

A second round of user testing sessions was conducted between January and February 2020 on an improved version of the web survey. The link to the web survey was sent to a sample of 28 individuals who were asked to send their feedback on any aspect of the survey. Out of these 28, 15 users filled in the survey on their own and sent their comments on the survey. The purpose of this second round of testing was to gather user feedback on the final web survey version and to gather some preliminary data to be used in doing a dry-run analysis of the data.

5.3.6 Survey calibration

Comments of both technical and content nature were received during the two user testing sessions. Most comments concerned the visual presentation of the survey and the wording of survey instructions. Summaries of the main comments made by users can be found in *Appendix E. User testing feedback*. Some participants raised issues around the difficulty of choosing food baskets which are solely described in terms of price and nutrient content as opposed to being described in terms of the actual foods contained. However, it was found that, in general, participants do understand what they are asked to do in the survey with most of them finding it relatively easy to answer the survey questions. No significant objections in relation to the Hidden Treatment were raised by participants over the age of 55 (n=4).

A great deal of participant feedback and comments were incorporated in a revised version of the web survey. Between July 2019, the start of the first testing session and February 2020, the end of the second testing session, the survey was constantly improved based on this author's experience and user feedback.

5.4 Participant recruitment

The online survey was distributed between March and April 2020 to a sample of 13,000 UK consumers who were part of a consumer database managed and owned by a UK-based private market research company. The market research company had no control and no responsibility over how the data was collected and was only responsible to send the survey link to the consumer database. To be eligible to take part in the study, participants had to be 18 or over, responsible for their own grocery shopping and a supermarket shopper. Participants were asked to only fill in the survey from a desktop computer or a laptop. Prior to starting filling in the survey, participants were asked to give their informed consent for participating in the study by downloading and reading the Participant Information Sheet which explained the purpose of the survey and research and informed participants about how their data would be collected, stored, and disposed of. The research protocol, Participant Information Sheet and data collection instrument were reviewed prior to the data collection process according to the procedures specified by the University of Reading Research Ethics Committee and had been given a favourable ethical opinion for conduct (see *Appendix B. Ethical Clearance for Online survey*).

As an incentive to fill in the survey, participants were told they will be entered into a lottery with the possibility of winning an Amazon voucher worth £50. This possibility was only offered to participants who were willing to share their email address so they could be contacted in case they have won. Participants who opted out from entering their email address were not included in the lottery. The average time required for completing the survey was 13 minutes. In total 275 full responses were received which is equivalent to a 2.1% response rate. A more detailed description of the final sample used in this research is shown in Section 5.7 below.

5.5 Data cleaning and preparation

The dataset was cleaned by removing participants that replied to more than one set, those that did not finish the survey, and those that chose the same basket for every choice. It is important to say that out of the 31 respondents that were removed from the final dataset, 25 respondents answered more than one set, 4 respondents were removed because they had chosen the option 'None of the baskets' across all their choices while only 2 respondents did not finish the survey. Dropout rates were therefore very low. The data cleaning process yielded a final sample of 244 participants which made a total of 5,856 choices. These participants are relatively evenly distributed across the four versions of the survey (see Table 2) as follows: set 1A includes 55 respondents, set 1B includes 56 respondents, set 2A includes 58 respondents and set 2B includes 75 respondents. Given the grouping described in Section 5.3.3, set A included 113 respondents (55+58) and set B included 131 respondents (56+75). These are included in the final analysis.

5.6 Mouse-tracking data

Section 5.3 described how the mouse-tracking data has been collected as part of the Discrete Choice Experiment. This Section describes how the mouse-tracking data has been retrieved and how the different measures of fixations and dwell time have been extracted from this data.

5.6.1 Retrieval of the mouse-tracking data

After all participants have completed the DCE, the mouse-tracking data has been downloaded from the Datalyser. This mouse-tracking data reflects participants' mouse movements in terms of the DCE attributes that were inspected, the order in which they were inspected, and the length of time spent on inspecting these attributes. A sample of the mouse-tracking data obtained through the Datalyser is shown in Table 3. The table shows the mouse-tracking data obtained for one participant for one choice. The table headers refer to the following aspects. 'Expname' stands for the name of the experiment, which in the case of this research referred to the choice card number (Choice card 1 to 24). The 'Subject' header refers to the identification details of the respondents, which in this case were kept anonymous for the researcher. The 'ip' header shows the IP (Internet Protocol) address of each respondent which was also kept anonymous. The 'choice' column refers to the actual basket that the respondent chose for that particular choice card: Basket 1, Basket 2, Basket 3, or None. The 'submitted' column shows the date and time when the participant hovered their mouse over the attribute. The 'event' column shows the type of interaction that respondents had with the mouse-tracking experiment: 'mouseover' refers to the moment in which the respondent hovered their mouse on the hidden box to inspect the attribute information and 'mouseout' refers to the moment in which the respondent left the hidden box. 'Onload' refers to the moment in which the choice card was loaded onto the participant's screen, 'btnClick' and 'submit' refer to the moment in which the respondent clicked on the chosen basket and when their answer was submitted in the database. The 'name' column refers to the attributes which were uncovered when the mouse hovered on the hidden box. These are shown in the order in which they were inspected. Values in this column such as 'Salt2' and 'Sugar3' refer to mouse hovers on the Salt attribute in basket 2 and mouse hovers on the Sugar attribute in basket 3. The 'value' column offers information about the value of the attribute that was hovered on, but since the values of the attributes were pictures of the three Traffic Light System colours (green, amber, red), this information is not visible in the column. The 'body' value refers to the loading of the choice card on the respondent's webpage while the values relating to 'btnClick' refer to the chosen basket (which in the example below was None). Finally, the 'time' column shows the time (in milliseconds) when the respondent opened the hidden box with the attribute level information and when the respondent left the hidden box.

Table 3 Mouse-tracking data sample

id	expname	subject	ip	condnum	choice	submitted	event	name	value	time	submit	test	optionOrde	attributeOrder	set
304	Choice1	anonymous	134.225.92.64	-1	Basket 2	06/07/2019 10:56	onload	body	body	42	confirm	1	1-2-3-4	Salt/Sugar/Fat/Saturates/Pri	Set1
304	Choice1	anonymous	134.225.92.64	-1	Basket 2	06/07/2019 10:56	btnClick	Basket 2		1699	confirm	1	1-2-3-4	Salt/Sugar/Fat/Saturates/Pri	Set1
304	Choice1	anonymous	134.225.92.64	-1	Basket 2	06/07/2019 10:56	mouseover	Price		2125	confirm	1	1-2-3-4	Salt/Sugar/Fat/Saturates/Pri	Set1
304	Choice1	anonymous	134.225.92.64	-1	Basket 2	06/07/2019 10:56	mouseout	Price		2375	confirm	1	1-2-3-4	Salt/Sugar/Fat/Saturates/Pri	Set1
304	Choice1	anonymous	134.225.92.64	-1	Basket 2	06/07/2019 10:56	mouseover	Saturates		2376	confirm	1	1-2-3-4	Salt/Sugar/Fat/Saturates/Pri	Set1
304	Choice1	anonymous	134.225.92.64	-1	Basket 2	06/07/2019 10:56	mouseout	Saturates		2407	confirm	1	1-2-3-4	Salt/Sugar/Fat/Saturates/Pri	Set1
304	Choice1	anonymous	134.225.92.64	-1	Basket 2	06/07/2019 10:56	mouseover	Fat		2408	confirm	1	1-2-3-4	Salt/Sugar/Fat/Saturates/Pri	Set1
304	Choice1	anonymous	134.225.92.64	-1	Basket 2	06/07/2019 10:56	mouseout	Fat		2590	confirm	1	1-2-3-4	Salt/Sugar/Fat/Saturates/Pri	Set1
304	Choice1	anonymous	134.225.92.64	-1	Basket 2	06/07/2019 10:56	mouseover	Sugar		2591	confirm	1	1-2-3-4	Salt/Sugar/Fat/Saturates/Pri	Set1
304	Choice1	anonymous	134.225.92.64	-1	Basket 2	06/07/2019 10:56	mouseout	Sugar		2641	confirm	1	1-2-3-4	Salt/Sugar/Fat/Saturates/Pri	Set1
304	Choice1	anonymous	134.225.92.64	-1	Basket 2	06/07/2019 10:56	mouseover	Salt		2642	confirm	1	1-2-3-4	Salt/Sugar/Fat/Saturates/Pri	Set1
304	Choice1	anonymous	134.225.92.64	-1	Basket 2	06/07/2019 10:56	mouseout	Salt		2908	confirm	1	1-2-3-4	Salt/Sugar/Fat/Saturates/Pri	Set1
304	Choice1	anonymous	134.225.92.64	-1	Basket 2	06/07/2019 10:56	mouseover	Salt		2924	confirm	1	1-2-3-4	Salt/Sugar/Fat/Saturates/Pri	Set1
304	Choice1	anonymous	134.225.92.64	-1	Basket 2	06/07/2019 10:56	mouseout	Salt		3075	confirm	1	1-2-3-4	Salt/Sugar/Fat/Saturates/Pri	Set1
304	Choice1	anonymous	134.225.92.64	-1	Basket 2	06/07/2019 10:56	mouseover	Sugar		3075	confirm	1	1-2-3-4	Salt/Sugar/Fat/Saturates/Pri	Set1
304	Choice1	anonymous	134.225.92.64	-1	Basket 2	06/07/2019 10:56	mouseout	Sugar		3141	confirm	1	1-2-3-4	Salt/Sugar/Fat/Saturates/Pri	Set1
304	Choice1	anonymous	134.225.92.64	-1	Basket 2	06/07/2019 10:56	mouseover	Fat		3142	confirm	1	1-2-3-4	Salt/Sugar/Fat/Saturates/Pri	Set1
304	Choice1	anonymous	134.225.92.64	-1	Basket 2	06/07/2019 10:56	mouseout	Fat		3207	confirm	1	1-2-3-4	Salt/Sugar/Fat/Saturates/Pri	Set1
304	Choice1	anonymous	134.225.92.64	-1	Basket 2	06/07/2019 10:56	mouseover	Saturates		3208	confirm	1	1-2-3-4	Salt/Sugar/Fat/Saturates/Pri	Set1
304	Choice1	anonymous	134.225.92.64	-1	Basket 2	06/07/2019 10:56	mouseout	Saturates		3273	confirm	1	1-2-3-4	Salt/Sugar/Fat/Saturates/Pri	Set1
304	Choice1	anonymous	134.225.92.64	-1	Basket 2	06/07/2019 10:56	mouseover	Price		3274	confirm	1	1-2-3-4	Salt/Sugar/Fat/Saturates/Pri	Set1
304	Choice1	anonymous	134.225.92.64	-1	Basket 2	06/07/2019 10:56	mouseout	Price		3373	confirm	1	1-2-3-4	Salt/Sugar/Fat/Saturates/Pri	Set1
304	Choice1	anonymous	134.225.92.64	-1	Basket 2	06/07/2019 10:56	submit	submit	succe	4347	confirm	1	1-2-3-4	Salt/Sugar/Fat/Saturates/Pri	Set1

5.6.2 Extraction of the mouse-tracked data

After retrieving the participants' data, the next step was to extract the information related to fixations counts and dwell time. Fixation counts refer to the number of times that a participant has hovered their mouse over an attribute to read the attribute level information. To facilitate comprehension, the term 'fixation counts' has been chosen for this research to refer to mouse hover counts. Dwell time refers to the amount of time (in milliseconds) spent on looking at the attribute level. The term 'dwell time' has been chosen for this research to refer to mouse hover time. Fixations counts and dwell time measures were recovered from the raw mouse-tracking data (see sample in Table 3) in the following way. Fixation counts were recovered by summarizing the information in the 'event' and 'name' columns which show the attributes that were inspected by each participant. Dwell time data was recovered by subtracting the 'time' column values relating to 'mouseout' from the 'time' column values relating to 'mouseover'. The basket choice of each participant was recovered from the 'choice' column. The IP address was only used to link participants' answers and was not used to identify participants in any way.

5.7 Descriptive statistics of sample

This Section presents some descriptive statistics for the final sample. These statistics are presented in terms of the socio-demographic profile of the sample, their food shopping habits, and the extent to which they are familiar and use the Traffic Light System during their food shopping. This Section also presents some descriptive statistics in relation to respondents' IT skills and their perception of the difficulty of filling in the survey in Hidden Treatment when compared with the Open Treatment.

5.7.1 Socio-demographic profile

Table 4 on the next page reports the summary statistics of the sample for the socio-demographic variables: age, gender, education, and income. The study sample is predominantly female (around 70%), but relatively heterogeneous in terms of age, education, and income levels. In comparison to the general UK population, this sample is slightly younger, includes more females and is more educated (*ONS, 2021*).

Table 4 Socio-demographic characteristics of the sample

Socio-demographic data	Percentage of total sample (n=244)
Age	
18-24	15.16%
25-34	12.70%
35-44	18.03%
45-54	15.98%
55-64	21.72%
65-74	12.30%
Over 75	2.87%
Rather not say	1.23%
Gender	
Female	70.90%
Male	27.87%
Rather not say	1.23%
Education	
Secondary School	18.85%
College/Vocational training	25.82%
Undergraduate degree	31.56%
Postgraduate degree	22.13%
Rather not say	1.64%
Income	
Less than £14,000	9.02%
£14,000-£24,999	11.89%
£25,000- £34,999	15.57%
£35,000- £44,999	8.61%
£45,000- £54,999	10.66%
£55,000-£64,999	10.25%
£65,000 - £79,999	8.20%
Over £80,000	9.84%
Rather not say	15.98%

5.7.2 Food shopping habits

Table 5 on the next page describes the sample in terms of their food shopping habits. For less than half of the sample the food that they shop on a typical day needs to be easy to prepare, while for a quarter of respondents (24%) whether the food is easy to prepare or not does not represent an important factor during their shopping. Buying food which is low in bad nutrients is important for more than half of the sample. 52% of respondents stated that the food they shop on a typical day must be low in salt, 63.11% stated that it must be low in sugar, 56.13% that it must be low in fat and 61.47% that it must be low in saturated fats. Food that is low in calories was important only for 36.46% of respondents.

Table 5 Food shopping habits for the sample (% total sample, N=244)

Habit/lifestyle question It is important to me that the food I shop on a typical day:	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Is easy to prepare	8.6	38.11	29.5	20.9	2.86
Is low in sugar	16.8	46.31	25.81	9.01	2.04
Is low in calories	8.6	27.86	43.03	17.62	2.86
Is cheap	9.83	27.04	39.75	20.08	3.27
Is low in fat	9.01	47.12	28.68	13.52	1.63
Is high in fibre	12.7	42.62	37.29	6.14	1.22
Is nutritious	30.73	58.06	8.6	1.63	0.4
Is low in salt	14.34	37.7	33.6	13.11	1.22
Helps me control my weight	10.65	35.24	36.88	13.52	3.68
Contains a lot of vitamins and minerals	11.47	47.54	34.01	6.55	0.4
Is high in protein	9.42	42.21	41.39	6.96	0
Keeps me healthy	29.09	56.14	13.52	1.22	0
Is low in saturated fat	17.62	43.85	31.55	6.14	0.81

5.7.3 Use and familiarity with the Traffic Light System

Figure 3 and Figure 4 describe the respondents in terms of their familiarity with and frequency of use of the Traffic Light System when shopping for food. The Traffic Light System appears to be familiar to a large part of the sample, with almost three quarters of respondents stating that they are either extremely familiar or moderately familiar. However, the extent to which the Traffic Light System is used when shopping for food greatly differs between respondents. Around 28% of respondents claim never to use or almost never to use the Traffic Light System, while 42% of respondents stating that they sometimes use the information offered by the Traffic Light System when shopping for food. Only a third of respondents use the Traffic Light System every time or almost every time they shop for food.

Figure 3 Use and familiarity with the Traffic Light System (% total sample, N=244)

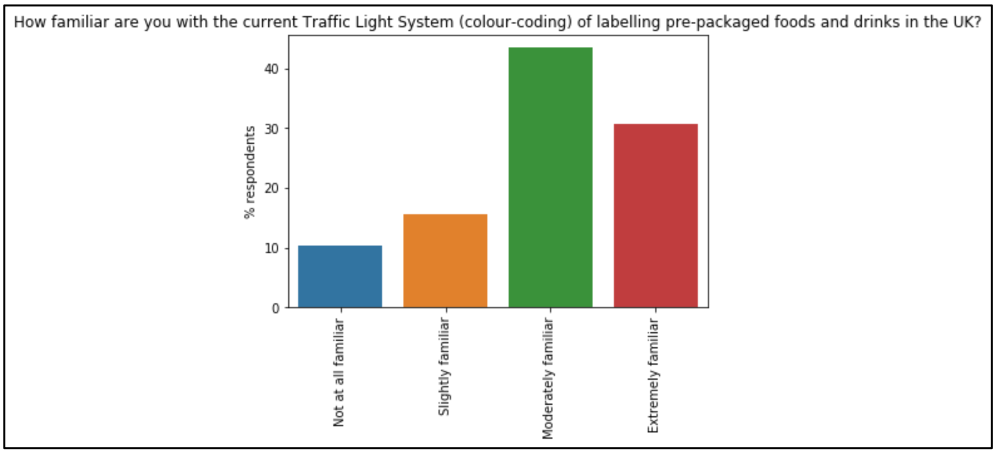
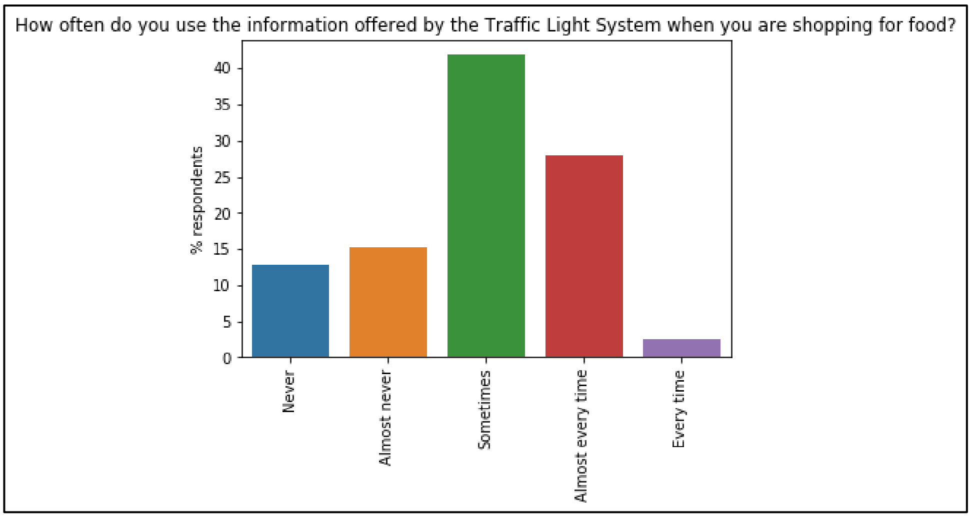
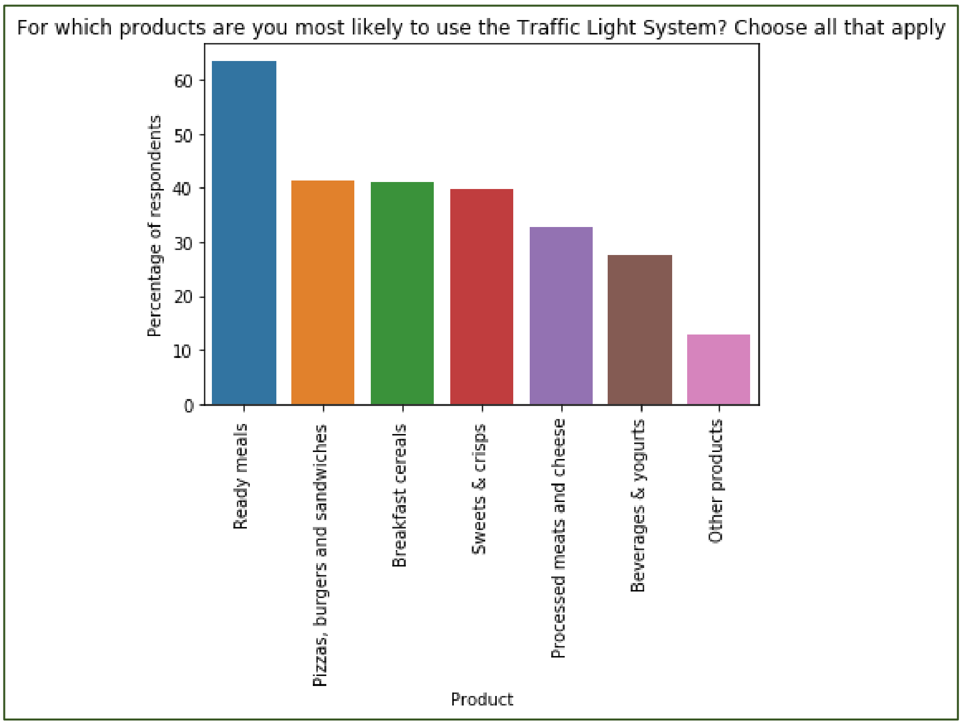


Figure 4 Frequency of using the Traffic Light System



In terms of the actual products that the Traffic Light System is used for, Figure 5 shows that a large majority of people use it when buying for ready meals (63.52%), followed by pizzas, burgers and sandwiches (41.39%) and breakfast cereals (41%). Only a third of people use the Traffic Light System when buying beverages and yogurts or processed meats and cheeses.

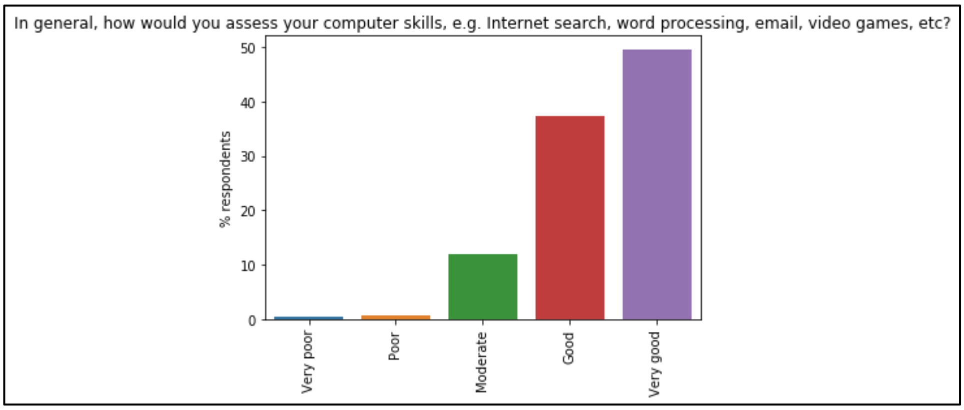
Figure 5 Products most likely to be used with the Traffic Light System (% total respondents, N=244)



5.7.4 IT literacy

Figure 6 shows the extent of IT literacy amongst the respondents. An overwhelming majority reported to have moderate, good, or very good computer skills, with only a small minority of respondents declaring poor IT skills. Given that the survey was distributed to the respondents as a web survey, the fact that an overwhelming majority of the sample assessed their IT skills as good or very good might not come as a surprise.

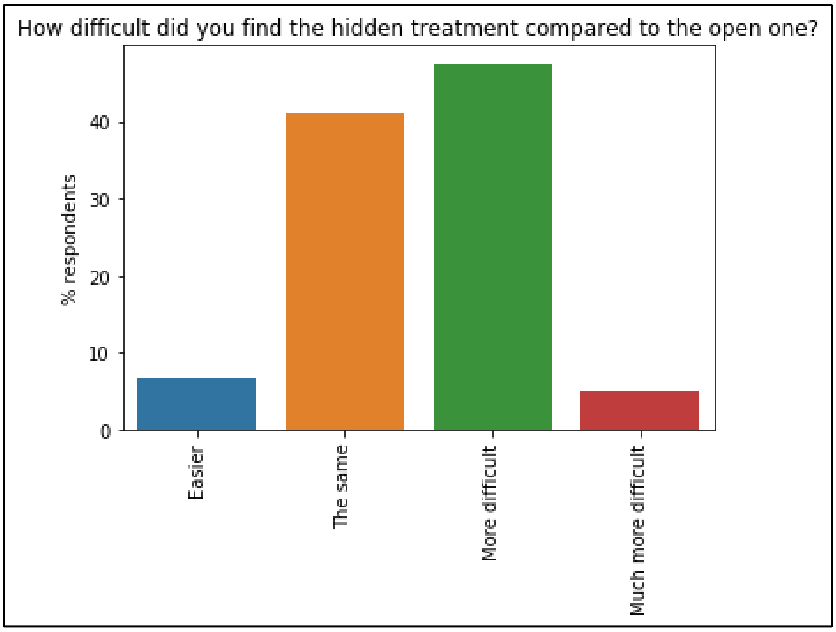
Figure 6 IT literacy (% total respondents, N=244)



5.7.5 Difficulty of interacting with the Hidden Treatment

An important component of this research was understanding the extent to which respondents find the Hidden Treatment of the DCE survey more difficult than the Open Treatment. The reader is reminded that in the Hidden Treatment the nutrient level and price information related to Basket 2 and 3 were hidden behind individual opaque boxes and participants had to hover their mouse cursor on each individual attribute to see the nutrient and price information. The Open Treatment did not require respondents to hover their mouse cursors as the attribute information was visible. A more detailed description of the Hidden and Open Treatment was offered in Section 5.3.3 and a sample choice set in the Hidden and in the Open Treatment was shown in Figure 2.Figure 7 shows the extent to which respondents found the Hidden Treatment more difficult than the Open Treatment. Around 45% of respondents found the Hidden Treatment more difficult than the Open Treatment, while 40% believed that the level of difficulty between the two treatments was broadly similar. Less than 4% found the Hidden Treatment much more difficult than the Open Treatment.

Figure 7 Difficulty responding to the Hidden Treatment vs. Open Treatment (% total respondents, N=244)



6 Results Part 1: Consumer willingness-to-pay (WTP) for reductions in Traffic Light System nutrients

6.1 Introduction

This chapter presents the results of the discrete choice model as implemented in the two treatments: the Hidden Treatment (with participant mouse-tracking) and the Open Treatment (without participant mouse-tracking) and as described in Section 5.3.3. The choice modelling results are presented as Willingness-to-Pay (WTP) estimates for reducing exposure to the Traffic Light System nutrients. As mentioned in Chapter 4 Methods, the WTP estimates were obtained using Bayesian inference. The results of this chapter contribute to understanding the extent of interference of Mouselab with respondents' inferred preferences (Objective 1).

This chapter is structured as follows. Section 6.2 presents the WTP estimates for reductions in the Traffic Light System nutrients as derived from the Hidden, the Open Treatment, and from a model combining the two treatments together (a merged model). Section 6.3 compares the two WTP estimates from the two treatments while Section 6.4 compares the predictive validity of the merged model and the separate models.

6.2 WTP estimates

This Section presents the choice modelling results, as outlined in Chapter 4. Consumer preferences and WTP for reductions in the Traffic Light System nutrients for the overall sample were estimated using a Mixed Logit model. The WTPs were estimated for both the Hidden Treatment (which involved tracking participants' mouse movements) and for the Open Treatment (which did not involve participant mouse-tracking). The WTPs are estimates for respondents' willingness to pay to switch from one colour to another, with Amber being the base. For each of the nutrients the changes from Amber to Green (G-A) and from Amber to Red (R-A) have been estimated. These parameters provide a measure of how much respondents are willing to pay to reduce exposure to high levels of a given nutrient. In other words, these parameters provide a measure of how much respondents are willing to avoid high levels of Salt, Sugar, Fat or Saturates in their food baskets. For instance, the WTP Amber to Green (WTP G-A) provides an estimate of how much respondents are willing to pay to reduce their exposure to Amber. The WTP Amber to Red (WTP R-A) provides an estimate of how much respondents are willing to pay to avoid having Red on the nutrient.

The Hamiltonian Monte Carlo sampler described in Section 4.2.7 was run for 8,000 iterations. This was done for 2 chains started at independent chains where the first 2,000 draws were discarded as burn-in, giving 6,000 draws which were then used for analysis. As is characteristically done in Bayesian reporting, the mean values for the parameters along with the standard deviations are reported for all the parameters (including the WTPs for individual participants). The mean values for these parameters are taken to be the estimates for the parameters in question. The full statistical output after estimation for choice set A only (open treatment) is offered in Appendix I. Full statistical output after estimation (set A open). This appendix shows the mean parameters as well as the individual WTP parameters as estimated in Python.

Model convergence is checked by using the "*Rhat*" criteria (Gelman and Rubin, 1992), which ensures that both the individual chains themselves behave in a way that is consistent with convergence, and that each of the chains appears to be drawing from the same stable posterior. The *Rhat* for all the parameters in the model were close to unity (<1.02), which is consistent with convergence (which requires that these should be less than 1.1). Additionally, convergence was checked visually using trace plots which are available in *Appendix G. Trace plots for WTP estimates*. These trace plot show that the Hamiltonian Monte Carlo sampler has converged since the retained simulated values seem to fluctuate around constant means.

6.2.1 WTP estimates in the Hidden Treatment

Table 6 on the next page shows the mean and the standard deviation for the resulting posterior densities for the Hidden Treatment. Set A on the left shows the WTP estimates for participants who first saw the Hidden Treatment, then they saw the Open Treatment for the same choices (Choices 1 to 12 or Choices 13 to 24). Set B on the right shows the WTP estimates for participants who first saw the Open Treatment, and then the Hidden Treatment for the same choices (Choices 1 to 12 or Choices 13 to 24). Irrespective of the order of treatments, these estimates are for Hidden Treatment (see

Figure 2 for a sample choice card illustrating the Hidden Treatment and Table 2 for an illustration of the sets used in this analysis).

The WTP estimates are rather high but have the expected sign. For example, the mean WTP to move from Amber to Green on Salt is £4.268 in set A. This means that respondents are willing to pay approximately £4.3 to have Green on Salt, or put differently, to go from Amber to Green on Salt. The WTP to move from Amber to Red on Salt is -£3.733 in set B. This suggests that respondents are willing to pay £3.75 to have Amber on Salt. The largest WTP for moving from Amber to Green is for Salt and Saturates while the lowest WTPs are for Sugar and Fat. This means that respondents valued more having low levels of Salt and Saturates than Sugar and Fat. Also, the mean WTP for Salt and Saturates seem to be higher in absolute terms for set B compared to set A. This means that, on average, people who saw the Open Treatment first, valued reductions in Salt and Saturates more than people who saw the Hidden Treatment first. When comparing the WTP estimates to move from Amber to Green with WTP estimates to move from Amber to Red, the estimates for Salt, Saturates and Sugar appear to be much higher when moving from Amber to Green than when moving from Amber to Red. This suggests that for these three nutrients, it is more important to have Green than to avoid Red.

Table 6 MXL results: WTP estimates in the Hidden Treatment, set A (left table) and set B (right table)

Attributes		**Posterior parameter estimates**	
		Mean	**Standard deviation**
Salt	Amber to Green	4.268	0.420
	Amber to Red	-2.890	0.535
Sugar	Amber to Green	3.654	0.525
	Amber to Red	-2.433	0.547
Fat	Amber to Green	3.463	0.540
	Amber to Red	-3.814	0.510
Sat	Amber to Green	4.026	0.487
	Amber to Red	-2.739	0.531

Attributes		**Posterior parameter estimates**	
		Mean	**Standard deviation**
Salt	Amber to Green	4.441	0.360
	Amber to Red	-3.733	0.491
Sugar	Amber to Green	2.909	0.519
	Amber to Red	-3.739	0.490
Fat	Amber to Green	3.993	0.478
	Amber to Red	-3.680	0.490
Sat	Amber to Green	4.423	0.371
	Amber to Red	-3.386	0.498

Figure 8 and

Figure 9 on the next page show the distribution of individual WTP estimates by attribute for set A and set B, respectively. As with all estimates these are derived from the mean of the posterior WTP for each individual. These figures show that there is considerable heterogeneity in terms of how individual respondents value reductions in the TLS nutrients, with some nutrients showing more heterogeneity than others. For instance, the standard deviations, which measure how spread out the WTP estimates are from the mean, range from 1.2 for Salt G-A to 1.9 for Sugar R-A in set A. Taking the example of Sugar in set A, most of the individual WTP estimates for moving from Amber to Green are concentrated between £3 and £5 with values less than £2 and more than £6.5 being extremely rare. When examining Sugar in set B, one can notice a larger degree of heterogeneity, with a few respondents having negative WTP to move from Amber to Green on Sugar.

Figure 8 Distribution of individual WTP estimates by attribute, set A, Hidden Treatment (with standard deviations), n=113

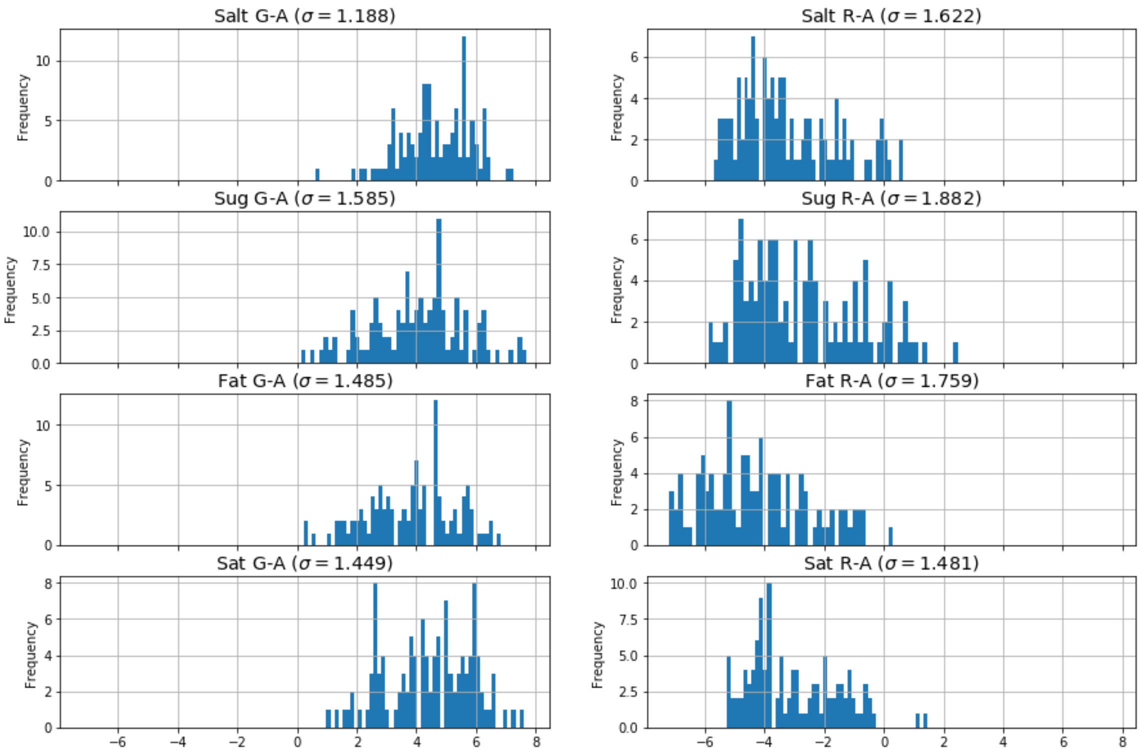
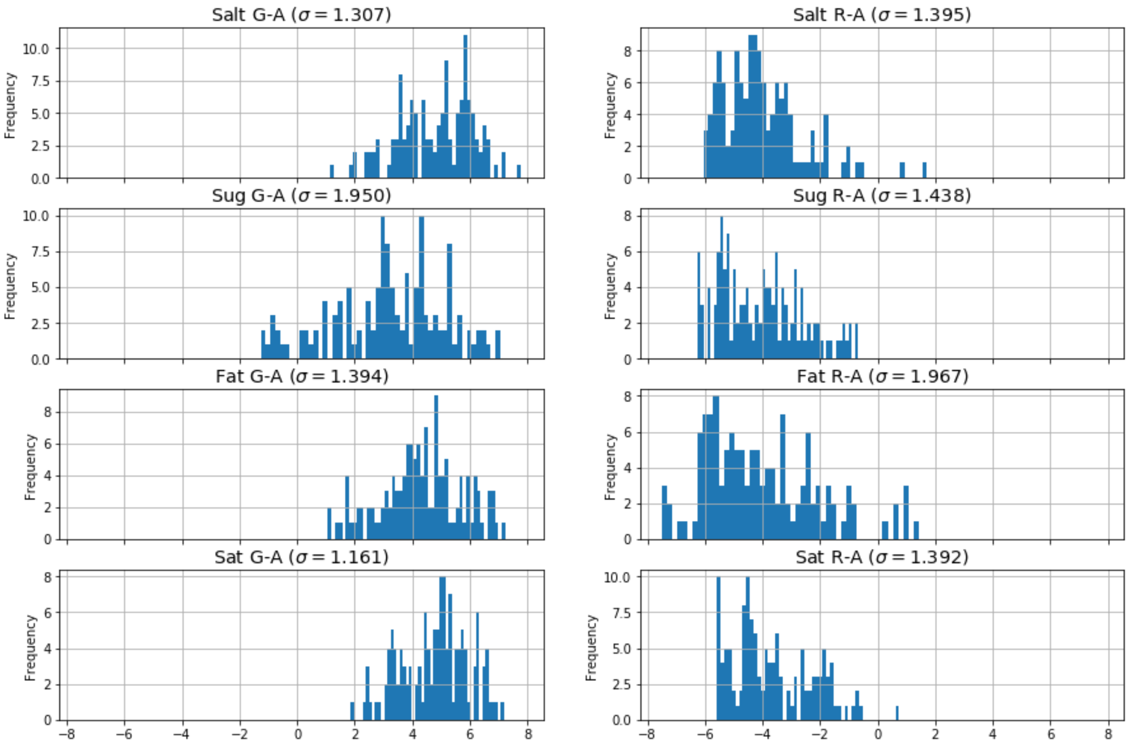


Figure 9 Distribution of individual WTP estimates by attribute, set B, Hidden Treatment (with standard deviations), n=131



6.2.2 WTP estimates in the Open Treatment

Table 7 below shows the mean and standard deviation for the resulting posterior densities for the Open Treatment. Similar to Section 6.2.1, set A on the left shows WTPs for participants who first saw the Hidden Treatment, then they saw the Open Treatment for the same choices (Choices 1 to 12 or Choices 13 to 24). Set B on the right shows WTPs for participants who first saw the Open Treatment, and then the Hidden Treatment for the same choices (Choices 1 to 12 or Choices 13 to 24).

The WTPs are rather large but have the expected sign. For example, the largest WTPs for moving from Amber to Green are for Saturates and Salt while the lowest WTPs are for Sugar and Fat. Also, the WTP means for Salt, Sugar and Saturates R-A seem to be higher in absolute terms for set B compared to set A. This means that, on average, people who saw the Open Treatment first valued a reduction in Red for Salt, Sugar and Saturates higher than people who saw the Hidden Treatment first. For Salt and Sugar G-A, the WTP means are higher in set A than in set B, which implies that on average, respondents who saw the Hidden Treatment first valued having Green on Salt and Saturates more than respondents who saw the Open Treatment first. When comparing the

WTP estimates to move from Amber to Green with WTP estimates to move from Red to Amber, Salt and Saturates WTP estimates seem to be much higher when moving from Amber to Green than when moving from Red to Amber.

Table 7 MXL results: WTP estimates in the Open Treatment, set A (left table) and set B (right table)

Attributes		**Posterior parameter estimates**	
		Mean	**Standard deviation**
Salt	Amber to Green	4.383	0.391
	Amber to Red	-3.759	0.497
Sugar	Amber to Green	3.474	0.526
	Amber to Red	-3	0.528
Fat	Amber to Green	3.564	0.532
	Amber to Red	-3.918	0.498
Sat	Amber to Green	4.466	0.372
	Amber to Red	-3.395	0.517

Attributes		**Posterior parameter estimates**	
		Mean	**Standard deviation**
Salt	Amber to Green	4.107	0.450
	Amber to Red	-4.196	0.434
Sugar	Amber to Green	2.377	0.536
	Amber to Red	-3.444	0.518
Fat	Amber to Green	3.777	0.491
	Amber to Red	-3.359	0.523
Sat	Amber to Green	4.430	0.375
	Amber to Red	-4.007	0.466

The distributions of WTP estimates by attribute for set A and set B are shown in

Figure 10 and Figure 11. Similar to the estimates presented above, these figures show considerable heterogeneity in individual WTP estimates for reductions in the TLS nutrients. For instance, in the case of moving from Amber to Green on Saturates in set A, the majority of WTP estimates are between £4 and £7 while for moving from Amber to Red, the WTPs range from -£5.5 to -£2.

Figure 10 Distribution of individual WTP estimates by attribute, set A, Open Treatment (with standard deviations), n=113

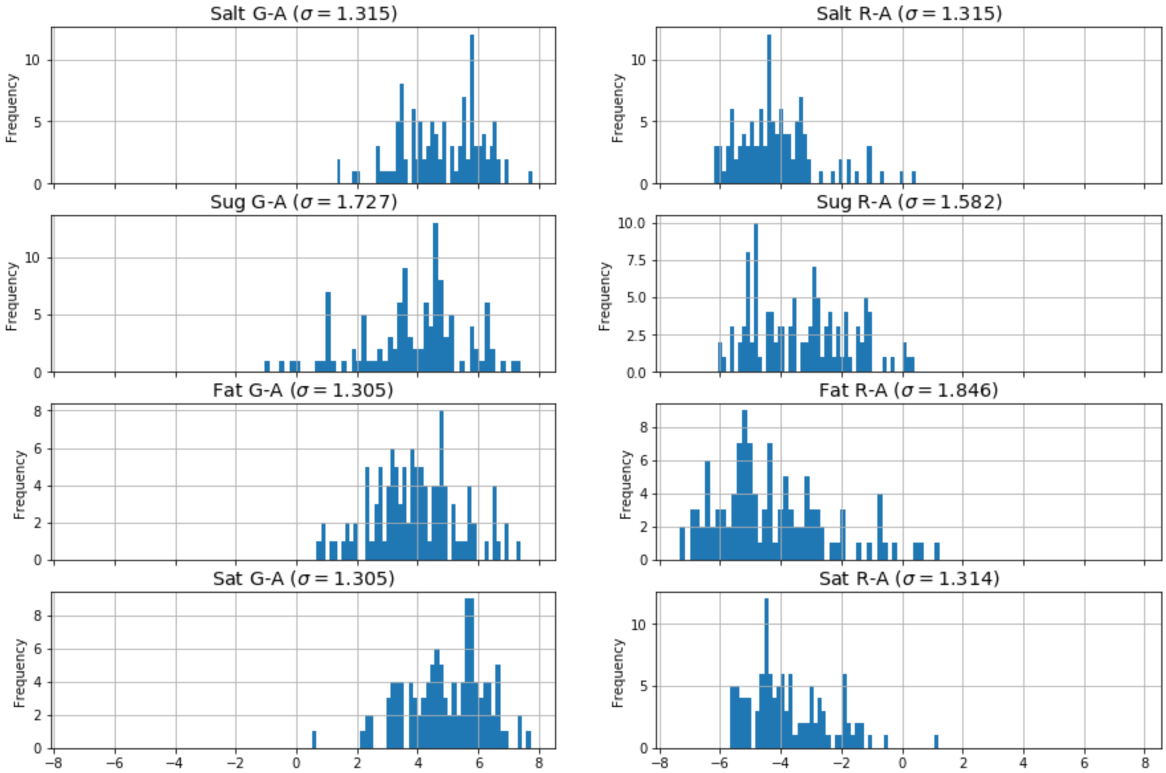
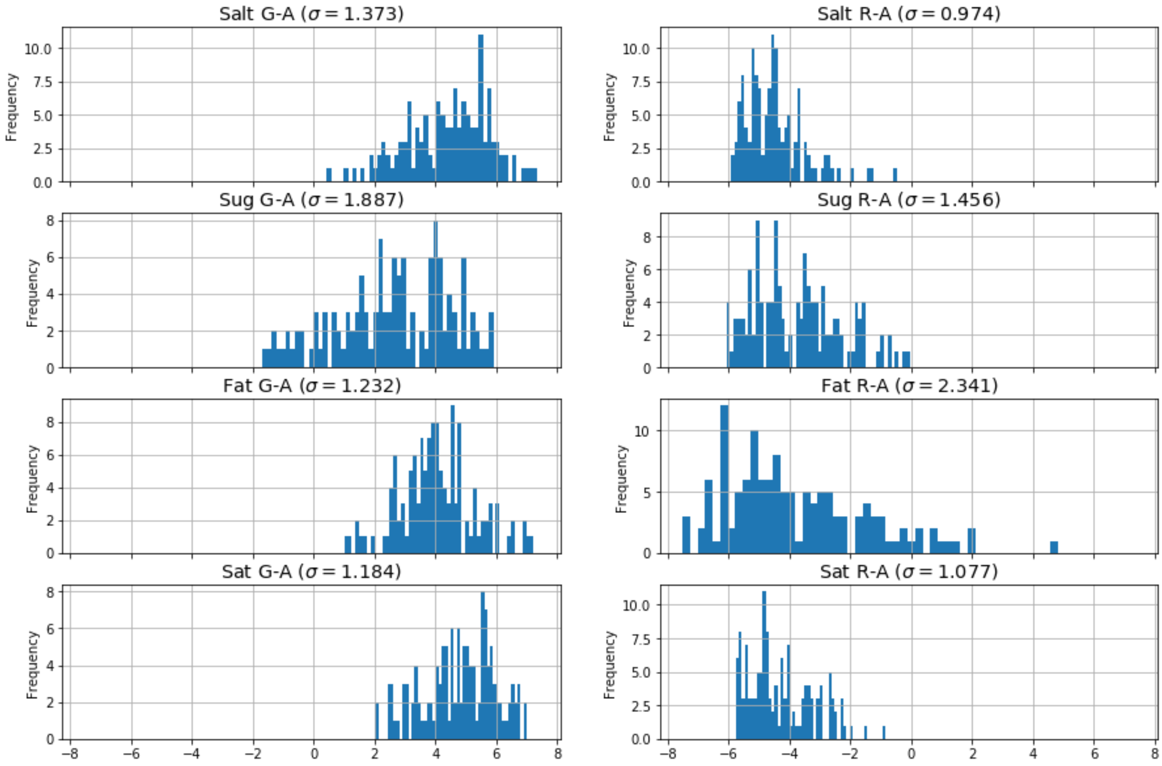


Figure 11 Distribution of individual WTP estimates by attribute, set B, Open Treatment (with standard deviations), n=131



6.2.3 WTP estimates of a model applied to all choices (both hidden and Open Treatment)

Table 8 on the next page shows the mean and standard deviation for the resulting posterior densities for the model where all 24 choices made by participants in both Open and Hidden Treatment were used to estimate the WTP. Set A on the left shows WTP estimates for participants who first saw the Hidden Treatment, then they saw the Open Treatment for the same choices (Choices 1 to 12 or Choices 13 to 24). Set B on the right shows WTP estimates for participants who first saw the Open Treatment, and then the Hidden Treatment for the same choices (Choices 1 to 12 or Choices 13 to 24).

The WTP estimates are rather large but have the expected sign. For example, the largest WTPs for moving from Amber to Green is for Salt and Saturates while the lowest WTPs are for Fat and Sugar. Also, the WTP means for Salt, Sugar and Saturates R-A seem to be higher in absolute terms for set B compared to set A. This means that, on average, people who saw the Open Treatment first, valued a reduction in Red for Salt, Sugar and Saturates higher than people who saw the Hidden Treatment first. For Salt and Sugar G-A, the WTP means are higher in set A than in set B, which implies that on average, respondents who saw the Hidden Treatment first valued having Green on Salt and Saturates more than respondents who saw the Open Treatment first. When comparing the WTP estimates to move from Amber to Green vs. WTP estimates to move from Red to Amber, Salt and Saturates WTP estimates seem to be much higher when moving from Amber to Green than when moving from Red to Amber for set A, while for set B Salt and Sugar WTP estimates seem to be higher in absolute terms when moving from Red to Amber than when moving from Amber to Green.

Table 8 MXL results: WTP estimates from the merged model, set A (left table) and set B (right table)

Attributes		**Posterior parameter estimates**	
		Mean	**Standard deviation**
Salt	Amber to Green	4.551	0.305
	Amber to Red	-3.897	0.450
Sugar	Amber to Green	3.685	0.470
	Amber to Red	-3.484	0.485
Fat	Amber to Green	3.959	0.436
	Amber to Red	-4.042	0.441
Sat	Amber to Green	4.566	0.311
	Amber to Red	-3.591	0.441

Attributes		**Posterior parameter estimates**	
		Mean	**Standard deviation**
Salt	Amber to Green	4.393	0.350
	Amber to Red	-4.639	0.273
Sugar	Amber to Green	2.702	0.462
	Amber to Red	-4.452	0.343
Fat	Amber to Green	4.331	0.362
	Amber to Red	-3.787	0.443
Sat	Amber to Green	4.665	0.253
	Amber to Red	-4.376	0.357

The distributions of WTP estimates by attribute for set A and set B are shown in Figure 12 and Figure 13 on the next page. Similar to the estimates presented in the previous sections, these figures show that there is substantial heterogeneity in individual WTP estimates for reductions in the TLS nutrients. For instance, in the case of moving from Amber to Green on Fat in set B, the majority of WTP estimates are between £2.5 and £6. When moving from Amber to Red, the WTP for Fat range from -£7.5 to -£2, with a few respondents having positive WTP.

Figure 12 Distribution of individual WTP estimates by attribute, set A, merged (with standard deviations), n=113

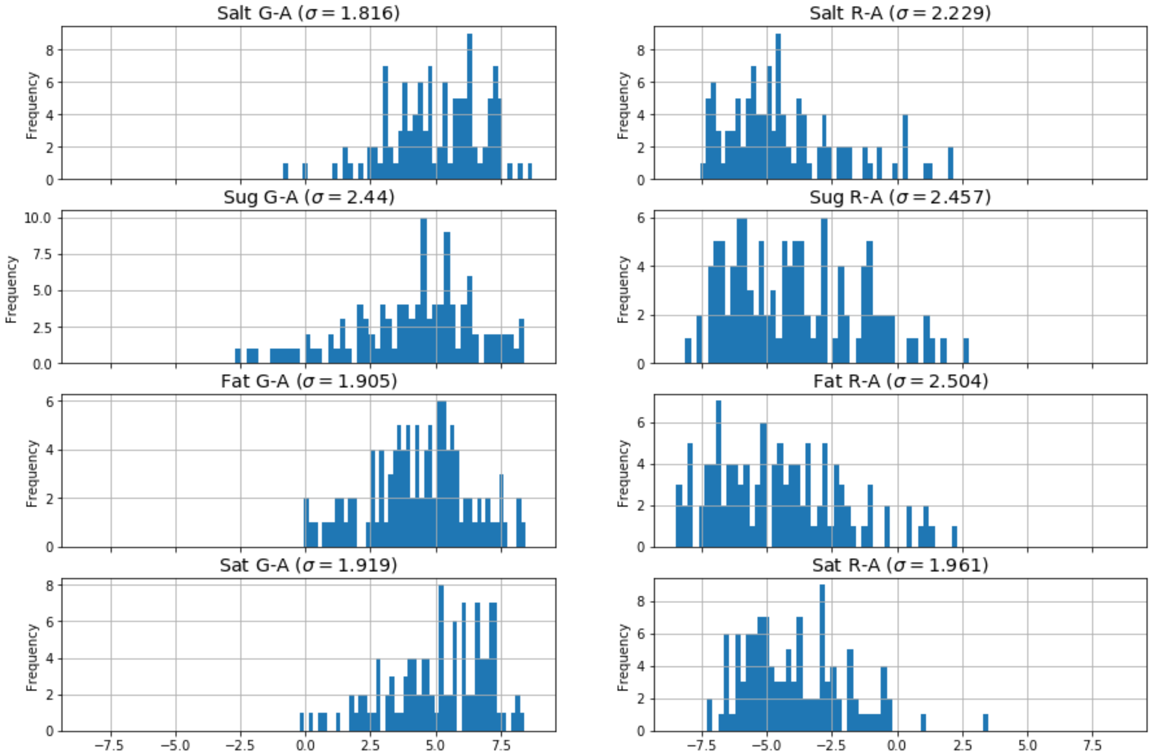
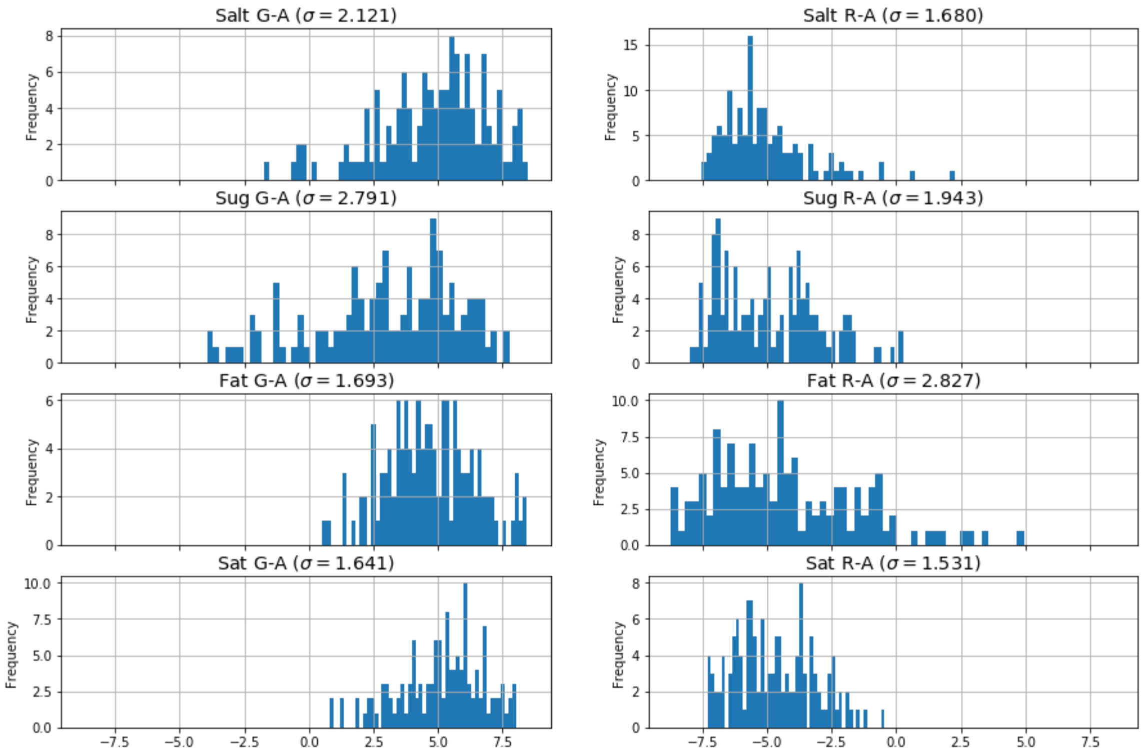


Figure 13 Distribution of individual WTP estimates by attribute, set B, merged (with standard deviations), n=131



6.3 Comparing WTP estimates in Open and Hidden Treatment

Given the WTP estimates for reductions in the TLS nutrients were obtained for both the Hidden (with participant mouse-tracking) and the Open Treatment (without participant mouse-tracking), the next step was to understand whether using mouse-tracking (as implemented with Mouselab) in a DCE context, interferes with model estimates (Q1). The reader is reminded that the Hidden Treatment as implemented in Mouselab allowed tracking of participants' mouse movements but was more difficult for respondents than the Open Treatment. This was because participants had to hover their mouse cursor on each individual attribute level for the information on the attribute level to be revealed. To this end, this section examines the extent to which model estimates in Hidden and Open Treatment are correlated.

Scatter plots showing correlations between individual WTP estimates in Open and Hidden Treatments are shown in Figure 14 and in Figure 15. The plots show that there is a relatively strong positive correlation at an individual level between WTP estimates in Hidden and WTP estimates in Open Treatment. This is true for most nutrients and for moving from Amber to Green as well as for moving from Amber to Red. There are a few exceptions, however. For Salt R-A and Saturates R-A in both sets and Sugar R-A in set A, there are more points below the 45-degree line than there are above the line and the regression slope is flatter than for the rest of the nutrients. This means that those respondents below the 45-degree line valued more moving from Red to Amber when seeing these nutrients in Open Treatment than when seeing them in Hidden Treatment. In other words, these participants would want to pay a lot more to avoid having Red on Salt, Saturates and Sugar when they see these nutrients in Open Treatment than when they see them in Hidden Treatment.

The next investigation was to understand whether there are any differences between the two sets. As a reminder, in set A respondents saw the Hidden Treatment first, while in set B respondents saw the Open Treatment first. When comparing the regression slopes of the two sets, there are no noticeable differences between respondents who saw the Hidden Treatment first and those who saw the Open Treatment first. The only exception is Sugar R-A where set B has a steeper regression slope than set A. This means that the relationship between the two WTP estimates is stronger for moving from Amber to Red on Sugar when participants see the Open Treatment first than when they see the Hidden Treatment first. Taken together, the results seem to suggest that the order in which respondents saw the treatments did not have a significant influence on their WTP. In other words, there was no learning happening between the two treatments.

Figure 14 Scatter plots for the association between WTPs in Open and WTPs in Hidden Treatment (regression line in blue and 45-degree line in orange) for Set A, n=113

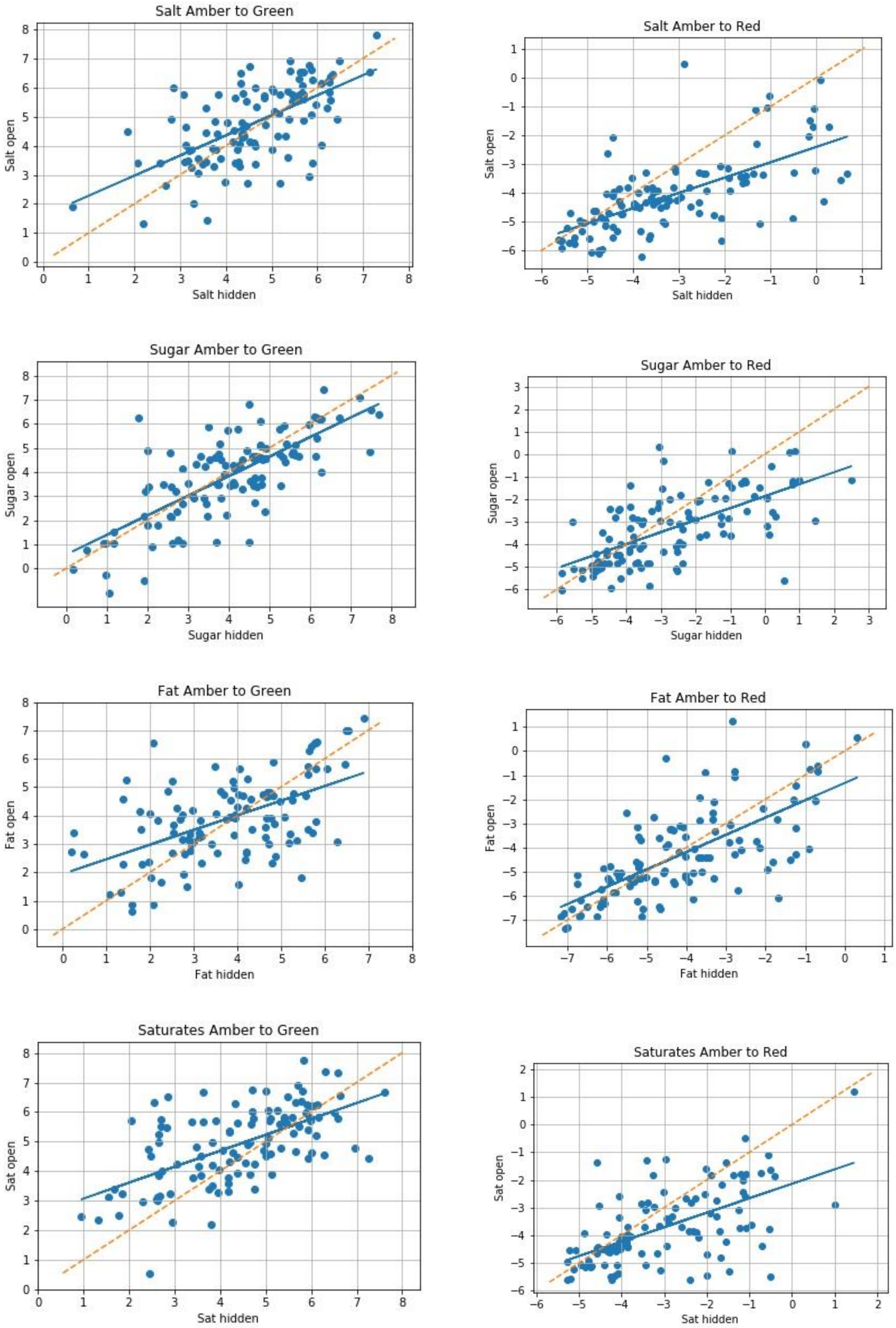
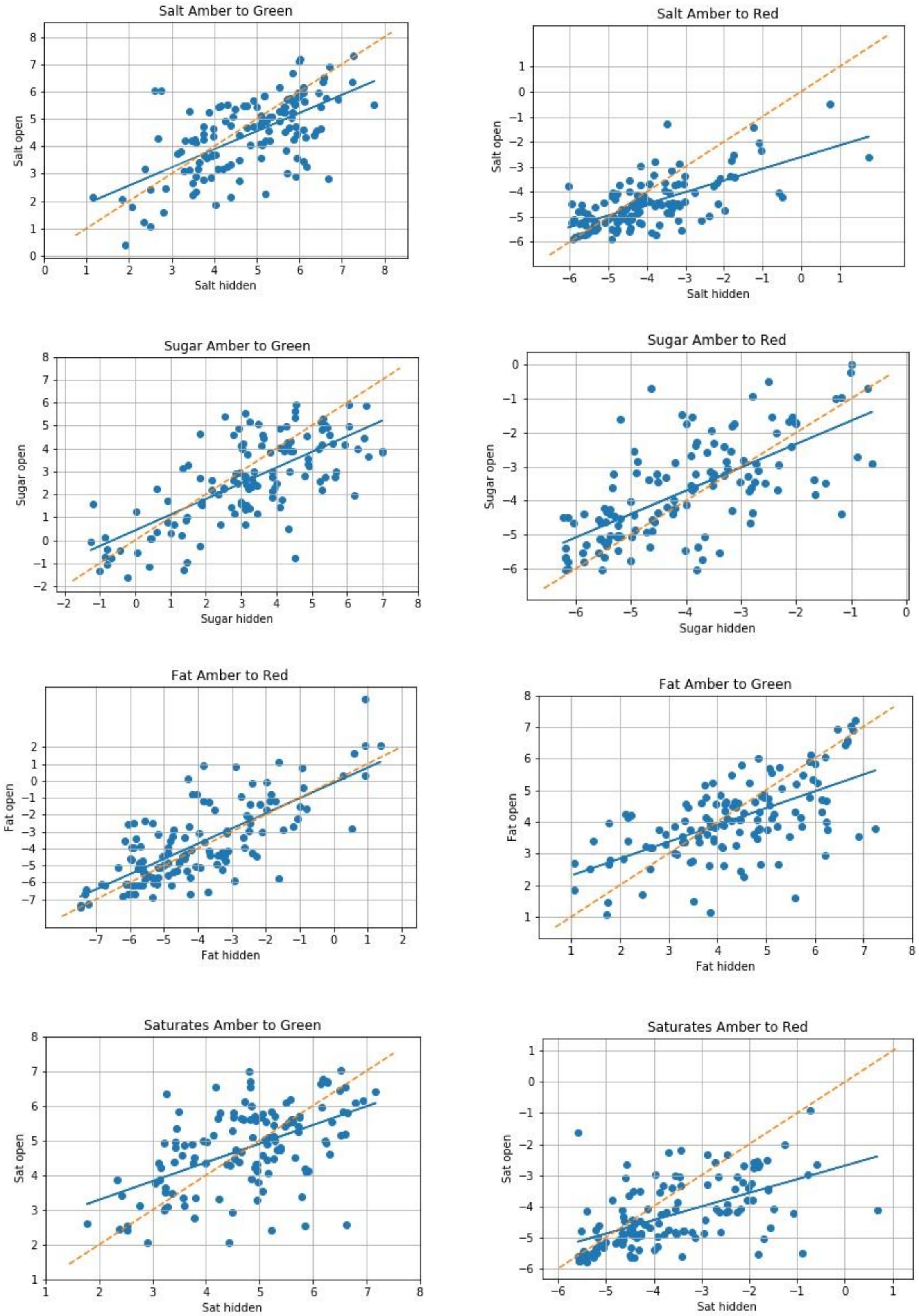


Figure 15 Scatter plots for the association between WTPs in Open and Hidden Treatment (regression line in blue and 45-degree line in orange) for Set B, n=131



6.4 Comparing the predictive validity of merged models and separate models

This section continues the analysis started in the previous section by further examining whether the Hidden Treatment (which was cognitively more demanding than the Open Treatment but involved tracking of participants' mouse movements) could have radically changed the WTP estimates. To this end, a comparison is made between the merged model (where choices in both treatments are analysed together) and the separate models (Open and Hidden). More specifically, the predictive accuracy of the merged model is compared to that of the separate models by using the widely applicable information criterion or WAIC. The reader is reminded that section 4.3 has described how WAIC is computed to estimate the out-of-sample prediction accuracy and thereby compare between different Bayesian models. That is, WAIC has been computed by using the log-likelihood evaluated at the posterior simulations of the parameter values.
Table 9 and

Table 10 below show the predictive accuracy estimates (WAIC and the standard error of WAIC) for the Open and Hidden Treatments and for the merged model. The reader is reminded that for one model to be considered superior (according to the WAIC criteria) to another it should be at least one standard deviation different from the alternative. As can be seen, the value of WAIC in Table 9 and

Table 10 for the merged models compared to that for the separate models gives support to the merged model (the WAIC for the merged models is more than one standard deviation than the WAIC for the separate models). This means that incorporating both the WTP in Open Treatment and the WTP in Hidden Treatment provides a better fit to the data than treating these WTP as separate. This result further corroborates the results reported in Section 6.3 confirming that there is no compelling evidence to suggest that the Hidden Treatment radically changed participants' preferences.

Table 9 Predictive accuracy estimates for set A (Open and Hidden Treatment and merged model), n=113

Set	**Treatment**	**WAIC**	**SE WAIC**
A	Open	2392.804	45.686
A	Hidden	2613.601	46.030
A	Merged	4395.139	70.082

Table 10 Predictive accuracy estimates for set B (Open and Hidden Treatment and merged model), n=131

Set	**Treatment**	**WAIC**	**SE WAIC**
B	Open	2867.179	47.321
B	Hidden	2783.853	46.821
B	Merged	5006.729	74.351

6.5 Summary

This chapter has presented the results of the choice model employed for this research. More specifically, the mean and standard deviation of the posterior densities for the Hidden and the Open Treatment were presented as well as the mean and standard deviation of the posterior densities for a model which merged the estimates for the Hidden and Open Treatment. To investigate whether mouse-tracking (as implemented with Mouselab) interfered with participants' behaviour in any significant way (Question 1), two further analyses were carried out. One analysis looked at the correlation between the WTP estimates in the Hidden and Open Treatment. A second analysis looked at the predictive validity of a model incorporating both the Hidden and Open Treatment in comparison with the models incorporating the two treatments separately. Both analyses suggest that the use of Mouselab to track participants' mouse movements within the DCE did not appear to radically interfere with choice modelling estimates.

The following chapter will present the results from analysing the mouse-tracking data which has been collected as part of the Hidden Treatment.

7 Results Part 2: Examining mouse-tracking data in a DCE context

7.1 Introduction

This chapter presents the results obtained from analysing the mouse-tracking data collected during the Hidden Treatment stage of the Discrete Choice Experiment (see section 5.3.3 in the Methods chapter for more information on the Hidden and Open Treatment). Several types of analyses are reported in this chapter. First, this chapter examines the extent of attribute attendance and non-attendance within the DCE, as measured by mouse-tracking and their links to stated attendance measures. This analysis offers insights into respondent engagement with a hypothetical DCE where there is a cognitive cost to fully engaging with the survey and is linked to Objective 2 of this research. This cognitive cost comes from the setup imposed by the Hidden Treatment where attributes for Basket 2 and Basket 3 are hidden and respondents need to hover their mouse cursor over the attribute levels for the information to be visible. This analysis fills the research gap presented in section 2.7.3. Second, this chapter examines the relationship between mouse movements and measures of attribute importance such as WTP estimates and self-reported attribute importance measures. This analysis contributes to understanding the extent to which the Rational Inattention Model is empirically valid within the context of the DCE used for this research (Question 4). Third, this chapter examines the relationship between mouse movements and heuristics. These last analyses contribute to better understand consumer engagement with the TLS and links to Objective 3. The analysis has been limited to these main areas due to time and resource constraints. In conducting these analyses, this chapter also uses the WTP estimates which were presented in Chapter 6. Although these estimates were derived using Bayesian procedures, the analyses in this chapter are carried out using frequentist statistical approaches.

The main types of mouse-tracking data examined in this chapter were mouse hover counts (or how many times a respondent hovered over an attribute) and mouse hover time (or how long a respondent hovered over an attribute). Mouse hover counts and mouse hover time are equivalent to what the eye-tracking literature usually calls ‘fixations’ and ‘dwell time’ respectively. Throughout this thesis, fixations will refer to mouse hover counts while dwell time will refer to mouse hover time.

This chapter is structured as follows. In Section 7.2 the basic features of the mouse-tracking data (fixations and dwell time) are described. Section 7.3 presents the extent of attendance and non-attendance in the DCE as tracked by Mouselab. Section 7.4 examines the relationship between the mouse-tracking measures and stated attribute importance measures. Section 7.5 examines the relationship between mouse-tracking measures and heuristics. Section 7.6 examines the mouse-tracking measures in relation to the socio-demographic profile of respondents.

7.2 Mouse-tracking: descriptive statistics

This section presents the basic features of the mouse-tracking data collected within this research. Measures such as the mean, the median and the standard deviation are reported for the number of fixations and the amount of dwell time allocated to the five DCE attributes: Salt, Sugar, Fat, Saturates, and Price. The extent of correlation between fixation numbers and dwell time are examined to understand the links between the two measures. The drop in attention as measured by mouse-tracking is also reported.

7.2.1 Fixation and dwell time: descriptive statistics

Fixation numbers are reported in Table 11 on the next page. The most fixated attribute was Sugar, with an average of 63 fixations per participant while the least fixated attribute was Salt with an average of 43.5 fixations. In terms of dwell time (Table 12), Salt and Sugar were the attributes with the longest dwell time while Price was the attribute that received, on average, the least amount of dwell time (21,914 ms). In terms of minimum and maximum dwell time, there is considerable respondent heterogeneity, with few respondents not hovering their mouse at all on some or all of the attributes and some others hovering their mouse a large number of times and spending a long time inspecting the attributes.

Table 11 Number of fixations for the five attributes across all 12 choice cards (n=244).

	Salt	Sugar	Fat	Sat	Price
Total	10,624	15,358	14,756	13,782	11,771
Mean	43.54	62.94	60.48	56.48	48.24
St. Dev.	20.85	27.82	26.86	23.22	19.31
SE	1.33	1.78	1.72	1.49	1.24
Median	39	58	56	53	46.5
Minimum	0	0	0	0	0
Maximum	127	186	198	184	113

Table 12 Dwell time (in milliseconds) for the five attributes across all 12 choice cards (n=244).

	Salt	Sugar	Fat	Sat	Price
Total	6,788,085	6,534,709	5,682,902	6,485,620	5,347,099
Mean	27,820	26,782	23,291	26,580	21,914
St. Dev.	27,205	19,140	14,788	22,174	21,465
SE	1,742	1,225	947	1,420	1,374
Median	22,159	23,095	20,155	22,510	19,180
Minimum	0	0	0	0	0
Maximum	230,631	124,009	103,099	193,505	263,978

To examine the link between fixation measures and dwell time measures, scatter plots of fixation counts against dwell time for each attribute are shown in Figure 16. The regression line shows a positive relationship between the number of fixations on an attribute and the amount of dwell time spent on that attribute. The strongest correlations between fixations and dwell time are for Sugar (correlation coefficient of 0.703) and Fat (0.684) while the lowest correlations are for Salt (0.506). Saturates and Price show similar correlation patterns of 0.526 and 0.536. Overall, the correlation coefficients show that the relationships between fixation counts and dwell time are moderate to high.

Figure 16 Scatter plots of fixation numbers against dwell time for each of the five attributes (with regression line and correlation coefficient, shaded area shows the confidence intervals).

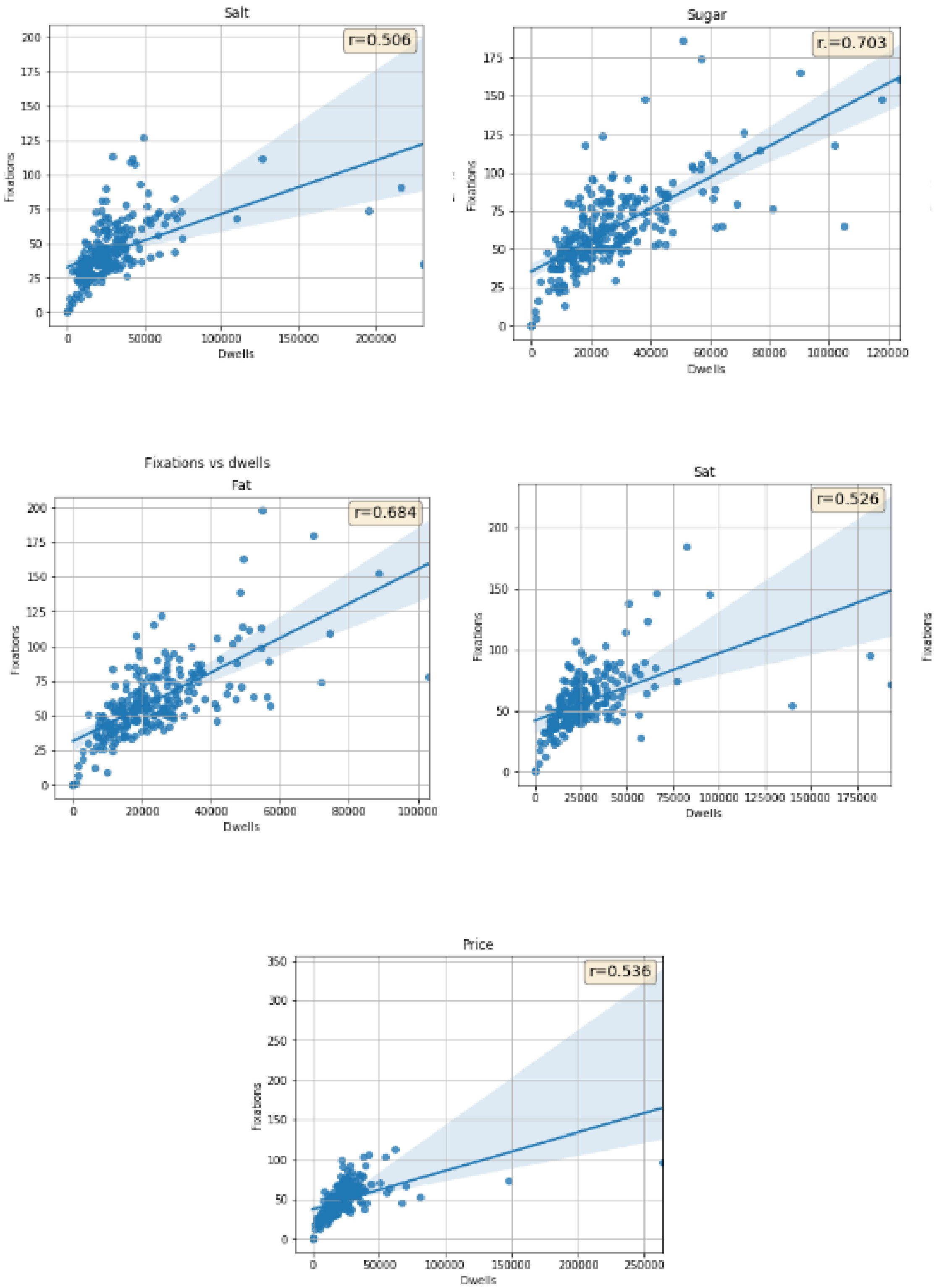


Table 13 below reports the number of times the three TLS colours appeared over the 24 choice cards in Basket 2 and Basket 3 and the number of times these colours were fixated on by the respondents in the sample. The colours are approximately balanced across Basket 2 and 3. For each colour, the table reports the number of fixations it received, in total and in percentages as well as the number of fixations per number of appearances. In terms of absolute fixations, Green has received more fixations, however, relative to the number of times the colour appeared on the choice cards, Red has received more than double fixations (324) compared to Green (158).

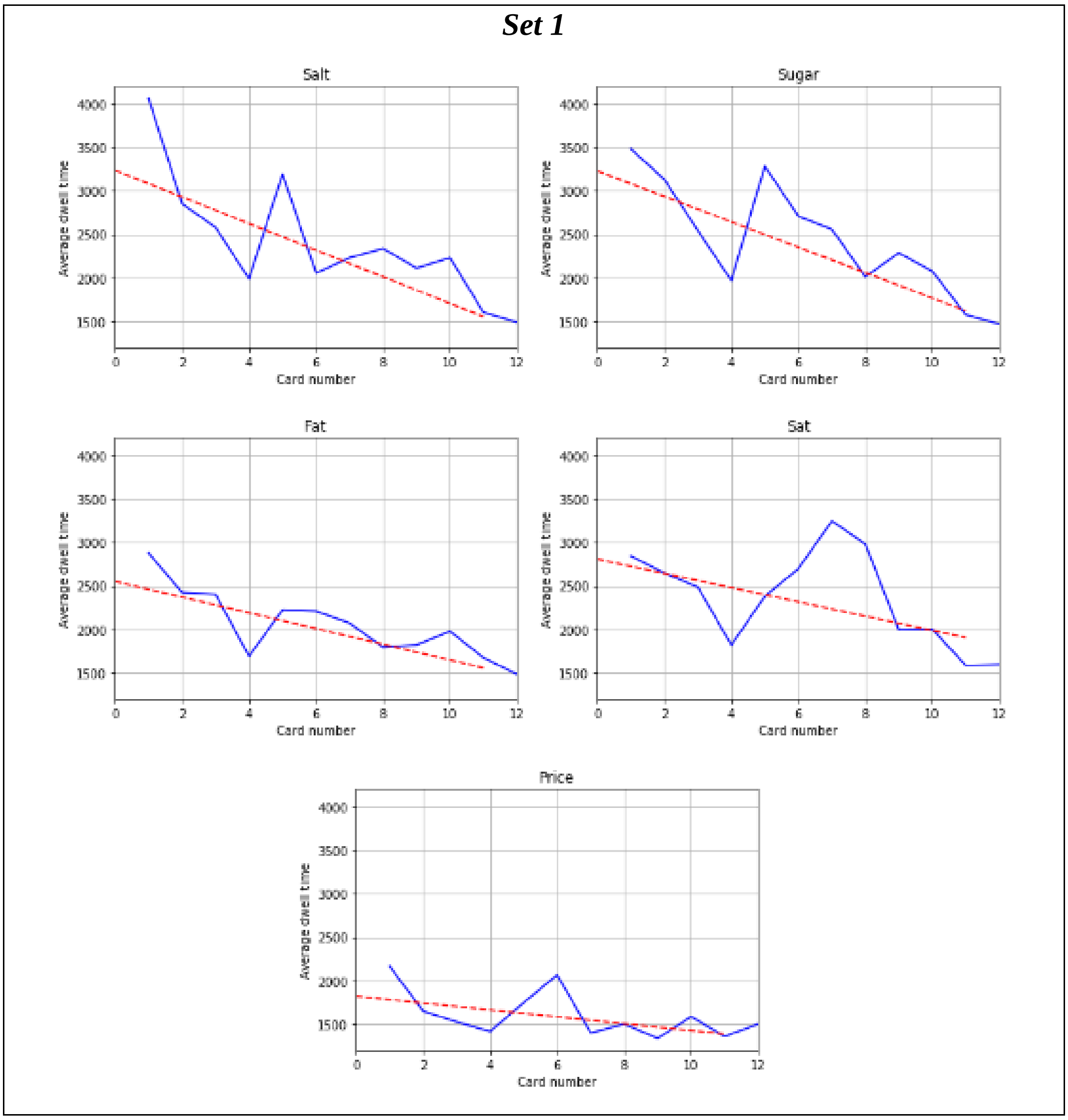
Table 13 Colour and fixation frequency on all 24 choice cards

Attribute level	**Total no. of times colour appeared on Basket 2 and 3**	**% times colour appeared**	**Number of fixations**	**Fixations/appearance**
Green	88	45.9	13,929	158
Amber	63	32.8	13,680	217
Red	41	21.3	13,269	324

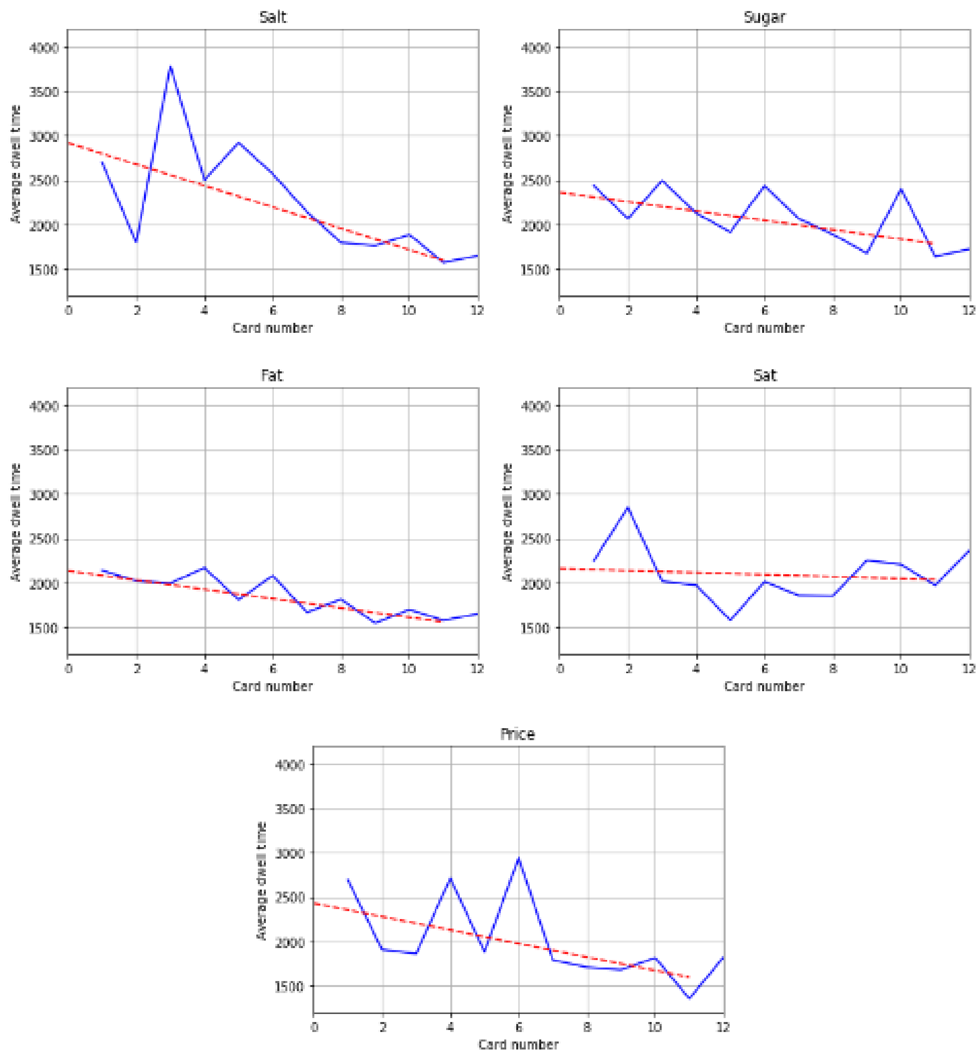
7.2.2 Mouse-tracked attention over time

The next analysis was to understand the extent to which mouse-tracked attention changes over time. Figure 17 shows plots of respondent average dwell time by choice card for set 1 (Choices 1 to 12) and set 2 (Choices 13 to 24). These plots show a considerable drop in dwell time as respondents go through the twelve choice cards within the experiment, as shown by the red dashed lines. Dwell time on Salt shows the most significant drop: average dwell time on Salt was 4 seconds for the first choice card, while average dwell time for the 12th choice card dropped to only 1.5 seconds in set 1 which consisted of choice cards 1 to 12. At the opposite end, Saturates in set 2 show only a very minor change in attention.

Figure 17 Average dwell time by choice card for each attribute (Set 1 includes Choices cards 1 to 12 and Set 2 includes Choice cards 13 to 24).



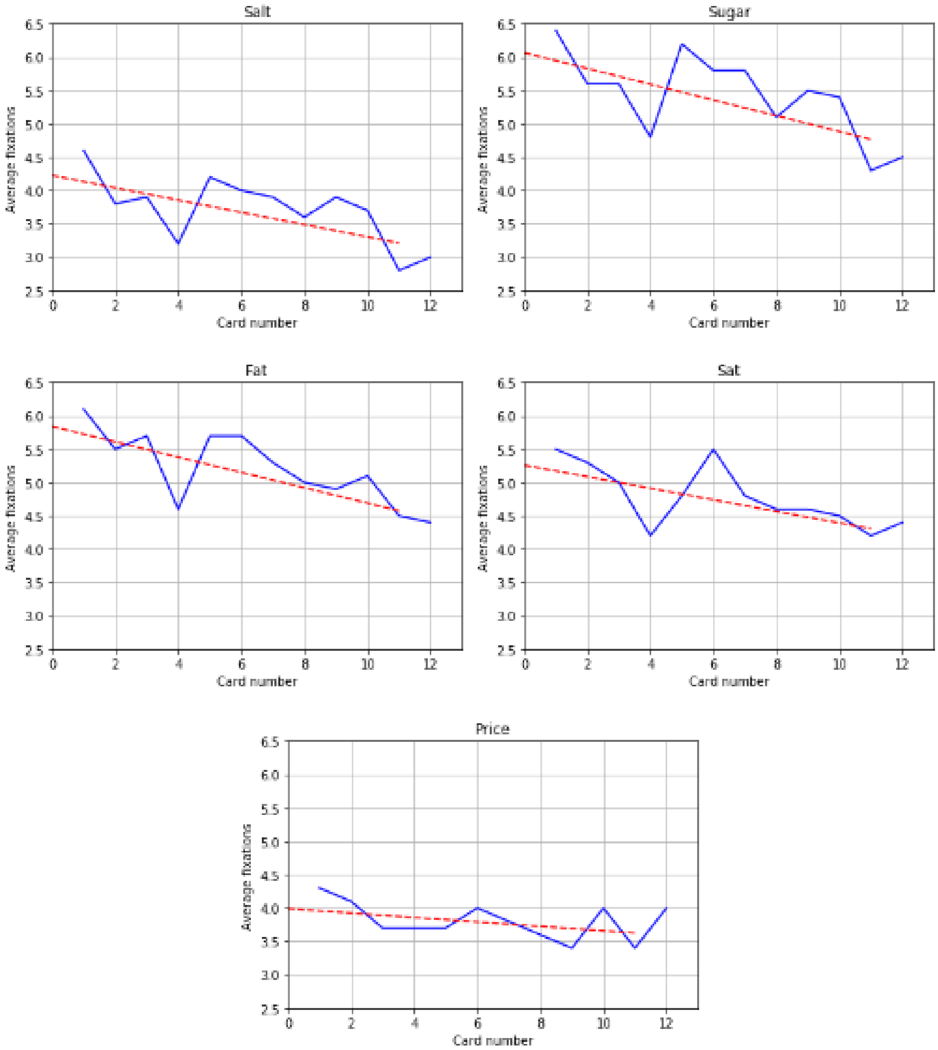
Set 2



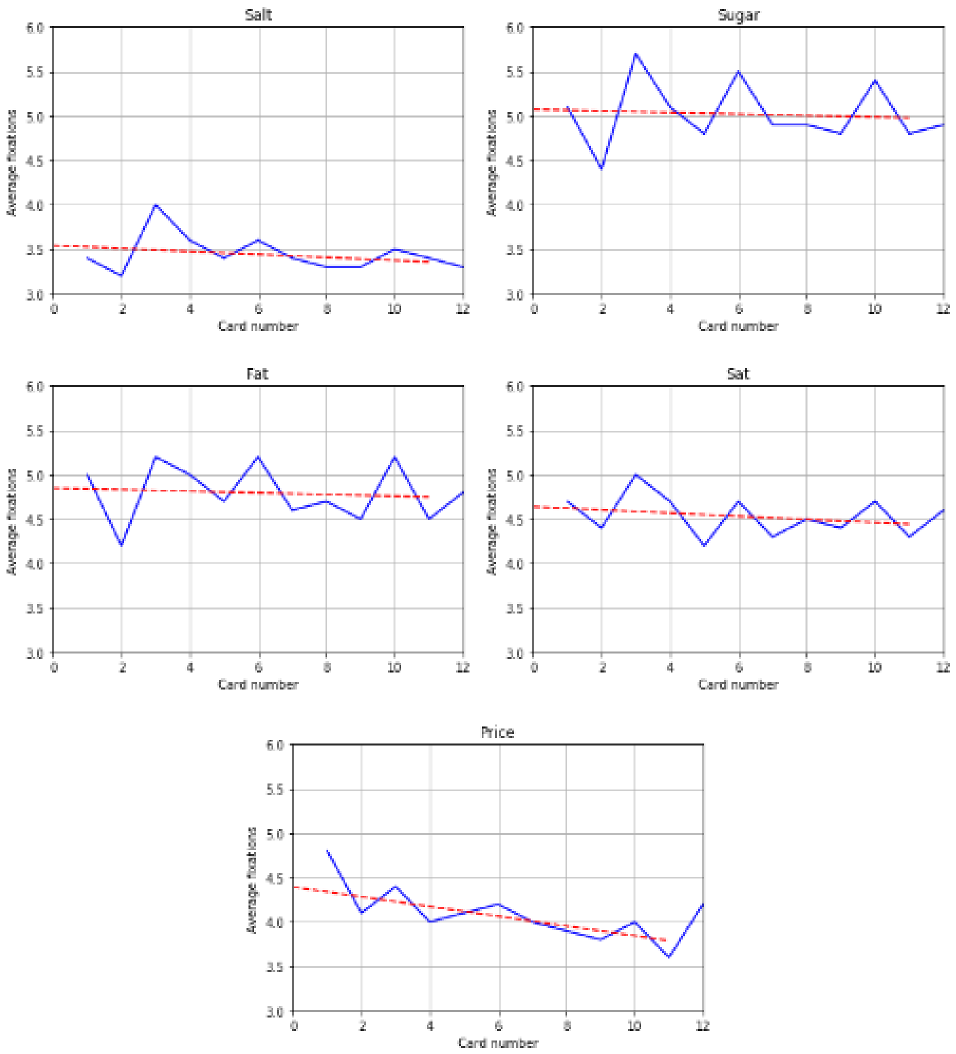
The drop in mouse-tracked attention is reflected to a certain extent in Figure 18 which shows the plots in terms of average fixation counts. For instance, fixations on Price were at an average of 4.8 in choice card 13 and these dropped to an average of 4.2 in choice card 24. However, the drop in attention as measured by fixation counts appears to be less significant than when this was measured by dwell time, especially when looking at set 2.

Figure 18 Average fixations by choice card for each attribute for set 1 (choice cards 1 to 12) and set 2 (choice cards 13 to 24) with time trend (red dashed line).

Set 1



Set 2



Referring to Figure 18, despite there being a general downward trend in the number of fixations, there are still a few choice cards that stand out in terms of fixation counts. For instance, there seems to be a pattern for choice cards 1 to 12, with average fixations rising after choice card 4. Namely, Salt, Sugar and Fat get the peak at choice card 5, while Saturates and Price get the peak at choice card 6. Similarly, there seems to be a distinct pattern for fixations on choice cards 13 to 24 with cards 15, 18 and 22 in this order getting the peak of average fixations for all attributes.

Table 14 shows the results of a Mixed Model where the log of total fixations was regressed against the log of number of choice card while controlling for the impact of each attribute by allowing a random intercept and a random slope for each attribute (see Section 4.4 for the model specification). As it can be seen from the table, the parameter estimate on Choice Card is negative (-0.053) and the associated p-value is significant indicating that the sequence in which cards were seen by the respondents had an impact on the number of fixations allocated to them. Interpreting the parameter as an elasticity implies that a 10% increase in cards leads to a 0.5% decrease in total fixations. Given that each individual faced 12 choice cards with each choice card having two baskets hidden, this decrease over time can be attributed to learning and fatigue.

Table 14 Mixed Model results for Fixations against Time (Choice card)

	Coefficient	**Std. error**	**P-value**
Intercept	7.094	0.062	0.000
Ln (Choice card)	-0.053	0.010	0.000
Intercept RE	0.016	0.181	
Intercept RE x Card No Re	0.000	0.009	
Card No. RE	0.000		

RMSE=0.051

7.3 Mouse-tracked attendance and non-attendance of attributes

The next step was to examine DCE attribute attendance and non-attendance as tracked by Mouselab. This was motivated by the need to understand respondent engagement with a costly survey such as the Hidden Treatment of the DCE used in this research (Objective 2). More details about the Hidden Treatment can be found in 5.3.3.

Attendance was examined in terms of two main categories: *attendance per choice card* and *attendance over choice cards*. An attribute was considered *attended in a choice card* if a respondent hovered their mouse on both levels of that attribute i.e. for Salt to have been attended in choice card 1, the respondent should have at least 1 hover on both Basket 2 and Basket 3. It was assumed that respondents have in some ways attended Basket 1 across all choices (given that it was fixed across choices and was always open). Similarly, an attribute was considered non-attended in a choice card if it had not been hovered on in either Basket 2 or Basket 3 or both. For instance, Sugar was deemed non-attended in a choice card if it had received no hovers in either Basket 2 or Basket 3 or both (Basket 1 was always open). An attribute was considered *attended over choice cards* if it had been attended in six (half) or more of the choice cards.

7.3.1 Mouse-tracked attribute attendance

An overview of mouse-tracked attendance for each attribute is offered in

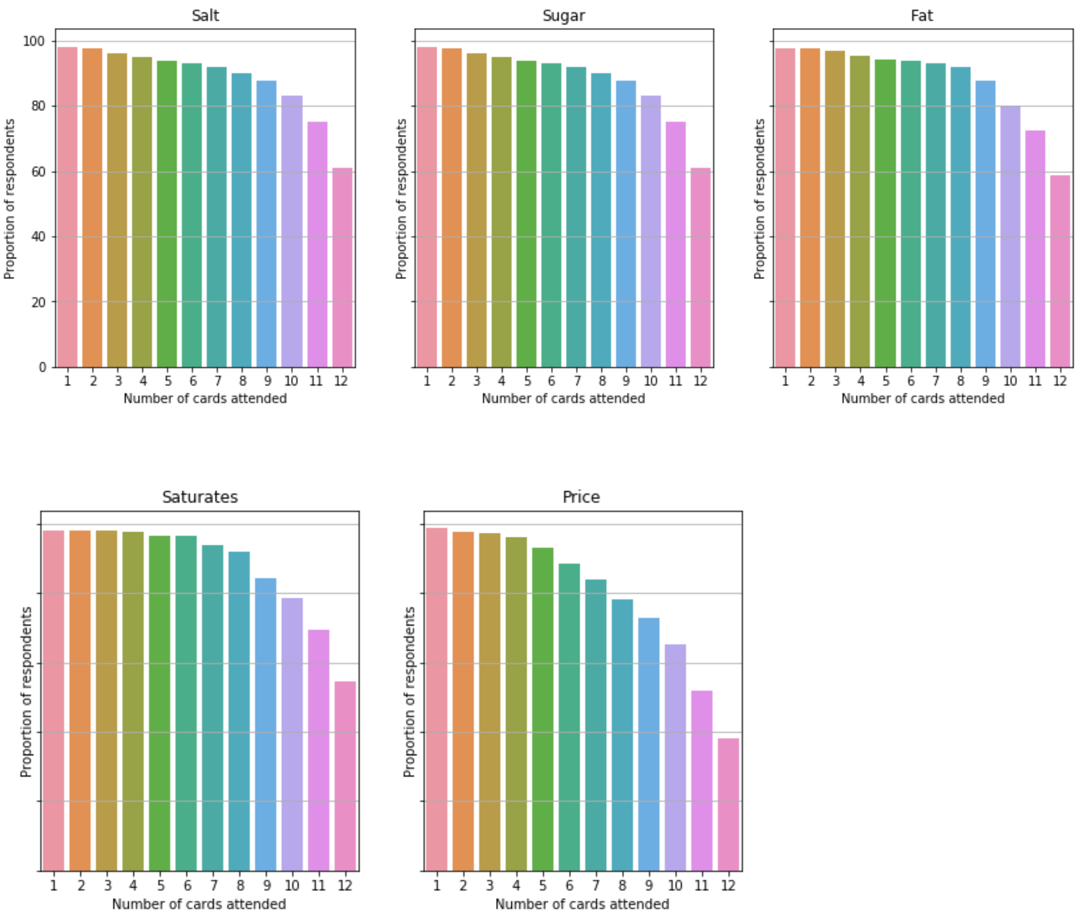
Figure 19. The data in this figure were obtained as follows. First, for each of the five DCE attributes, attendance per choice card was obtained for each respondent following the definition above. Then, for each attribute the proportion of respondents in the sample that have attended the attribute in one or more choices was calculated. The figure shows therefore an overview of cumulative attendance, that is the proportion of respondents that attended each attribute in one or more (up to 12) choices.

The main takeaway from

Figure 19 is that an overwhelming majority of people (around 90%) attended the four nutrients in at least two thirds of the choice cards (eight cards), while Price was attended by around 78% of respondents in at least two thirds of the choice cards. Using the more conservative definition above of *attendance over choice cards* implying attendance in half or more of the choice cards, the five attributes were attended by an average of 92% of respondents. While attendance patterns for the four TLS nutrients are broadly the same, attendance for Price is slightly lower, with just over 80% of respondents attending Price in six or more choice cards. However, even if lower than the rest of the attributes, attendance for Price across choice cards is still relatively good. Overall,

Figure 19 shows that despite being confronted with a costly survey, respondent attendance is still reasonably good.

Figure 19 Proportion of respondents attending the attributes in at least 1 to 12 choice cards.



7.3.2 Mouse-tracked attribute non-attendance (ANA)

This section examines the other side of the story: the extent of mouse-tracked non-attendance or mouse-tracked ANA. The reader is reminded that an attribute was considered non-attended in a choice card if it had not been hovered on in either Basket 2 or Basket 3 or both. Table 15 shows the frequency of mouse-tracked attribute non-attendance (ANA) per number of choice cards. The figures in column 1 show the percentage of respondents that did not attend each of the five attributes in at least one of the choice cards, column 2 shows the percentage of respondents that did not attend the attributes in at least two of the choice cards, and so on. The table shows that Price was not attended in at least one of the choice cards by 61% of respondents. At the opposite end, Sugar and Salt were not attended in at least one of the choice cards by 38% and 39%, respectively of respondents. What this table also suggests is that full non-attendance of attributes across the twelve choice cards is quite rare, with each of the five attributes not being attended at all throughout the twelve choice situations by an average of 2% of respondents. The final row shows the percentage of participants that have not attended at least one of the five attributes at least on one of the choice cards. What this table suggests is that half of the participants (48%) have not attended at least one attribute on three or more choice cards while a quarter of them did not attend at least one attribute on six or more choice cards. The last cell in the bottom right of the table shows that only 3% of participants (seven) have ignored one or more attributes across all twelve choice cards.

Table 15 Frequency of mouse-tracked ANA by number of choice cards (% of total sample).

	1	2	3	4	5	6	7	8	9	10	11	12
Salt	39	28	21	16	13	11	12	7	7	5	4	2
Sugar	38	25	17	13	10	8	7	6	5	2	2	2
Fat	41	27	20	12	8	7	6	6	10	1	2	2
Saturates	45	31	21	16	8	6	4	4	6	1	2	2
Price	61	48	35	27	21	16	12	7	10	1	2	1
Total ANA	76	62	48	38	30	24	18	14	10	7	5	3

7.3.3 Relationship between stated attribute non-attendance (stated ANA) and mouse-tracking measures

Next, the relationship between the different measures of mouse-tracked attention and the respondents' answer to the stated attribute attendance question (stated ANA) was examined. This is motivated by understanding the links between mouse movements and stated attendance measures and thereby by understanding the potential of using mouse-tracking in a DCE context.

The proportions of respondents that claimed to have ignored each of the five attributes is shown in Figure 20 (left). A bit over a third of respondents claimed to have ignored Price while the other attributes seem to have been ignored by around 10% to 12% of respondents. In terms of the number of attributes most likely to have been ignored, Figure 20 (right) shows that more than a third of stated non-attenders claim to have ignored one attribute only, with no respondent claiming to have ignored all attributes.

Figure 20 Proportion of stated non-attenders by attribute (left) and by number of attributes claimed to have been ignored

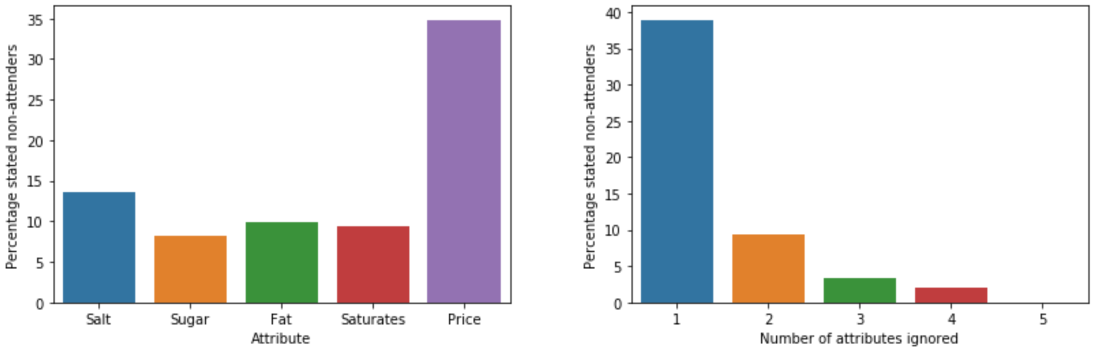


Table 16 on the next page shows the proportions of fixations by stated ANA class while

Table 17 shows the Logit Model results when regressing a stated non-attendance dummy on fixations proportions. Three out of five attributes (Salt, Fat and Price) show a statistically significant relationship between stated non-attendance and fixations. The coefficients for these three attribute show a negative relationship between the proportions of fixations a respondent has allocated to the attribute and whether that person claimed to have ignored the attribute. If we were to interpret the coefficients on Price, for 1 more fixation on Price the odds of stated non-attendance on Price versus attendance decrease by a factor of 0.88. However, the low explanatory power of the model points to a weak relationship between fixations and stated attendance. The models have been run with number of fixations and dwell time and the results are broadly similar (these results can be found in *Appendix F. Logit results from Chapter 6 Results Part 1*).

Table 16 Fixation proportions by Stated ANA

	Salt	**Sugar**	**Fat**	**Saturates**	**Price**
Stated Attenders					
Mean	15.43	22.58	21.69	20.44	18.98
Std. error	0.30	0.28	0.27	0.26	0.77
Stated Non-Attenders					
Mean	16.37	21.74	20.57	20.78	17.97
Std. error	0.63	1.33	1.06	0.48	0.71

Table 17 Logit Results for Stated ANA vs. Fixation proportions for each attribute

Attribute	Parameters	Coefficient	Odds Ratio	Std. error	P-value	Pseudo-R^2	LLR p-value
Salt	Intercept	-0.043	0.957	0.623	0.945	0.044	0.003
	Fixations	-0.122	0.885	0.042	0.004***		
Sugar	Intercept	-0.900	0.406	0.880	0.306	0.018	0.108
	Fixations	-0.069	0.933	0.040	0.084		
Fat	Intercept	0.779	2.179	0.837	0.352	0.087	0.000
	Fixations	-0.145	0.865	0.040	0.000***		
Saturates	Intercept	-1.191	0	0.982	0.225	0.007	0.299
	Intercept	-0.053	0.948	0.048	0.271		
Price	Intercept	1.543	4.678	0.493	0.002	0.084	< 0.001
	Fixations	-0.124	0.883	0.028	0.000***		

*** significant at 1% level of significance, **significant at 5% level of significance

7.4 Relationships between mouse movements and stated preference measures

Next, the relationship between the mouse-tracking measures collected within this DCE and the stated attribute importance measure was examined. This analysis is linked to Hypotheses 1, 2 and 3 which aimed to empirically test the validity of the Rational Inattention Model. First, the relationship between respondents' mouse movements and the WTP estimates was investigated. Next, the relationship between mouse movements and measures of self-reported attribute importance was investigated.

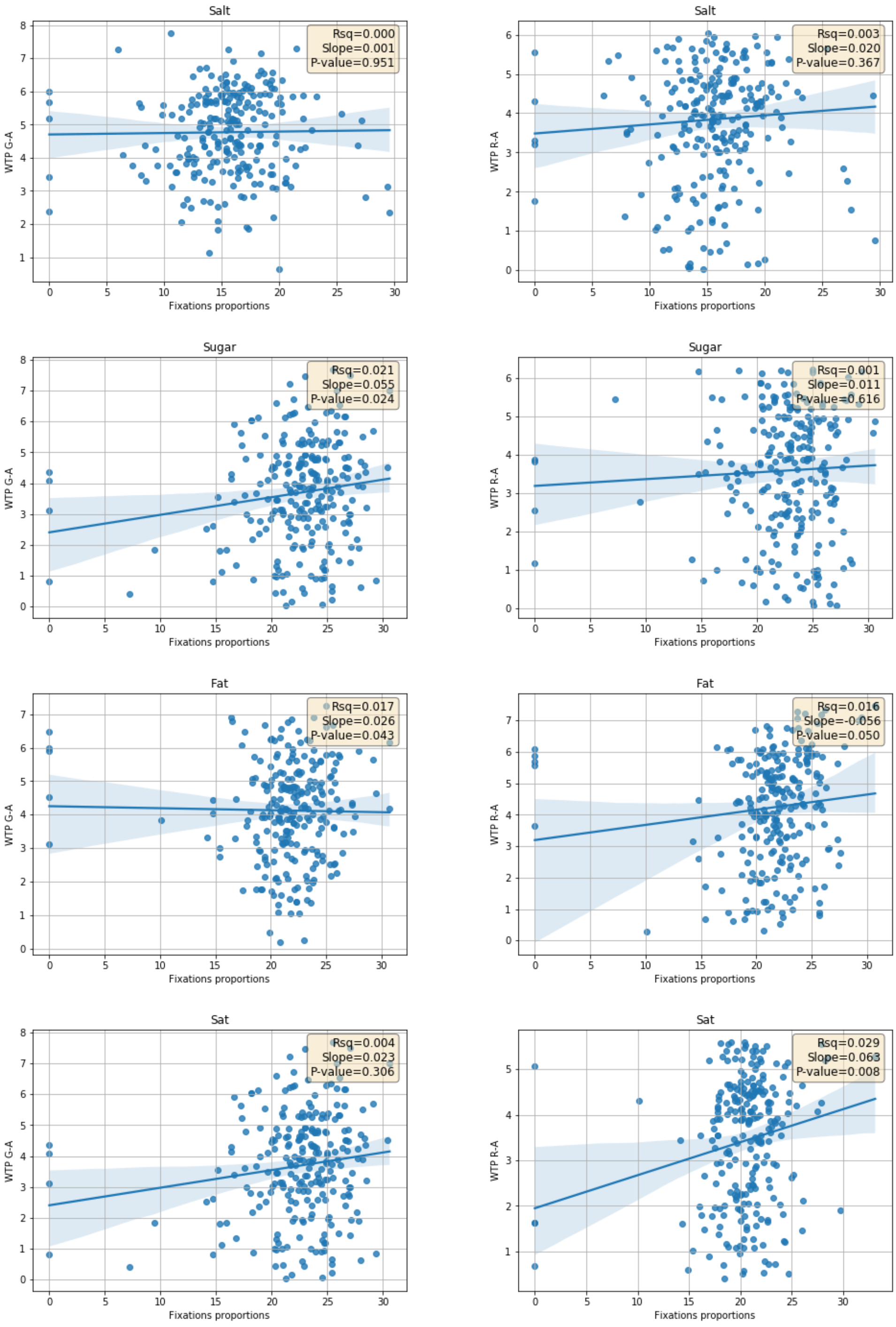
7.4.1 Mouse movements vs. WTP estimates

This section examines the relationship between mouse movements and WTP estimates (Hypotheses 2, 3 and 4). This analysis is carried out on two levels: an individual and a collective level. At an individual level, the relationship between mouse movements and the individual WTP estimates is explored. The interest was to understand whether an individual that paid more attention to a certain attribute meant that she valued it more relative to another individual (H1 & H2). At a collective level, the relationship between the mean WTP estimate for attributes was examined against mean mouse-tracking measures (H3).

7.4.1.1 Mouse movements vs. WTP at an individual level

The plots on the next page show correlations between the mouse movement measures and the WTP estimates with robust regression lines. Figure 21 plots the relationship between fixation proportions and WTP estimates for the TLS nutrients (both R-A and G-A) while Figure 22 plots the relationship between proportional dwells and WTP estimates. All WTP estimates were plotted in absolute terms. Figure 21 shows that there is some degree of correlation, although small, between WTP estimates and fixations proportions. For some nutrients (Salt and Saturates), the robust regression line is sloped upwards indicating a positive, albeit very small, relationship between fixations and WTPs. However, the low R-squared indicates a weak relationship between the two variables.

Figure 21 Relationship between WTP (G-A and R-A) and fixations proportions with robust regression lines (shaded areas are the confidence intervals)



When looking at dwell time, the correlations between WTP estimates for nutrients and dwell proportions over the nutrients seem to be stronger. The plots show some degree of positive correlation for some nutrients (see Figure 22). The relationship between dwell proportions and WTP estimates is statistically significant for Salt, Sugar (R-A) and Fat and Saturates, however the low Rsquared points to a weak relationship between WTP estimates and dwell proportions.

Figure 22 Relationship between WTP and dwell time proportions with robust regression lines (shaded areas are the confidence intervals)

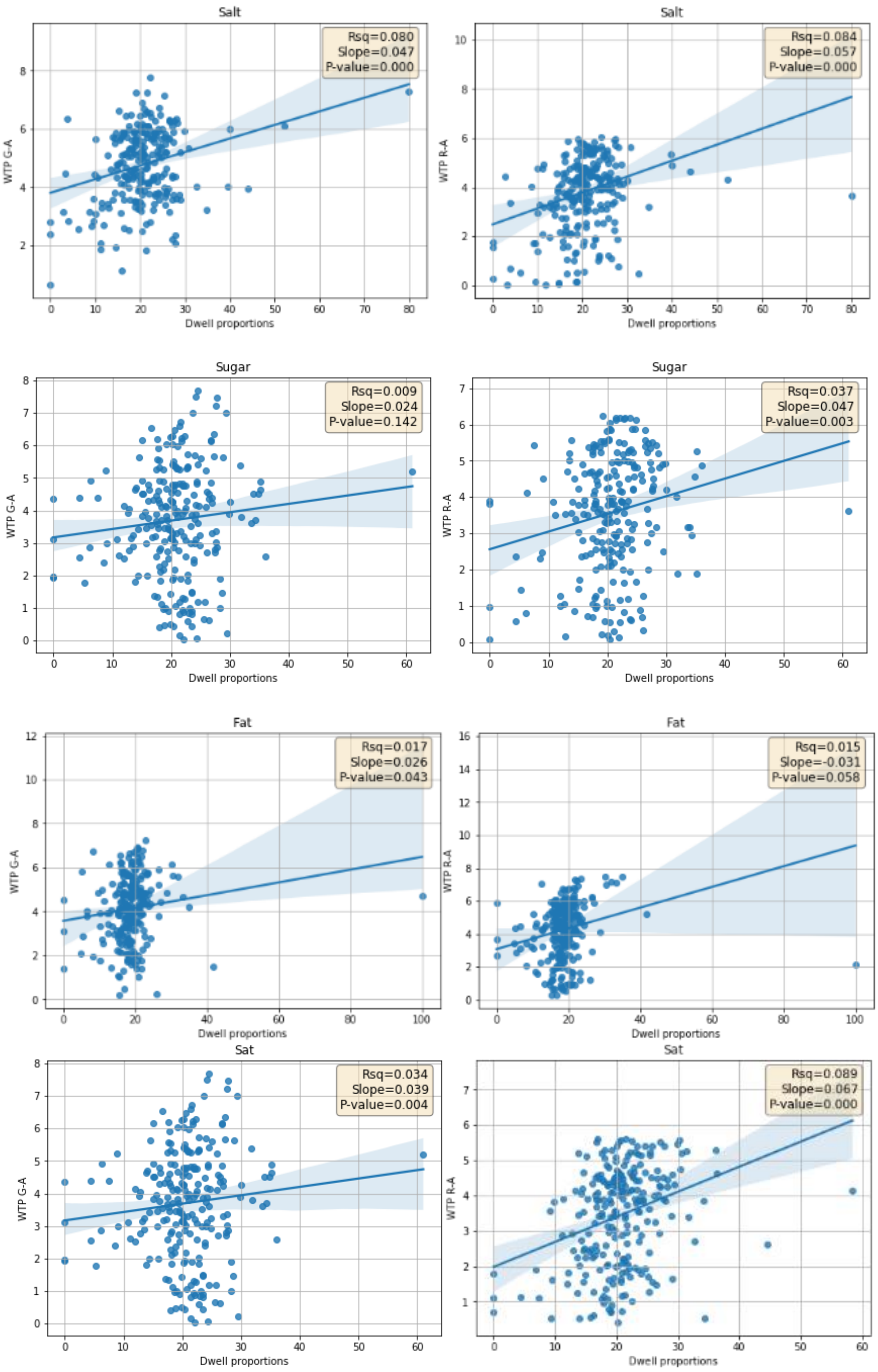


Table 18 shows the results of a mixed model where WTP G-A was regressed on Fixations number for each individual and by allowing a random intercept and a random slope for each attribute. The parameter estimate on Fixations is positive, but the associated p-value is not significant.

Table 18 Mixed Model results for WTP G-A

	Coefficient	Std. error	P-value
Intercept	4.081	0.152	0.000
Fixations	0.004	0.003	0.207
Intercept RE	0.037	0.032	
Intercept RE x Fixations	0.001	0.000	
Fixations RE	0.000		

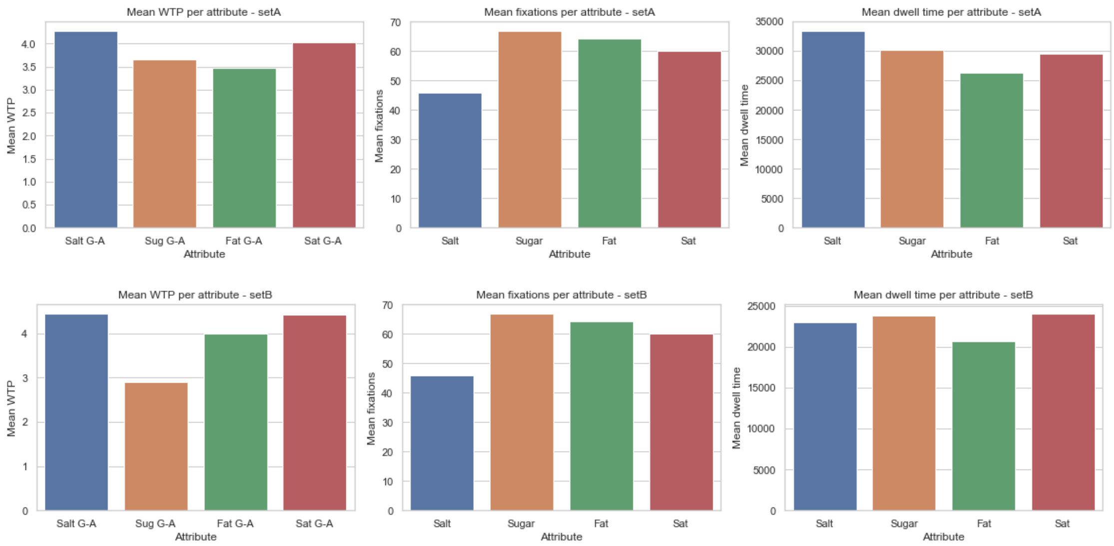
RMSE=1.47

7.4.1.2 Mouse movements vs. WTP at a collective level

The next step of analysis was to investigate whether the WTP for an attribute is associated with higher levels of mouse-tracked attention: in other words, whether attributes that are valued more on average also receive significantly more fixations or dwell time compared to the other attributes (Hypothesis 4).

Figure 23 shows the WTP means and mean fixations and mean dwell time for set A and set B for each attribute. In the case of Salt and Saturates, one can see that, despite having the highest WTP of all four attributes, Salt and Saturates have received the lowest number of fixations. Sugar, on the other hand, has received the highest number of fixations of all attributes, while the WTP for Sugar is among the lowest. When looking at mean dwell time, however, Salt has received the highest amount of dwell time out of all four attributes in set A, followed closely by Sugar and Saturates. A similar pattern can also be seen for set B, where dwell time for Saturates corresponds to a high WTP for Saturates. This suggests that higher fixations might not necessarily indicate that the attribute is more valued than others, but that high dwell time on an attribute might weakly indicate a higher valuation for that attribute.

Figure 23 WTP means, mean fixations and mean dwell time for the four nutrients (set A and set B)



Note: G-A refers to WTP to move from Amber to Green.

7.4.2 Mouse movements and self-reported attribute importance

The next step of the analysis was to understand the relationship between mouse movements and measures of stated attribute importance other than the WTP estimates. These measures were derived from the respondents' answers to several diet and lifestyle questions. For the full list of these questions, see *Appendix A. The survey with DCE and mouse-tracking (set 1A)*. To understand the relationship between mouse movements and stated attribute importance, separate logit regressions were run for each of the attributes where a stated attribute importance dummy (1=high or very high importance, 0=low importance) for that attribute was regressed against the percentage of fixations allocated to that attribute throughout the course of the choice experiment. The results in Table 19 point that three out of the five attributes show a statistically positive significant relationship between fixations and stated importance: Salt, Sugar and Price. However, this relationship is quite weak, in that for 1% increase in fixations proportions increases the odds of a high attribute importance for the three attributes in question by a factor of 1. Substantively similar results were obtained when using dwell proportions instead of fixation proportions. These results can be found in *Appendix F. Logit results from Chapter 6 Results Part 1*.

Table 19 Logit Results for Stated attribute importance vs. Fixation proportions for each attribute

Attribute	**Parameters**	**Coefficient**	**Odds Ratio**	**Std. error**	**P-value**	**Pseudo-R^2**	**LLR p-value**
Salt	Intercept	-1.602		0.550	0.004	0.033	0.000
	Fixations	0.108	1.114	0.034	0.002**		
Sugar	Intercept	-0.953		0.707	0.177	0.015	0.026
	Fixations	0.066	1.068	0.031	0.032**		
Fat	Intercept	-0.560		0.689	0.416	0.004	0.225
	Fixations	0.037		0.031	0.233		
Saturates	Intercept	-0.431		0.733	0.556	0.004	0.207
	Fixations	0.044		0.035	0.213		
Price	Intercept	-1.886		0.427	0.000	0.046	0.000
	Fixations	0.072	1.074	0.022	0.001***		

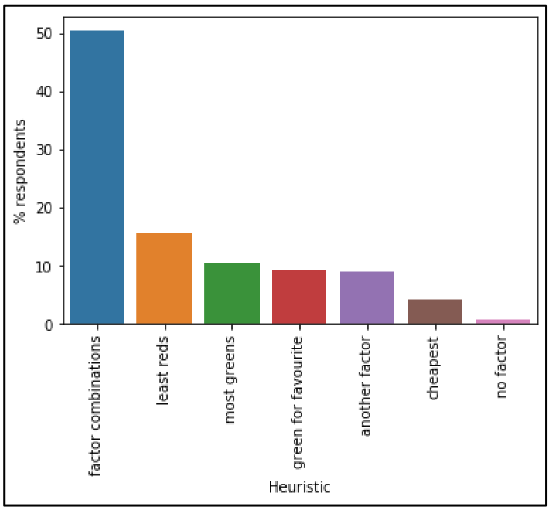
*** significant at 1% level of significance, **significant at 5% level of significance

7.5 Relationship between mouse movements and heuristics

Another interest was to examine the relationships between mouse-tracking measures and the use of heuristics within the context of a DCE applied to colour-coded nutritional labelling (Question 5). As described in Section 3.6, individuals might employ heuristics to deal with the complexity of a choice problem, or with their own cognitive limitations. Examining the extent to which heuristics are used in nutritional labelling is a component of understanding engagement with these labels.

Figure 24 shows how respondents answered the heuristic question. The reader is reminded that at the end of the DCE, respondents were asked whether they used any heuristic or decision rule in deciding between the baskets (see Section 5.3.4 for more details). Respondents were asked to state whether they used any heuristic at all, whether they used a combination of factors, or whether they did not use any heuristic at all. The heuristics from which respondents could choose were the following: choosing the baskets with least reds, choosing the baskets with most greens, choosing the basket with green for the favourite attribute and choosing the cheapest basket. As seen in Figure 24, half of the respondents stated to have used a combination of factors in deciding between the baskets, while the other half stated to have used either of the heuristics.

Figure 24 Decision rules (heuristics) used by respondents.



7.5.1 Relationship between mouse movements and heuristics

To understand whether the use of heuristics is related to the level of attention a respondent has allocated throughout the twelve choice tasks, a Logit Model was run whereby a heuristic dummy (1=whether the respondent used a heuristic, 0=whether the respondent used a combination of factors) was regressed against total fixations for all attributes. Table 20 shows these results. The coefficient on fixations is statistically significant at 5% level of significance and negative, although the derivative of the log odds of using a heuristic with respect to fixations is very small (-0.003). This suggests that there is a negative relationship between how many times a respondent has fixated on the attributes and whether that respondent has used any heuristic. The derivative of the odds ratio suggests that one more fixation decreases the probability of using a heuristic by a factor of 0.99. However, the low Pseudo-Rsquared points to a weak relationship between number of fixations and using heuristics.

Table 20 Logit Model results for heuristic use against number of fixations

	Coefficient	**Std. error**	**ΔOdds Ratio**	**P-value**
Intercept	0.815	0.372	2.259	0.029
Fixations	-0.003	0.001	0.997	0.018**

**significant at 5% level of significance, Pseudo-Rsq: 0.017

7.5.2 Relationship between specific heuristics and mouse movements

The next step was to understand whether using a specific heuristic results in a specific pattern of attention. One way to do this is to examine whether using the cheapest basket as a heuristic is associated with higher levels of attention towards the Price attribute. This heuristic was used because it was relatively easy to link to a specific attribute, in this case, Price. To this end, two separate Logit Models were estimated (see Table 11) where a heuristic dummy (1=whether the respondent claimed to have used cheapest as a criterion, 0=otherwise) was regressed against fixations proportions on Price and against dwell time proportion on Price. Relative fixations as opposed to absolute fixations were used to account for the fact that some individuals might pay more attention overall than others.

The estimation results show that there is a statistically significant relationship between the proportions of fixations on Price and whether the heuristic used was the cheapest basket: the coefficient on fixations proportions is significant at 5% significance level while the derivative of the odds ratio shows that this relationship is positive: higher fixations proportions are associated with higher probability to have used the cheapest basket as a heuristic. Similarly, the coefficient on dwell time proportions is significant at 1% level and the derivative of odds ratio suggests that higher dwell time proportions on Price are associated with higher probability to have used the cheapest basket as a heuristic. However, the low Pseudo-Rsquared of 0.133 points to a weak relationship between dwell time on Price and using the cheapest basket as a heuristic. While in a statistical sense, Hypothesis 5 has been supported, in a practical sense the amount of dwell time on Price cannot be used to predict whether a person has used ‘cheapest basket’ as a heuristic.

Table 21 Logit Model results for using cheapest basket as a heuristic against fixations proportions and dwell time proportions

	Coefficient	**Std. error**	**ΔOdds Ratio**	**P-value**
Intercept	-4.946	0.762	0.007	0.000
Fixations proportions	0.081	0.029	1.08	0.005**
Intercept	-4.494	0.584	0.011	0.000
Dwell time proportions	0.053	0.015	1.054	0.000***

**significant at 5% level of significance, Pseudo-Rsq: 0.140

***significant at 1% level of significance Pseudo-Rsq: 0.133

7.6 Mouse-tracking measures and socio-demographics

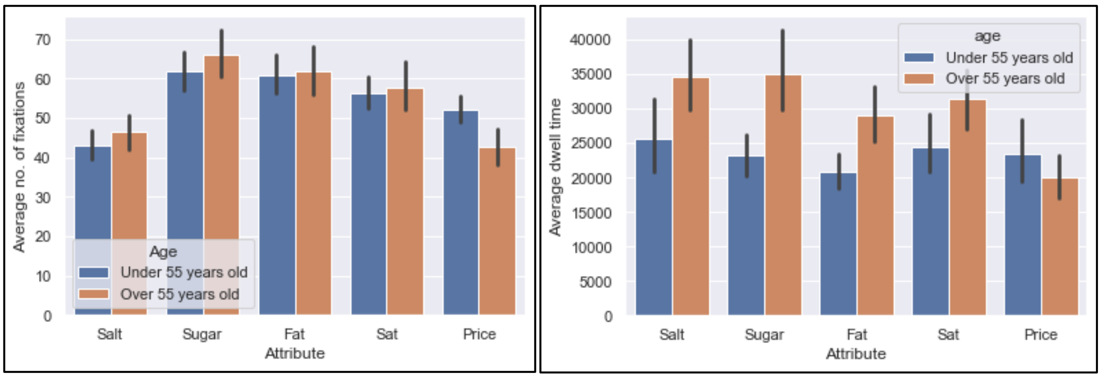
This section examines the mouse-tracking measures in relation to socio-demographic variables. More specifically, fixation and dwell time measures are examined in relation to the age of respondents, their education and income level and their gender. For the purposes of this analysis, fixations on Price were also included despite Price not being an attribute covered by the Traffic Light System.

7.6.1 Age and mouse-tracking measures

Figure 25 shows the number of fixations and dwell time for each attribute by age group (under 55 years old and over 55 years old). For fixations, we can see that the ranking in terms of fixations per attribute is similar across the two age groups. Out of the four TLS nutrients, Sugar has received the highest average number of fixations across both age groups, followed by Fat, Saturates and Salt. On average older people (aged 55 or above) allocated more fixations than younger people (under 55 years old) across all four attributes. However, the opposite holds for Price which on average received more fixations from younger people than from older people. The effect of age on the number of fixations was found to be statistically significant ($F(201) = 11.42$, $p=0.000$) for Price but not statistically significant for all the other four attributes.

A similar pattern is seen also when looking at attention in terms of dwell time, with older participants dwelling on average longer on each of the four attributes than younger participants, except for Price. The effect of age on dwell time was found statistically significant for Salt ($F(201) = 4.36$, $p=0.03$), Sugar ($F(201) = 16.29$, $p<0.001$), Fat ($F(201) = 13.26$, $p=0.000$) and Saturates ($F(201) = 4.40$, $p=0.03$), but not for Price.

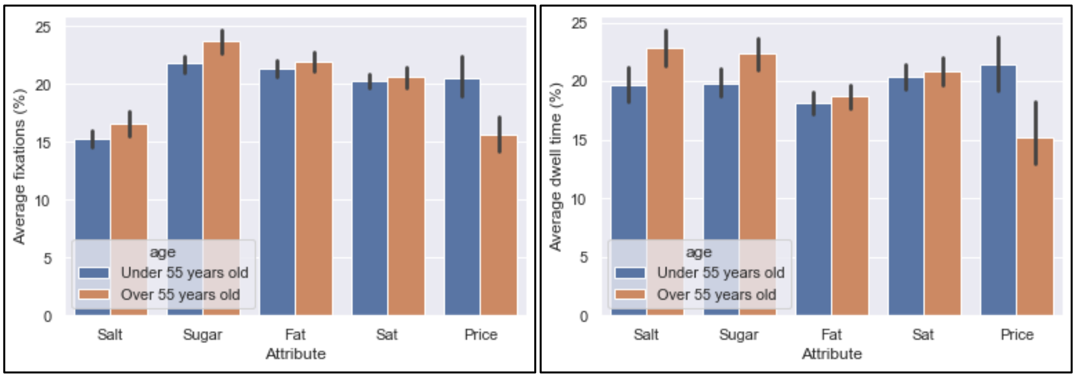
Figure 25 Fixations and dwell time by age for each attribute



Error bars show standard errors of the mean.

Figure 26 below shows similar data with Figure 25 but with fixations and dwell time as a percentage of total fixations and total dwell time allocated to the five attributes throughout the experiment. Compared to people under 55, people over 55 years old seem to be allocating a higher proportion of their fixations and a higher proportion of their dwell time towards the four TLS nutrients, except Price.

Figure 26 Average fixations (%) and average dwell time (%) by age for each attribute

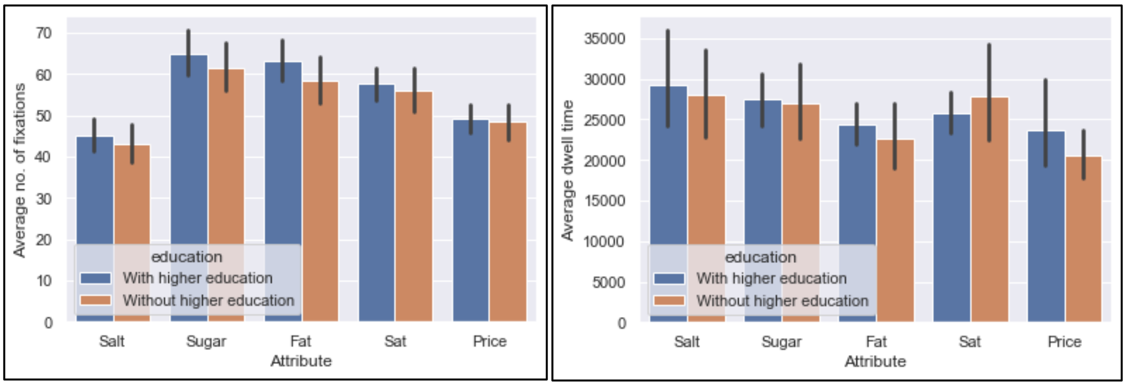


Error bars show standard errors of the mean.

7.6.2 Education and mouse-tracking measures

When examining the mouse-tracking measures in relation to the education level of respondents, people with a higher education degree appear to allocate a higher number of fixations and longer dwell time to the five attributes than people without a higher education degree (Figure 27). The only exception is dwell time for Saturates which seems to attract longer dwell times from those without a degree. One-way ANOVA analyses show no statistical difference between the two educational level groups for any of the attributes irrespective of the mouse-tracking measure used (fixation numbers or dwell time).

Figure 27 Average fixations and dwell time by education level for each attribute

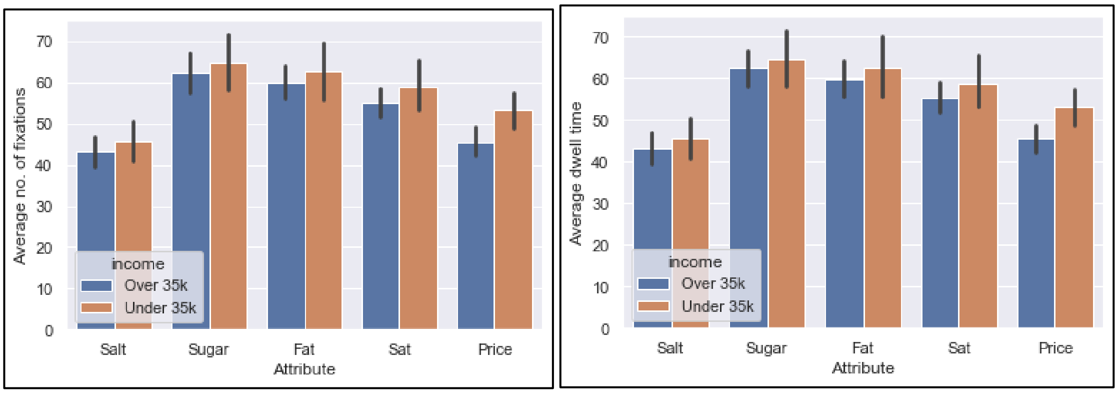


Error bars show standard errors of the mean.

7.6.3 Income level and mouse-tracking measures

When examining the MT measures in relation to the income level of the respondents, people with an annual household income below £35k appear to allocate a higher number of fixations and longer dwell time to the five attributes than people with an annual household income above £35k (Figure 28). One-way ANOVA analyses shows that only for Price there is a statistical significance between the two income level groups ($F (201) = 7.70$, $p=0.006$).

Figure 28 Average fixations and dwell time by income level for each attribute

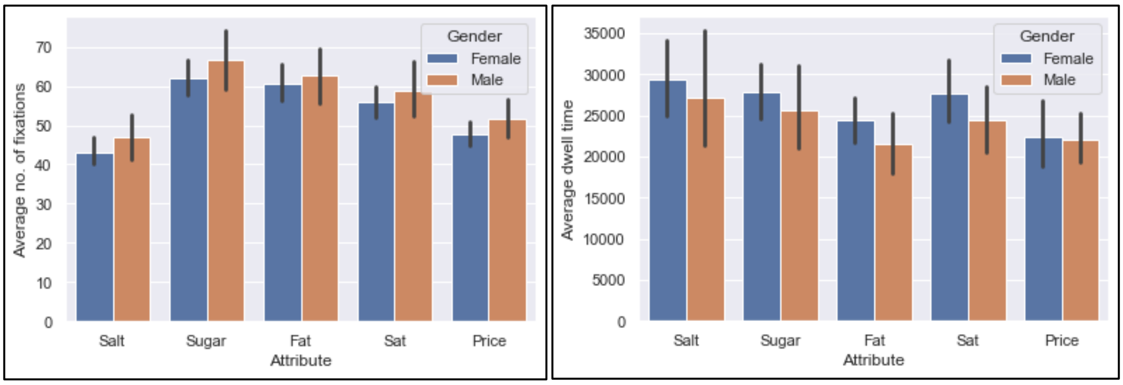


Error bars show standard errors of the mean.

7.6.4 Gender and mouse-tracking measures

Finally, the differences between the two genders in terms of attention to TLS were examined. In terms of fixation counts, males appear to pay more attention than females across the five attributes (Figure 29). The opposite holds if dwell time is taken into account with females dwelling longer on the five attributes than males. However, one-way ANOVA analyses show no statistical significance between males and females for any of the attributes irrespective of the MT measure used (fixation numbers of dwell time).

Figure 29 Fixations and dwell time by gender for each attribute



Error bars show standard errors of the mean.

7.7 Chapter summary

This chapter has examined the mouse-tracking data collected as part of this research and within the Hidden Treatment of the DCE. Several analyses have been carried out to test the hypotheses of this research. These analyses provide the basis for the two discussion chapters of this thesis in the following way.

The extent of DCE attribute attendance was examined to understand the impact of a costly survey on respondent engagement. This analysis was complemented by an analysis of the links between mouse movements and stated attribute non-attendance (ANA). While these findings have been part of a preliminary discussion, these are further discussed and reflected upon in Chapter 8 where the potential of using mouse-tracking in DCEs is examined.

This chapter has also analysed the links between mouse-tracking measures and several other variables such as: i) WTP estimates, ii) use of heuristics and iii) socio-demographic variables. These findings are further discussed and reflected upon in Chapter 9 which focusses on consumer engagement with colour-coded nutritional labelling.

8 Discussion Part 1: Using mouse-tracking as a tool to examine individual economic behaviour

8.1 Introduction

This chapter discusses the potential that mouse-tracking data might hold in understanding individual behaviours and decision-making. It first discusses the value of using mouse-tracking data in the context of a Discrete Choice Experiment by examining the extent to which collecting this type of data could interfere with model estimates (Objective 1). It then discusses the impact that a cognitively costly DCE such as the mouse-tracked DCE used in this research has on respondent overall engagement with the DCE survey (Objective 2). Finally, the strengths and limitations of gathering and using mouse-tracking data in economic research are discussed in relation to eye-tracking data as well as in terms of implications for researchers interested in incorporating mouse-tracking in their surveys.

This chapter is structured as follows. Section 8.2 discusses the extent to which mouse-tracking interferes with DCE model estimates. Section 8.3 examines the impact of a costly DCE on respondent engagement. Section 8.4 discusses the strengths and limitations of using mouse-tracking to collect data about individual behaviour.

8.2 Understanding mouse-tracking interference in a DCE

One of the main objectives of this research was to understand the potential benefits that mouse-tracking tools might bring to researchers interested in gathering mouse-tracking data as part of economic experiments such as DCEs. An important component of this objective was to understand whether using Mouselab interferes with respondents' choices in any significant way (Question 1) given concerns in the literature that the occluded design that Mouselab imposes might 'alter the choice process investigated' (Rigby, Vass and Payne, 2020). This concern stems from the fact that Mouselab requires participants to hover their mouse cursor on the attribute level for the information to be revealed. While respondents are not aware they are being tracked, they face a task which is costly from a cognitive point of view.

Overall, the results reported in Sections 6.3 and 6.4 suggest that using Mouselab as part of a DCE did not change or interfere with respondents' choices in a significant way. This finding is supported at three different levels. At a first level, the WTP estimates are in line with what one would expect from a choice modelling exercise. Although large, the WTP estimates have the expected sign and are line with previous literature examining consumers' preferences for TLS nutrients (Balcombe, Fraser and Di Falco, 2010; Balcombe, Fraser and McSorley, 2015; Scarborough *et al.*, 2015). At a second level, findings show a relatively strong correlation between individual WTP estimates in the two treatments (with mouse-tracking and without mouse-tracking). With a few exceptions, the WTP estimates in the Hidden Treatment (with mouse-tracking) and in the Open Treatment (without mouse-tracking) were not significantly different from each other. At a third level, a merged model which incorporates all participants' choices (with and without mouse-tracking) was shown to have a better predictive validity than the models estimating the WTPs separately for the two treatments. This means that merging the mouse-tracked choices together with the choices without mouse tracking are better reflective of participants' behaviour. These findings further corroborate results from a previous study by Meissner, Scholz and Decker, (2010) that finds that mouse-tracking does not substantively interfere with inferred participant preferences.

Despite there being an overall strong correlation between WTP estimates in the two treatments, some exceptions are worth mentioning. For some respondents, the WTP estimates for moving from Amber to Red on Salt and Saturates in the Hidden Treatment were less than the WTP estimates for the same nutrients in Open Treatment. In other words, these participants appear to want to pay more to avoid having Red when they see these nutrients in Open Treatment than when they see them in Hidden Treatment. One reason for this might be that it is easier to process red in Open Treatment than in Hidden Treatment. It might also be that the red colour makes more of an impact when people see it in relation to other colours than when they see it individually. For instance, evidence from psychology suggests that in certain situations, red carries a negative connotation, being associated with danger, failure or threat (Elliot and Maier, 2014; Pravossoudovitch *et al.*, 2014; Elliot, 2015). At the same time, red seems to elicit stronger reactions whereas green elicits more moderate reactions (Briki and Hue, 2016).

Overall, these findings suggest that mouse-tracking technology such as Mouselab might be a promising tool to be used in future stated preference research where there is an interest to collect process data in addition to choice data. Even if we consider the few exceptions of higher discrepancies between WTPs means for Saturates R-A and Salt R-A as being important, the benefit of collecting data about participants' attention or information acquisition behaviour might outweigh the costs of getting less precise WTPs. At the same time, as described in Section 5.5, only two respondents were removed from the dataset because they had not finished answering all the survey questions. This suggests that the cognitive cost imposed by the Hidden Treatment was not so high so as to make respondents give up the experiment. While some researchers have argued that Mouselab might introduce an unnecessary cognitive cost and thereby interfere with the decision process (Rigby, Vass and Payne, 2020), the occluded box design needed to gather mouse movements might favour specific research objectives. For instance, Mouselab might be preferred by researchers interested in understanding human behaviour in situations where there is a cost or constraint. Theories of attention, information acquisition and decision-making such as those described in Section 2.5 could therefore be empirically tested. This might suit experiments where researchers are interested in simulating contexts where information can be obtained subject to a small cost. For researchers interested in gathering attendance data within the context of a DCE, the results of this research show that this can be done without interfering too much with WTP estimates. Overall, it depends on what the purposes of research ultimately are as the usefulness of Mouselab comes at two levels: on the one hand, it allows researchers to examine attention and information acquisition in the context of a costly task, and on the other hand, it helps gather additional insights about individuals related to the choice process other than their final choice.

8.3 Understanding the impact of a cognitively costly DCE on respondent engagement

Section 8.2 discussed the extent to which collecting mouse-tracking data as part of a DCE might interfere with choice modelling estimates. This section discusses the impact of a cognitively costly DCE on respondent overall engagement with the survey (Objective 2). The reader is reminded that the DCE used in this research imposed a cognitive cost to respondents. In the Hidden Treatment, the information about the attribute levels could only be visualized if respondents hovered their mouse cursor over the attribute box and this information disappeared once the mouse cursor left the attribute box. As reported in Section 5.7.5, just under half of respondents found this format more difficult than the classical DCE format. This choice situation provided the opportunity to examine respondent engagement with a cognitively costly survey that did not entail real consequences for respondents. This analysis is linked to the wider debate in the stated preference literature about the necessity to have surveys that have some degree of consequentiality (Carson and Groves, 2007).

Respondent engagement with the DCE was measured in terms of respondent overall attribute attendance and non-attendance of the DCE as well as in terms of mouse-tracking measures such as fixations and dwell time. The reader is reminded that in Section 7.3 mouse-tracked attendance and mouse-tracked non-attendance were defined. An attribute was considered attended in a choice card if a respondent hovered their mouse (fixated) on both levels of that attribute i.e. for Salt to have been attended in choice card 1, the respondent should have had at least one mouse hover on both Basket 2 and Basket 3. An attribute was considered attended across choice cards if it had been attended in six or more (therefore a majority) of the choice cards. In terms of non-attendance, an attribute was considered non-attended for a given choice task if it had not been hovered on in either Basket 2 or Basket 3 or both.

Overall, the mouse-tracking data described in Chapter 7 point to a relatively good level of respondent engagement with the Hidden Treatment of the DCE survey**.** Results show a reasonable degree of engagement with the survey instrument, with an overwhelming majority of people (around 90%) attending the four attributes in at least two thirds of the choice cards. Even more significant is that 81% of respondents attended the four attributes in over three quarters of choice cards. However, the same level of attendance over choice cards does not hold for the Price attribute for which the proportion of attendance seems to be lower than for the rest of the attributes. Only 84% of respondents attended the price attribute in six or more choice cards, while only 65% attended Price in nine or more choice cards. At the same time, an analysis of mouse-tracking data from the perspective of non-attendance reveals that around half of respondents did not attend one or more attribute in at least 3 choice cards. However, the results also show that full non-attendance of attributes is quite rare.

Taken together, these findings provide evidence that even in the context of a relatively costly task, there is still a relatively good level of attendance. Given that there was no explicit incentive for respondents to attend the DCE attributes and that acquiring the information about the attribute levels required some degree of effort, these results are quite significant. These findings are related to another DCE study by Spinks & Mortimer (2016) which use eye-tracking to examine the relationship between ANA and choice problem complexity in the context of health decisions. They find that ANA increases as the number of attributes in a choice experiment increases. However, although examining a similar issue, the study of Spinks and Mortimer is quite different from the present study. Spinks and Mortimer were able to examine how attendance changes in situations when costs are higher (more attributes) versus situations when costs are lower (less attributes). During the experiment conducted as part of this research, participants' attendance in the Open Treatment was not tracked and therefore no comparison can be made to the Hidden Treatment attendance. The results of the experiment conducted as part of this research however show what happens to respondents' engagement in a choice situation where there are costs to paying full attention. The finding that even in the presence of a cognitively costly task, there is still a reasonable degree of attendance is relatively surprising. This finding has implications for the stated preference literature which has been concerned with ensuring that there is some consequentiality to participants' choices. The findings of this research therefore point to the potential existence of intrinsic incentives that respondents might have when answering hypothetical surveys. For instance, altruistic incentives such as helping researchers or more egoistic incentives such as enjoyment from filling surveys have been documented as important non-financial incentives for survey respondents (Singer and Ye, 2013).

The findings on attribute attendance in a DCE also corroborate previous research coming from examining eye movements also in the context of DCEs. For instance, Balcombe, Fraser and McSorley (2015) find a reasonable degree of attribute attendance in a DCE applied to the Traffic Light System as well as no evidence of attendance being completely full. However, their experiment did not introduce additional cognitive costs to respondents. The findings of this study also seem to suggest that the Random Utility Model offers a relatively good approximation of behaviour within a DCE, despite not all respondents appearing to behave in line with the RUM assumptions. Lower attendance of Price might raise concerns as to the validity of the WTP estimates, a key concern of DCEs. Previous eye-tracking literature has found a similar low attendance for Price. For instance, Grebitus, Roosen and Seitz (2015) find lowest mean dwell time for the Price attribute compared to other attributes in a DCE which corroborates similar findings by Van Loo, Grebitus and Verbeke (2020).

The level of respondent engagement was not constant throughout the survey. Fixation and dwell time data extracted from participants' mouse movements showed a considerable drop in attention as participants went through the twelve choice cards. This drop in attention was found to be statistically significant. While finding that attention drops with time is not a novel insight into human behaviour, this finding is consistent with previous literature, such as the eye-tracking literature. There is a considerable body of evidence coming from the eye-tracking literature that people's attention tends to wane off with time as evidenced in the drop in fixations and dwell time spent on attributes over time (Meissner, Musalem and Huber, 2016; Balcombe *et al.*, 2017; Ahn *et al.*, 2018; Drexler *et al.*, 2018). For instance, Meißner, Musalem and Huber (2016) demonstrate similar drops in attention from an average of 50 fixations to an average of 32 fixations. This reduction in attention over time has been attributed to respondent fatigue or learning (Savage and Waldman, 2008). An important caveat is needed here. If respondents are learning, then what mouse-tracking is measuring is not so much attention per se, but the extent to which respondents have become more efficient at answering the choice task.

Overall, the findings of this study contribute to the stated preference literature by providing some degree of insight into understanding overall engagement with hypothetical DCEs that introduce a cognitive cost for respondents. At a more general level, these findings suggest that costly or complex surveys are still likely to entail a reasonable degree of engagement from a large proportion of respondents. However, these findings are sensitive to how respondent engagement has been inferred. In this study, fixation and dwell times were used to infer respondent engagement. Previous research has used other measures of respondent engagement by asking respondents debrief questions related to their overall satisfaction with the survey experience. For instance, self-reported measures of engagement such as the extent to which respondents have found the survey interesting, easy to read and answer, or enjoyable have been used as proxies for respondent engagement (Guin *et al.*, 2012). Besides the limitations of inferring engagement from mouse-tracking data, one cannot rule out that part of respondent engagement with the mouse-tracked survey could have been due to its gamified nature which required participants "to play" with the mouse (Keusch and Zhang, 2017). For instance, Guin *et al.* (2012) find that visually appealing and gamified online surveys lead to higher respondent satisfaction.

8.4 Understanding the potential of mouse-tracking data in understanding individual behaviours within a DCE

This section discusses the potential of mouse-tracking data in examining and understanding individual behaviours within a DCE. Several strengths and limitations related to the use of mouse-tracking in stated preference research are outlined and discussed. The strengths of using mouse-tracking are a relatively precise identification of attendance in a DCE as well as the cost and practicality of conducting a mouse-tracked experiment. Limitations relate to the decision complexity faced by respondents, the difficulties in tracking covert forms of attention as well as a requirement for controlled forms of attention. These advantages and limitations are discussed in relation to findings from the eye-tracking literature.

8.4.1 Strengths of gathering and using mouse-tracking data in economic research

8.4.1.1 Relatively precise identification of attendance

A large concern in the stated preference literature is the possibility that a substantive proportion of respondents are not attending to all the information presented to them. Non-attendance of a part of attributes in a DCE might signal that respondents are not making trade-offs and thereby their behaviour violates convexity, one of the axioms of consumer theory on which DCEs are founded (Lancsar and Louviere, 2006). Of particular concern is whether respondents are not attending the Price attribute because this might undermine attempts to value the attributes of the DCE. Understanding the extent of attribute non-attendance is important for the researcher who wants to produce unbiased choice modelling estimates and does not wish to overvalue attributes.

Based on the findings of this research, mouse-tracking data appears to provide the researcher the ability to record the amount of time and the specific type of information respondents have inspected during their decision-making with relative ease and certainty. This is because the specific design of a mouse-tracked experiment only allows the participants to investigate one piece of information at a time and thereby not allowing for other pieces of information to be visible to the peripheral vision. In comparison, eye-tracking methods collect data on eye movements at the pupil's point of gaze and thereby while allowing for other information to be visible, they are unable to record participants' peripheral vision (Vass *et al.*, 2018).

Findings reported in section 7.3.3 also show that there seems to be a relationship between the different measures of mouse-tracked attention and respondents' stated attribute non-attendance (ANA). For three out of five attributes (Salt, Fat and Price), the proportions of fixations allocated by a respondent was negatively related to whether that respondents stated to have ignored the attribute. However, the strength of the relationships is quite low, illustrated by a low explanatory power of the two models. In addition, a bit over a third of participants claimed to have ignored Price, while the other attributes were reported to have been ignored by around 10-12% of respondents. This is consistent with the analysis of non-attendance data which finds Price to be the least attended attribute of all the five attributes.

The consistency between what people said they took into account and their mouse movements might be explained by the specificity of using Mouselab which involves the respondent being more aware of which attribute they have looked at and which they have ignored, or it might be because respondents are more able to recall what they have ignored. The eye-tracking literature finds mixed results in relation to the consistency between stated measures of attendance and eye-tracking measures. Vass *et al.* (2018) find consistency in relation to two attributes, but not in relation to the Price attribute while Balcombe, Fraser and McSorley (2015a) find stated and eye-tracked attendance to contain largely non-overlapping information.

The findings reported above suggesting a weak relationship between stated ANA and mouse-tracking measures have implications for future research incorporating mouse-tracked DCEs. They suggest that using mouse-tracking measures might offer some indication in relation to a respondent's stated ANA. However, these findings need to be taken with caution since the relationship between mouse-tracking measures and stated ANA was quite weak and only concerned three out of five DCE attributes.

8.4.1.2 Low research monetary costs and easy roll-out

Besides identifying ANA, another advantage to collecting mouse-tracking data is its low cost and practicality, especially when compared with eye-tracking data. In terms of costs, researchers can download free of charge the MouselabWeb 2.0 code, embed it on a webpage and easily retrieve the data after the experiment. Conditional on having some programming skills, researchers can easily deploy a mouse-tracked experiment without requiring respondents to undertake the experiment in a laboratory. Being able to gather mouse-tracking data as part of an online experiment also enables researchers to gather mouse-tracking data in very large samples since the web survey link can be sent to anyone with a basic Internet connection and a mouse. In addition, while mouse-tracking provides a large amount of data that requires a lot of effort and skill in cleaning and summarizing, the pipeline of data appears to be relatively manageable when compared with eye-tracking which has been reported to provide between 60 and 120 data points per second (Lahey and Oxley, 2016). These advantages make mouse-tracked experiments relatively attractive when compared to eye-tracking experiments which, despite having become more affordable in recent years, are still considered to be relatively expensive and time consuming (Graham, Orquin and Visschers, 2012; Van Loo *et al.*, 2017).

From the perspective of cost and practicality, mouse-tracking seems to have advantages over eye-tracking. However, there are also several limitations related to gathering and using mouse-tracking data relative to eye-tracking data which will be discussed in Section 8.4.2 below.

8.4.2 Limitations to gathering and using mouse-tracking data

8.4.2.1 Relative complexity of a mouse-tracked survey

Any experiment which uses MouselabWeb 2.0 requires the boxes containing the choice information to be occluded or covered so that the mouse movements can be tracked. This might pose difficulties in responding to the survey since respondents are required to actively move their cursor on the relevant box. This design might pose an additional challenge to respondents who do not have good working memory. In this experiment, this challenge was considered not to be very serious since the occluded information was mostly colours (Green, Amber, and Red).

Evidence from psychology shows that humans are relatively quick at identifying images even when these are represented in a sequence of six or 12 images, with image detection happening in as fast as 13 milliseconds (Potter *et al.*, 2014). Moreover, as shown in Section 8.2, the complexity of the mouse-tracked DCE did not lead to an interference with participants' choices, with WTP estimates in the mouse-tracked

(Hidden Treatment) DCE being highly correlated with the WTP estimates in the Open Treatment. To ensure that respondents do not find the experiment too difficult, one of the three options offered to respondents (the fixed basket) was always visible. However, the downside of this decision was that participants' mouse movements were not recorded for the non-occluded, Open Treatment. There are strong reasons to believe that a mouse-tracked survey where respondents are required to make decisions based on more complex information such as numbers or text might be even more cognitively difficult. This might deter researchers from using mouse-tracked surveys to estimate WTP for different attributes.

8.4.2.2 Overt vs. covert attention

Like eye-tracking, mouse-tracking data suffers from limitations related to what type of attention is being tracked. In psychology, an important distinction is made between overt and covert attention (Posner, 1980; Hunt and Kingstone, 2003). Overt attention refers to visually attending an item by moving the eyes to the direction where the item is located while covert attention refers to the mental shift of attention which might not necessarily be accompanied by eye movements. Overt attention is closely related to the 'eye-mind assumption' whereby what is seen is also what is processed ('I am looking at you, therefore I am paying attention to what you are saying'), while covert attention refers to the mental control of attention ('I am looking at you, but actually my mind is elsewhere'). In the case of a mouse-tracked experiment, moving the mouse cursor over a box does not necessarily guarantee that the respondent has paid attention to the information that was uncovered. There might be cases when a respondent has opened the box but has moved their eyes somewhere else on the experiment page or outside of it. Therefore, while mouse-tracking might offer important insights into overt attention, it is less useful in understanding and measuring covert attention.

One method which has been shown to offer insights into covert forms of attention is the think-aloud approach. The think-aloud approach allows respondents to express their thought processes related to their decisions during the actual decision-making process (Ryan, Watson and Entwistle, 2009) or just after it (Tanner, McCarthy and O'Reilly, 2019). For instance, Vass, Rigby and Payne (2019) use the think-aloud method to gain a deeper understanding of how women use risk information when choosing between breast cancer screening programmes while Cheraghi-Sohi *et al.* (2007) conduct a DCE using a ‘think aloud’ protocol and find that attributes are interpreted in different ways by respondents. The potential insights into covert forms of attention offered by think-aloud protocols might therefore contribute to our understanding of mouse movements. Future research could therefore use mouse-tracked DCEs in combination with think-aloud protocols to better understand the relationship between attention and mouse movements.

8.4.2.3 Controlled vs. automatic attention

As mentioned in Section 8.4.2.1 above, the very nature of using mouse-tracking as part of a DCE necessarily creates a decision context whereby respondents are required to actively seek the attribute information by moving their mouse over the attribute box for the attribute information to be revealed. This specific context therefore fosters more controlled forms of attention as opposed to more automatic forms of attention which eye-tracking can capture. This limitation is important since there is some agreement in the literature that visual attention is not entirely or always under our cognitive control (Glockner and Betsch, 2008; Reisen, Hoffrage and Mast, 2008). There are instances when attention is an effortless, involuntary stimulus-driven process which is beyond our cognitive control (Haladjian and Montemayor, 2013).

However, one might also argue that decision contexts where there is a small cost to acquiring information such as those provided by a mouse-tracked experiment are quite realistic. For instance, a health-conscious shopper trying to choose between several competing brands for the same product might need to inspect nutrient information which comes in different shapes and is located in different areas of the packaging. This shopping context might arguably stimulate more deliberate and effortful types of attention. Overall, this suggests that mouse-tracking might be a gool tool in research where there is an interest to examine more deliberate forms of attention.

8.4.2.4 Links between mouse-movements, attention, and information processing

The experiment conducted as part of this research has collected data about respondents’ mouse movements during a web-based DCE. These mouse movements have been used to derive proxies for attention, namely fixations (or how many times someone has looked at an attribute) and dwell time (the amount of time someone has looked at an attribute). In doing so, this research has assumed that mouse movements are highly correlated with eye movements. However, there are reasons to believe that this assumption might not hold every time. For instance, it might be that some participants might have hovered their mouse on the attributes without necessarily paying attention to the attribute information. Given the fact that respondents answered the DCE from their own computers and without being in the presence of a researcher, this possibility cannot be ruled out. At the same time, even if one assumes mouse movements reveal information about a respondent's eye movements, whether people have looked at something does not necessarily mean that they have processed it. This limitation has been previously discussed in the context of eye-tracking data. For instance, Graham, Orquin and Visschers (2012a) point to the fact that eye-tracking data provides no information as to the reasons why people choose to ignore or look at something. They point to the potential of retrospective think-aloud methods in understanding the cognitive processes during eye-tracking. Future research in the context of mouse-tracking could provide some further insights into the cognitive processes behind mouse movements. Debriefing interviews and think-aloud methods could be used to gain a deeper understanding of the cognitions behind mouse movements. Conducting DCEs where participants are mouse-tracked and eye-tracked at the same time could provide useful insights in relation to the links between eye movements and mouse movements. Only one study has examined the links between eye-tracking and mouse-tracking measures. This study was conducted by Meissner, Scholz and Decker (2010) to examine how DCE respondents process attribute information and found that mouse-tracking favours an alternative-wise evaluation of choice tasks. However, this study did not concomitantly mouse-track and eye-track respondents which opens up an interesting avenue for future research in relation to understanding the relationships between eye-tracking and mouse-tracking measures.

8.4.3 When and how should mouse-tracking be used?

The previous section has discussed the strengths and limitations related to using mouse-tracking to gather additional insights into participant behaviour in a DCE. Several comparisons have been drawn with eye-tracking, based on evidence coming the eye-tracking literature. This section discusses the potential contexts in which mouse-tracking data might be useful for researchers.

Overall, mouse-tracking appears to be a promising tool to understand participant behaviour within a DCE. Its main strengths lie in its relative cost and practicality compared to eye-tracking methods as well as in its more reliable identification of attribute non-attendance. However, mouse-tracking presents several limitations. The most important limitation relates to a more complex interface compared to classical DCEs, which adds an extra layer of difficulty for respondents. Another limitation is that this complex DCE design favours more deliberate attentional processes at the expense of more automatic, involuntary types of attention.

The strengths and limitations outlined above make mouse-tracking a good candidate for specific types of research. For instance, mouse-tracking appears to be a suitable tool to identify respondent engagement with the experiment in the piloting stage of a DCE. For instance, mouse-tracking could identify at a piloting stage whether the attributes included in the DCE are relevant to respondents. If for example, systematic non-attendance of specific attributes by most respondents is detected during the pilot, this might be a signal for the researcher that those attributes might not be relevant in respondents' decision-making. At the same time, a mouse-tracking experiment appears to be suitable for empirically testing theories of attention and choice in contexts where information is costly.

It is important to note that mouse-tracking provides a wealth of data that has not been examined as part of this research. For instance, apart from data about participants' fixations and dwell time, mouse-tracking can provide data about the sequence in which DCE attributes have been examined and the length of the decision-making process (also known in the literature as deliberation time). Future research could use this data to better understand decision-making processes, the role of deliberation time in decision-making as well as their relationship with different measures of attention. For instance, it might be worthwhile to examine the speed with which respondents reach a decision in the context of a DCE and the links between deliberation time and DCEs with different levels of complexity. Another area of research could be examining the role of the first or the last fixation in the context of a costly task and their links with final choices. Some evidence coming from an eye-tracking paper by van der Laan *et al.* (2015) points to the fact that the first fixation has no effect on consumer choice. However, in their experiment the first fixation had been manipulated. In general, the eye-tracking literature excludes first fixations from analysis because of their randomness (Balcombe, Fraser and McSorley, 2015). However, there is no reason to believe that this might necessarily be the case in mouse-tracking because the stimulus needs to be actively uncovered. It might therefore be interesting to understand the role of first fixation in mouse-tracking.

9 Discussion Part 2: Examining consumer engagement with colour-coded nutritional labelling

9.1 Introduction

Chapter 6 has presented the results of the discrete choice model implemented in the Hidden and Open Treatment. These results were reported as WTP estimates for reducing exposure to the nutrients described by the Traffic Light System. Chapter 7 has presented the mouse-tracking data derived from conducting the DCE in the Hidden Treatment. The amount of fixations and dwell time for each Traffic Light System nutrient was examined. This chapter combines findings from these two chapters to discuss the extent of consumer engagement with colour-coded nutritional labelling. In doing so, this chapter examines the empirical relevance of the Rational Inattention framework which has been described in Section 3.3 and the links between attention and heuristics use in the context of colour-coded nutritional labelling.

This chapter is structured as follows. Section 9.2 examines the extent of the WTP for the TLS nutrients. Section 9.3 examines the amount of attention allocated to these nutrients by consumers. Section 9.4 combines the findings from the previous two sections and discusses the relevance of the RI theory in colour-coded nutritional labelling. Section 9.5 discusses the relevance of heuristic decision-making in nutritional label use and its links to patterns of attention.

9.2 WTP for TLS nutrients

Nutritional labelling policies aim to inform consumers about the nutritional content of their food and facilitate healthy food choices. The literature concerned with nutritional labelling has examined the best way to communicate nutritional information (Graham, Orquin and Visschers, 2012; Bialkova, Grunert and van Trijp, 2013). Colour-coded labelling has been found to be an attractive way to communicate nutritional information due to its attention-capturing elements compared to simple textual information (Bialkova *et al.*, 2014; Becker *et al.*, 2015) and its capacity to facilitate cognitive processing (Gomez, 2013). Several studies have looked at how consumers interact with the information provided by colour-coded nutritional labelling and whether it has any impact on food decisions (Balcombe, Fraser and Di Falco, 2010; Bialkova and van Trijp, 2010; Scarborough *et al.,* 2015).

This study examined consumer engagement with UK's Traffic Light System, a scheme which requires retailers and manufacturers to assign colour-coded labels to Salt, Sugar, Fat, and Saturated fat. Green, Amber, and Red were used to represent low, medium, and high levels for these nutrients. A mouse-tracked Discrete Choice Experiment was employed to understand consumer engagement with the scheme by estimating WTP for each nutrient in terms of moving from Amber to Red and from Amber to Green. The DCE was implemented in two different formats: a Hidden Treatment (with embedded mouse-tracking) and an Open Treatment (without mouse-tracking).

As reported in Section 6.2, this study finds that the highest WTP to move from Amber to Green is for Salt and Saturates and the lowest for Sugar. This finding is consistent with previous studies by Balcombe, Fraser and Di Falco (2010) and Scarborough *et al.* (2015) who also find that the most valued TLS nutrients are Salt and Saturates. This study also finds the WTP estimates to move from Amber to Green are higher than the WTP to move from Red to Amber for Salt, Saturates and Sugar. This finding is nevertheless contrary to the two studies cited above which find that consumers are more concerned with avoiding Reds than having Green. Given that this study was conducted some considerable time after the previous two studies, it is an interesting finding that consumers continue to value avoiding Salt and Saturates more than Sugar and Fat. However, the fact that they value more having Green than avoiding Red on these nutrients might signal a change in consumer behaviour from avoiding harmful nutrients towards seeking a healthy diet.

Another important finding is that a segment of consumers seems to value moving from Red to Amber on Salt and Saturates (and to a less extent, Sugar) more when they see these nutrients in Open Treatment compared to when they see them in Hidden Treatment. As discussed in Section 8.2, this might suggest that Red might make more of an impact when respondents see it clearly and in comparison with other colours than when they see it individually. The reader is reminded that in the Hidden Treatment respondents had to hover their mouse cursor on each individual box to see the colour related to the nutrient. This meant that respondents never saw all the colours at once, but one by one as the mouse hovered over them. Given that seeing Red is usually associated with danger, failure or threat (Elliot and Maier, 2014; Pravossoudovitch *et al.*, 2014; Elliot, 2015), this might explain the strong aversion to this colour on the most valued nutrients (Salt and Saturates). Another possible explanation might be that the Open Treatment, where respondents were able to see Red more clearly in comparison with better nutrient levels (Amber and Green), triggered a negativity heuristic. For instance, Gomez (2013) finds that negativity heuristics ('Avoid harm at all costs') are common in nutritional information processing because they reduce mental effort. This finding raises the possibility that for a certain segment of the population, avoiding Red on a nutrient is a stronger motivator than ensuring a balanced level of nutrients across their food choices. This finding has important implications for nutritional labelling policies since it points to the fact that consumers might not be making trade-offs between nutrients.

9.3 Extent of attention to different TLS nutrients

The previous section has discussed the extent to which consumers value the different nutrients described by the TLS. This section will examine the extent to which people pay attention to these nutrients given that the level of attention to the TLS nutrients has been a topic less investigated in the nutritional labelling literature.

Within this research, measures of attention to nutritional information were collected as part of a mouse-tracked DCE alongside people's actual basket choices. These measures of attention were how many times (fixation counts) and for how long (dwell time) respondents have looked at (hovered on) the TLS nutrients. As reported in Section 7.2, this research finds that, on average, the attributes that received most attention in terms of number of fixations (or times looked at) were Sugar and Fat while Salt received the least number of fixations. However, in terms of actual time spent on investigating the TLS nutrients (or dwell time), Sugar and Salt were the most attended nutrients, with Fat being the least attended one. Although not explicitly a component of the TLS, Price received the least amount of attention compared to the four nutrients - both in terms of number of fixations and dwell time. There was, nevertheless, considerable heterogeneity in terms of how many times and how long respondents looked at these nutrients, with some respondents not attending at all some nutrients, while others allocated large amount of attention. In terms of the socio-demographic profile of consumers, Sugar and Fat have received the highest average number of fixations of all four nutrients across both younger (under 55 years old) and older (over 55 years old) individuals. However, Price has received higher average number of fixations from younger than from older individuals and this has been found to be statistically significant. Similarly, Price has received a higher average number of fixations from people on lower incomes (less than £35k) than from people on higher (over £35k) incomes. There was a statistically significant effect of age on dwell time for all four TLS nutrients, with older individuals allocating higher average dwell time on average compared to younger individuals. Overall, the mouse-tracking data shows no age difference in terms of which nutrients were fixated the most. However, it does show that older people are more likely to dwell on the TLS nutrients compared to younger people. Additionally, younger, and lower income individuals are more likely to pay attention to Price compared to older respondents.

These findings support previous evidence of differential attention to nutritional labels and low attention to the Price attribute compared to other attributes. For instance, Van Loo, Grebitus and Verbeke (2020) find in an eye-tracking study that sweetener levels and genetic modification claims attract more attention than Price and antioxidant claims. Grebitus, Roosen and Seitz (2015) also find low attention to the Price attribute compared to other attributes. One explanation for why consumers attended Price less than the other attributes might be that it is easier to understand and recalled by consumers whereas trading-off nutrients is much more difficult. It might also mean that consumers are less familiar with the nutrient information compared to the Price information. The fact that younger respondents and lower income respondents were more likely to pay attention to Price compared to older respondents corroborates previous findings in relation to the importance of price in food choice for younger people. For instance, Chambers *et al.*, (2008) find that respondents under 30 years old were more conscious of price in relation to healthy eating than other age groups.

This research also found varying levels of attention to the colours of the TLS nutrients. Green has received the lowest amount of fixations, followed by Amber and Red. A surprising finding is that Red has received more than double fixations compared to Green. This finding is interesting in relation to the finding that consumers were more concerned to having Green on the TLS nutrients than to avoiding Red.

9.4 Relationship between attention and valuation in colour-coded nutritional labelling

The previous section has discussed the extent of consumer attention to TLS nutrients while section 9.2 discussed the extent to which consumers value the different TLS nutrients. This section will bring these two discussions together to examine the relationship between the level of attention to a TLS nutrient and the extent to which that nutrient is valued.

Another step in examining consumer engagement with the TLS is to understand the role that Rational Inattention might play in how people use colour-coded nutritional labels. Put differently, this means understanding whether consumers who use colour-coded nutritional labels manage their attention by paying more attention to nutrients they care more about. This analysis was carried out in light of the first three hypotheses which were outlined in Chapter 1, Section 1.5. The reader is reminded that according to Hypothesis 2, participants who spent more time (in relative terms) looking at an attribute valued it more relative to other individuals while according to Hypothesis 3, participants who looked more often at an attribute (in relative terms) valued it more relative to other individuals. Similarly, Hypothesis 4 theorized that at a collective level, attributes that received more attention were on average more valued than the rest of the attributes.

To understand this, Section 7.4.1 has analysed the links between individual mouse-tracking measures and the WTP for the Traffic Light System nutrients. Section 9.3 above showed that within the context of this experiment, Sugar and Fat were the most attended nutrients according to different mouse-tracking measures. However, just because Sugar and Fat were the most attended attributes throughout the experiment does not mean that these attributes were the most valued ones by the participants. The results showed some degree of correlation between a person's mouse movements and how much that person valued that attribute, with dwell time measures showing more correlation than the fixation measures. This relationship was statistically significant although weak for Salt, Fat and Saturates when using dwell time measures. At the same time, the results of a collective analysis of mouse movements and WTPs suggest that, whether an attribute was attended more than another did not mean that the attribute was more valued than other attributes. When replacing WTP with a self-reported measure of attribute importance, a weak relationship was found between a participant's mouse movements and their stated attribute importance but only for Salt, Sugar and Price. Taken together, these results show some, albeit not very strong, evidence of Rational Inattention within the context of this experiment. These results mean that there is some level of support for confirming the first three hypotheses (H1, H2, H3) of this research.

These results are consistent with existing eye-tracking literature which finds weak to moderate relationships between attention measures and individual valuations. For instance, Meissner, Scholz and Decker (2010) also find a moderate correlation between attribute valuation and attention in a DCE using eye-tracking. In a subsequent study, Meissner, Musalem and Huber (2016) examine in an eye-tracking study the link between attention and attractiveness of alternatives and attributes. They find that higher valued alternatives attract more attention, while less valued alternatives attract less attention. They also find that the focus on higher utility alternatives increases as respondents go through the choices by distinguishing between the first six choice cards and the last six choice cards. With experience across tasks, respondents make faster decisions and attend to more important attributes and more attractive alternatives. Similarly, Van Loo, Grebitus and Verbeke (2020) also find that attributes that are attended more are more valued, but in the context of a DCE where only positive claims are included. Two other studies, Balcombe et al (2015) and Balcombe et al. (2017) find evidence of a relationship between dwell time and fixations on one hand, and attribute valuation on the other hand, but this relationship was found to be relatively weak.

A possible reason offered in the literature for why attention might be a weak signal for valuation is that higher levels of attention might signal unfamiliarity with the attribute or difficulties in processing the attribute information (Just and Carpenter, 1980; Kok and Jarodzka, 2017), while lower levels of attention might imply that the respondent is relatively acquainted with the attribute and therefore does not need to allocate as much attention as to another attribute (Fenko, Nicolaas and Galetzka, 2018; Van Loo, Nayga, Campbell, H.-S. S. Seo, *et al.*, 2018). Another possible reason might be that higher attention levels might be associated with higher motivation (Bialkova *et al.*, 2014). For instance, Pieters & Warlop (1999) find a relationship between a participant's level of motivation and their eye movements. Or it might be that the most valued attribute enters the decision-making process as a cut-off point or threshold after which the other attributes are given attention. This is in line with Laroche, Kim and Matsui (2003) who find that consumers tend to eliminate brands that fall short of a specific cut-off point on an important dimension.

The findings above give credit to the idea that in the context of nutritional label use, attention to a nutrient is a signal for how that nutrient is valued, however that signal is quite weak. It is also revealing that despite being the least valued of all nutrients, Sugar was the most attended nutrient. At the same time, Price was the least attended attribute. This signals that respondents are engaging with the Sugar information when using the TLS, however it might be that despite knowing that they should avoid it, they still choose sweet products. These findings are interesting in the context of the recently introduced UK legislation that aims to tax sugar-sweetened beverages as a way to promote healthier drink choices (Tiffin, Kehlbacher and Salois, 2015). For instance, there is evidence to show that despite a certain level of agreement with this policy, some members of the public believe that some amount of moderate sugar consumption is acceptable (Thomas-Meyer, Mytton and Adams, 2017). If consumers do not pay enough attention to Price, yet choose sugary products, the objectives of this policy might not be attained.

These findings might also moderate some of the implicit assumptions that people look more at things they value most. For instance, the findings in Section 9.3 above showed that Price is the least attended attribute of all the DCE attributes. One might be tempted to assume that this is because consumers care less about price when making their food purchases. However, the findings reported in this section show little support for this assumption.

9.5 Relationship between attention and heuristics use in colour-coded nutritional labelling

The previous section examined the link between attention to and valuation of nutrients. This section discusses the relationship between attention and heuristics in colour-coded nutritional labelling. The reader is reminded that Hypothesis 4 theorized that heuristics use is associated with lower levels of attention towards the DCE attributes while Hypothesis 5 stated that using ‘the cheapest basket’ as a heuristic is associated with higher attention on the Price attribute. To understand these relationships, Section 7.5 has analysed the links between mouse-tracking measures and the heuristics used in nutritional decision-making.

The results reported in Section 7.5 show that around half of the sample used heuristics when deciding between the baskets, while the other half used a combination of factors. The results also provide some degree of support for H4, indicating that there is a negative relationship between attention and whether a person has used a heuristic in their choices. Furthermore, a relationship is found between specific heuristics and specific patterns of attention, therefore partly confirming H5. Namely, there is a positive relationship between using the cheapest basket as a heuristic and the proportions of fixations on the Price attribute. However, the strength of the two relationships is quite low, illustrated by a low explanatory power of the two models.

This finding provides evidence that some consumers employ heuristics when using nutritional labels and that this is related to patterns of attention. This finding gives some level of support to heuristics models which emphasize the role that heuristics have in determining visual attention. For instance, Horstmann et al. (2009) find that when participants are asked to use more deliberate types of thinking they allocate higher number of fixations than in situations when they are asked to think more intuitively. This is confirmed by another study which finds that respondents allocate more attention when they are motivated to make an accurate decision. At the same time, the findings of this research contradict the study of Reisen et al. (2008) which found a weak relationship between the heuristic employed and attention patterns when respondents were asked to choose between four mobile phones.

These findings also corroborate evidence from a qualitative study by Gomez (2013) showing that consumers rely on simple shortcuts to process nutritional information. However, this research provides evidence that heuristics are used even in the context of colour-coded nutritional labelling, which is in itself a simplified form of nutritional information. This finding broadly supports evidence coming from the ecological rationality literature which claims that heuristics use in daily decisions is common because it allows individuals to arrive to quick decisions using minimal information. This literature claims that simple heuristics perform even better than more complex computational methods and algorithms and that they are adapted to the decision-making environment (Gigerenzer, Todd and ABC Research Group, 1999). Finding evidence that half of consumers use heuristics in the context of colour-coded nutritional labelling might therefore suggest that consumers have become familiar with the TLS and have come up with their own heuristics which use only part of the TLS information.

These findings have implications for the current literature on nutritional labelling. A frequent assumption is that 'more information is always better'. However, if the nutritional information is not attended, then more information might even be redundant: 'less is more'. Unlike the ecological rationality literature, this research does not examine how accurate the food choices made by respondents are, which means that no conclusions can be drawn as to how suitable these heuristics are to the decision-making environment. However, this research does provide some evidence that the use of heuristics can explain to a certain extent how consumers pay attention to different nutritional labels.

These findings need to be taken with caution. The possibility that the Hidden Treatment itself might have facilitated the use of heuristics cannot be ruled out. At the same time, it is important to acknowledge that in real-life shopping situations, food-related decisions are complex and rarely based on nutritional labelling information and price only. In many cases, the effect of nutritional labels can be hampered by the presence of other marketing-related factors (Cowburn, 2016). There is a large literature that has documented a range of contextual factors that influence food purchasing behaviours in grocery stores such as placement, atmospherics and promotions (Cohen and Babey, 2012; Wilson *et al.*, 2016). In real-life shopping situations, these factors might impact consumer behaviour more than nutritional information.

10 Summary discussion and conclusions

10.1 Summary of this thesis

Attention is a key resource in decision-making. While the economic literature has acknowledged that attention plays an important role in decision-making, it has only recently started to incorporate measures of attention into economic models. The choice modelling literature has been one of the first strands to incorporate proxies of attention into modelling estimates. Initially, this was done by asking respondents to state whether they ignored any attribute when making their choices. More recently, eye-tracking technologies have been brought into the field of discrete choice methods. This has enabled economists to bring more psychological realism to their choice models by incorporating measures such as fixations and dwell time on DCE attributes. It has also enabled economists to examine the extent to which eye-tracking technology could provide useful insights into the behaviour and decision-making of a DCE respondent. A related tool which has the potential to provide insights into DCE decision-making in a manner similar to eye-tracking is mouse-tracking technology. However, little is known about the insights that mouse-tracking could bring if implemented in a DCE context. More specifically, little is known in relation to the extent to which mouse-tracking tools such as Mouselab, which necessarily impose additional cognitive costs upon respondents by hiding the attribute information behind a box, could potentially alter participants' choices and their overall engagement with the survey.

Attention is also a key resource in decisions related to food and nutrition. Common assumptions that more nutritional information is always better do not always take into consideration the fact that human attention is often limited. While the labelling literature has made considerable progress in terms of how nutritional labels should be designed to capture consumer attention, little is known in relation to how much attention is allocated to the different nutrients described by the labels. Moreover, little is known about the links between attention to the different nutrients and how consumers value the nutrient information as well as about the link between attention to nutrients and the heuristics used in nutritional label use.

This study set out to address the methodological and nutritional gaps described above. More specifically, this study aimed to: i) examine the value of mouse-tracking as a source of individual-level data in stated preference research, ii) understand the impact of a cognitively costly survey on respondent engagement and iii) examine the role of attention in nutritional label use.

This thesis has reviewed the current literature in relation to the economics of attention, Discrete Choice Experiments, and the role of attention in nutritional label use. It has described the different ways in which economists have attempted to incorporate attentional constraints into economic modelling as well as the ways in which they have tried to measure this constraint by making use of stated, inferred, and revealed measures of attention. The model underpinning this research, the Rational Inattention Model, together with its applications and implications, has also been described. The review has highlighted that mouse-tracking measures of attention have been less used in the literature despite their alleged potential to uncover individual level data within economic experiments. Using Mouselab as a mouse-tracking tool provides a useful avenue to examine individual behaviours in a DCE but also to understand the impact of a cognitively costly survey on respondent engagement. The review has also highlighted that the link between attention and the use of nutritional labels is still poorly understood.

To examine the value of using mouse-tracking data in understanding individual behaviours within a DCE, a Discrete Choice Model was estimated using a Hierarchical Bayesian Logit. The WTP estimates derived from this model were used to examine whether the mouse-tracking tool used in this research radically interfered with participants' choices. Given the novelty of mouse-tracking data in a DCE context, several descriptive analyses of fixations, dwell time and attribute attendance as measured by Mouselab have been carried out. To understand the links between attention and nutritional label use, the relationship between mouse movements and the use of heuristics and the relationship between mouse movements and WTP estimates for the different nutrients were examined.

The data used in this thesis was obtained through primary data collection methods. An online survey consisting of a Discrete Choice Experiment with embedded mouse-tracking capability (MouselabWeb 2.0) was distributed to a consumer database. The DCE was designed around UK's Traffic Light System for food labelling which aims to inform food shoppers about the level of Salt, Sugar, Fat and Saturates contained in their foods. DCE participants were asked to choose between three food baskets described by the TLS nutrients and Price or to choose none of the baskets. The DCE was implemented in two different treatments. In the Hidden Treatment two out of the three baskets had the attribute level information hidden behind a box while the third basket which was always fixed was always visible. Participants were able to see the attribute information as long as their mouse cursor was hovered over the attribute box. This was to allow participants' mouse movements to be tracked. In the Open Treatment, all three baskets were visible, but participants' mouse movements were not tracked. Participants had to fill in the DCE in both treatments for the same choice cards, without knowing they were answering the same choices or that they were being mouse-tracked. The final sample used for this research was made of 244 consumers.

This research finds that gathering mouse-tracking data (with Mouselab) as part of a DCE does not appear to radically interfere with WTP estimates. This claim was supported at several levels. A first analysis found a relatively strong correlation between the individual WTP estimates in the Hidden (with mouse-tracking) and the individual WTP estimates in the Open Treatment (without mouse-tracking). A second analysis found that the predictive validity of a model incorporating both the Hidden and Open Treatment was improved when compared with the models incorporating the two treatments separately. Also, despite the DCE introducing a small cost to attending an attribute in the Hidden Treatment, only a quarter of respondents chose to ignore one or more attributes in at least half of the choice cards while an overwhelming majority of people (around 93%) attended the four nutrients across six or more choice cards. Mouse-tracking data also appears to be a promising tool to examine respondent behaviour within a DCE and to provide insights similar to eye-tracking data at lower costs for the researcher. However, tracking mouse movements with Mouselab involves using a survey design that is cognitively costly for respondents. This might make Mouselab a more useful tool for testing theories of attention and choice in contexts where information is costly. Given the relative ease of deriving non-attendance data, Mouselab could also be used during the piloting stage of a DCE to identify attributes that are irrelevant for respondents.

In the context of nutritional labelling, this research finds that people value more reductions in the levels of Salt and Saturates compared to reductions in Sugar and Fat, thereby confirming previous research (Balcombe, Fraser and Di Falco, 2010; Scarborough *et al.*, 2015). Contrary to these studies, this research finds that consumers value more having Green on Salt, Saturates and Sugar than avoiding Red. Moreover, when consumers see Salt and Saturates in the Open Treatment they tend to value them more compared to when they see them in Hidden Treatment. This finding suggests that these consumers are more interested to avoid Red on a nutrient than to have a balanced level of nutrients across their food choices. This finding might point to the fact that consumers might not be trading-off between nutrients. This research also finds mouse-tracked attention to be a weak signal for how highly a nutrient is valued, thus providing only weak evidence of Rational Inattention in the context of nutritional label use. It finds that there is some degree of correlation between a person's mouse movements and how much that person valued a nutrient, with dwell time measures showing more correlation than fixation measures. However, this relationship was found to be weak and only apply to Salt, Fat and Saturates when using dwell time measures. At the same time, a collective analysis of mouse movements and WTP estimates suggests that, whether an attribute was attended more than another did not mean that the attribute was more valued than other attributes. For instance, Sugar was the most attended nutrient, yet it was one of the least valued nutrients. A possible explanation would for this would be that although aware of the need to buy less sugary products, consumers still find it hard to give up on Sugar. This research also finds a positive relationship between attention to Price and having used the cheapest basket as a heuristic, although the strength of this relationship is also quite low.

10.2 Research contribution and policy implications

The present thesis provides one of the first empirical investigations into the impact of using mouse-tracking within a Discrete Choice Experiment. By collecting data in relation to participants' mouse movements within a DCE applied to nutritional labels, this thesis makes contributions to the choice modelling literature, the Rational Inattention literature, and the nutritional labelling literature.

10.2.1 Methodological contributions

This thesis makes first and foremost a methodological contribution to the choice modelling literature. Given the recent interest in incorporating more psychological realism into economic models and the availability of new tools that can collect innovative types of individual-level data, this thesis contributes to understanding the potential of mouse-tracking as one such tool in a DCE context. The finding that using Mouselab to collect participants' mouse movements within a DCE does not appear to radically change WTP estimates lays the groundwork for future DCEs which aim to use mouse-tracking to collect additional data. By examining the strengths and limitations of mouse-tracking in relation to eye-tracking, this thesis also enables future researchers to make an informed choice as to which tracking tool might be suitable for their research purposes. For example, mouse-tracking tools such as Mouselab might be favoured by researchers that seek to examine decision-making under cognitive constraints. Mouselab therefore holds potential to conduct empirical investigations into theories of attention, information acquisition and decision-making. For discrete choice modellers interested in gathering attendance data within the context of a DCE, the results of this research show that mouse-tracking data can be collected without significantly altering stated preferences. At a broader level, the findings of this research link to the wider literature which aims to incorporate innovative tools that can track measures of individual behaviour (Caplin *et al.*, 2016). The findings that mouse-tracked measures are a weak predictor of consumer preferences and heuristics use point to the limitations of these measures in explaining individual behaviour. These findings also suggest that tracking measures in general provide some insight into individual behaviours but that they should be treated with caution when inferring behaviours.

10.2.2 Contribution to the Rational Inattention field

By examining the relevance of Rational Inattention in a cognitively costly DCE, this thesis also makes a contribution to the ever-growing Rational Inattention literature. This analysis has been carried out at two levels. At one level, by examining the relationship between the level of attention towards a nutrient and how much that nutrient is valued, this thesis has found weak evidence of Rational Inattention. In other words, how much attention a nutrient receives is only weakly related to how much that nutrient is valued. At a second level, this thesis finds evidence of good respondent engagement with the survey, despite the DCE imposing a cognitively costly task. Given that respondents have carried out an arguably large burden in answering the experiment and did so without consequences or direct incentives, this might be interpreted as evidence that respondents were actually, in this particular context, *irrationally attentive*. This finding links to the wider literature that is concerned with whether surveys, particularly web-based ones, should be incentive-compatible or consequential (Carson and Groves, 2007; Haab *et al.*, 2013). This finding is therefore useful for the wider experimental literature as it shows that hypothetical and cognitively costly surveys can still elicit reasonable respondent engagement even in the absence of direct consequences or monetary incentives.

10.2.3 Contributions to the nutritional labelling literature and policy implications

This thesis also makes a contribution to the nutritional labelling literature. It confirms previous research findings in relation to how consumers value the information offered by UK's Traffic Light System for nutritional labelling. Namely, consumers appear to value more Salt and Saturates than Sugar and Fat. While past research has found that consumers tend to value more not having a food basket dominated by Red rather than having a basket dominated by Green (Balcombe, Fraser and Di Falco, 2010; Scarborough *et al.*, 2015), this research finds that consumers value more having Green than avoiding Red. This finding has potential implications for policy-makers. It appears to signal a positive change in consumer behaviour from simply avoiding harmful level of nutrients to seeking a healthy diet. The fact that consumers value more low levels of these nutrients in 2020 compared to five or ten years before potentially indicates that consumers have become more familiar with front-of-pack nutritional labels and their role in improving food purchasing decisions. This might also point to a shift in consumer's awareness and understanding of what constitutes a healthy lifestyle. The finding that consumers seem to pay more attention to Sugar compared to other nutrients as well as compared to Price, has potential implications for the effectiveness of the recently-introduced tax of sugar sweetened beverages in the UK(Briggs *et al.*, 2016; Schwendicke and Stolpe, 2017). If consumers do look at the sugar content of these beverages but less to their Price, then the objective of dissuading people to drink unhealthy beverages might not be attained.

The finding that individual attention is a weak signal for how highly a nutrient is valued also contributes to our understanding of the links between attention and nutritional label use. This finding suggests that other factors might play a more important role in how consumers value nutritional information, such as their overall attitudes, their familiarity with nutrients, or their level of education. This finding might be of interest to policy-makers and food industry stakeholders. The finding that there is a weak relationship between attention and consumer preferences for nutrients might also feed into future nutritional policy efforts. If the objective of these future policies is to enable healthier food choices, then attracting consumers' attention towards these nutrients will not necessarily make consumers value them more. The more generic finding that higher attention does not necessarily imply higher valuation might also be of interest to food marketers who might assume that attracting and maintaining customers' attention towards their product will necessarily make customers like those products more and potentially drive purchases. For instance, a common claim in marketing and visual merchandising is that 'eye level is buy level' which might suggest that where and for how long consumers look at something says something about their preferences or behaviour. The findings of this research point to the need to treat with caution any speculation about consumer behaviour based on consumers' eye movements.

This thesis also finds that a significant part of consumers employs heuristics when using nutritional labels and that this is weakly associated with their attention patterns. More specifically, consumers who use the cheapest basket as a heuristic to decide between different food baskets also appear to pay more attention to Price, although this relationship is weak. These findings provide policy makers with some degree of insight into how consumers use nutritional labels and might contribute to ongoing policy efforts at European level which are aimed at introducing an EU-wide colour-coded nutritional label. While colour-coded nutritional labels facilitate food decisions by making complex nutrient information more easily accessible, consumers appear to still be employing decision shortcuts or rules of thumb when making decisions based on these labels.

10.3 Limitations and future research directions

There are several limitations related to this research which might restrict the generalization of the findings. These limitations relate to the particular DCE design employed for this research, the use of mouse movements as a proxy for attention and the potential for hypothetical bias. These are further discussed below together with references to future research directions.

One source of weakness in this study is that the mouse-tracking data obtained from implementing the Hidden Treatment of the DCE are sensitive to the specificities imposed by using Mouselab. Mouselab can only track respondents' mouse movements if the attribute level information is hidden behind a box. Respondents can see the occluded information as long as their mouse cursor is hovered over it. The information is hidden again when the mouse cursor leaves the box. Given the need to hide the attribute information to track mouse movements, the Hidden Treatment involved hiding attribute information for two out of three choice alternatives (baskets). The decision not to hide the fixed alternative (Basket 1) was motivated by the need to make the task manageable for respondents. However, this meant that attention to Basket 1 was not mouse-tracked. This setup might have steered respondents towards inspecting and choosing more the occluded baskets. Future research might attempt to implement mouse-tracked DCEs where *all* choice alternatives are hidden and thereby *all* attribute information is mouse-tracked. It is reasonable to believe that this design might nevertheless impose significant cognitive challenges to respondents.

This thesis has also assumed that mouse movements are akin to eye movements, since the eye usually follows the movements of the mouse. However, there is a possibility that some respondents might have hovered their mouse randomly on the choice cards without actually paying attention to the attribute information. It might also be that for some respondents uncovering the attribute information was an enjoyable activity and thereby their mouse movements might not reflect their attention towards their attributes. However, the analyses in this thesis were based on relative measures of individual attention to ensure the robustness of these results to individuals who had higher attention overall compared to other individuals. Future research could shed light onto this issue by implementing a DCE where respondents are mouse-tracked and eye-tracked at the same time. However, even if mouse movements and eye movements were strongly correlated, just the fact that people have looked at something does not necessarily mean that they have processed it. Conducting a debriefing interview after a mouse-tracking experiment might provide useful insights into what respondents were thinking at the moment of the choice. Similarly, as suggested in section 8.4.2, think-aloud protocols might be used in the future to shed more light into the cognitive processes behind mouse movements by asking respondents to express their thoughts while undertaking a mouse-tracked DCE.

Another limitation is that the DCE employed in this research used predominantly colours to describe the attribute levels. The three TLS colours (Green, Amber and Red) described three of the attributes while the Price was described in text format. The findings of this thesis might therefore be sensitive to the simplicity of the colour information, which makes it relatively easy for respondents to quickly process the attribute levels. Future research could therefore examine the extent to which the finding that mouse-tracking does not drastically interfere with modelling estimates might hold under a different DCE design where the attributes are described using more complex information or a larger number of attributes.

This research was also based on a DCE designed around the UK's Traffic Light System for nutritional labelling. This policy requires food manufacturers to show the amount of Salt, Sugar, Fat and Saturates that each food product contains by assigning Green, Amber or Red to each of the nutrients. However, a limitation of this policy is that Saturates are a subset of Fat. This might have confused some respondents. However, the decision to still include Saturates in the survey design was based on the need to be reflective of UK's nutritional labelling policy which provides information on both nutrients.

This research also examined the relationship between one heuristic – cheapest basket – and attention patterns. While the relationship was found to be positive and statistically significant, the strength of the relationship was weak. Future research could further examine the links between other heuristics that have been documented in the literature and patterns of attention. For instance, future research could examine the link between choosing the basket with most Greens as a heuristics and attention towards the Green colour. In the context of nutritional labelling, these insights could deepen our understanding of how consumers use labels, while in the context of a DCE, these insights could contribute to our understanding of how respondents interact with survey instruments.

As with any stated preference research, hypothetical bias is a limitation for this research. One way in which the literature has suggested that hypothetical bias can be tackled is by using cheap talk scripts. Cheap talk scripts allow respondents to be more aware of their hypothetical bias and has been shown to improve the reliability of WTP estimates (Tonsor and Shupp, 2011). Future research could therefore conduct a mouse-tracked experiment where respondents are made aware of their hypothetical bias.

11 References

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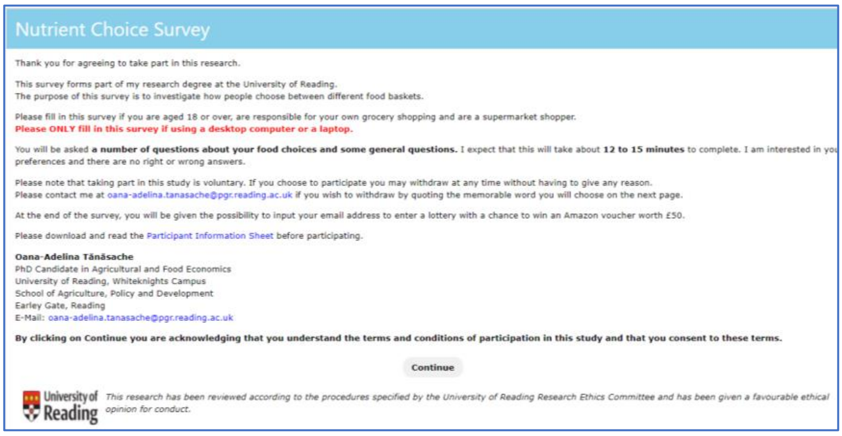
12 Appendices

12.1 Appendix A. The survey with DCE and mouse-tracking (set 1A)


Nutrient Choice Survey

Thank you for agreeing to take part in this research.

This survey forms part of my research degree at the University of Reading.
The purpose of this survey is to investigate how people choose between different food baskets.

Please fill in this survey if you are aged 18 or over, are responsible for your own grocery shopping and are a supermarket shopper.
Please ONLY fill in this survey if using a desktop computer or a laptop.

You will be asked **a number of questions about your food choices and some general questions.** I expect that this will take about **12 to 15 minutes** to complete. I am interested in you preferences and there are no right or wrong answers.

Please note that taking part in this study is voluntary. If you choose to participate you may withdraw at any time without having to give any reason.
Please contact me at oana-adelina.tanasache@pgr.reading.ac.uk if you wish to withdraw by quoting the memorable word you will choose on the next page.

At the end of the survey, you will be given the possibility to input your email address to enter a lottery with a chance to win an Amazon voucher worth £50.

Please download and read the Participant Information Sheet before participating.

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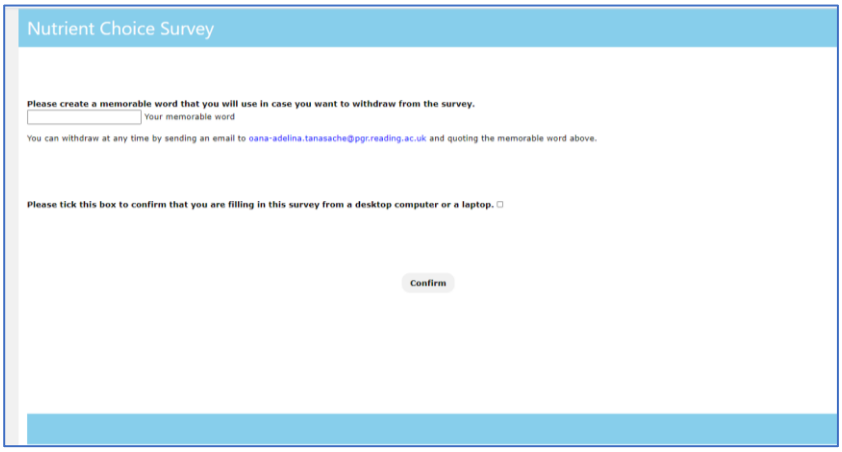
E-Mail: oana-adelina.tanasache@pgr.reading.ac.uk

By clicking on Continue you are acknowledging that you understand the terms and conditions of participation in this study and that you consent to these terms.

Continue

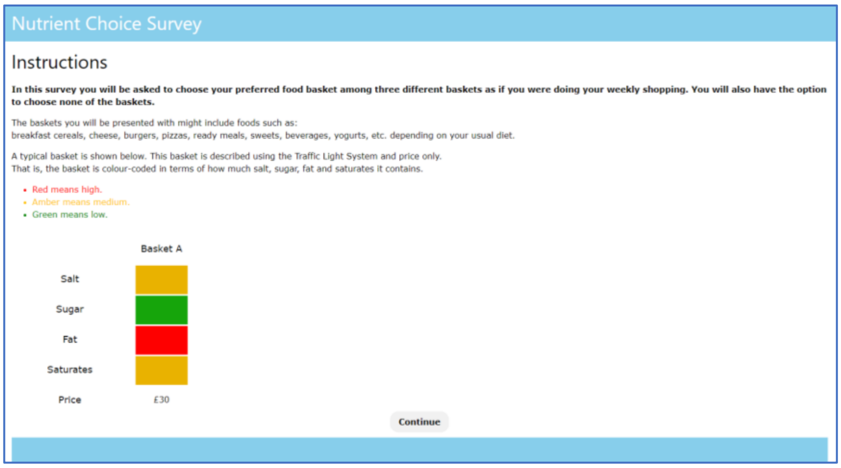
University of Reading *This research has been reviewed according to the procedures specified by the University of Reading Research Ethics Committee and has been given a favourable ethical opinion for conduct.*


Nutrient Choice Survey

Please create a memorable word that you will use in case you want to withdraw from the survey.
Your memorable word
You can withdraw at any time by sending an email to oana-adelina.tanasache@pgr.reading.ac.uk and quoting the memorable word above.

Please tick this box to confirm that you are filling in this survey from a desktop computer or a laptop. ☐

Confirm


Nutrient Choice Survey

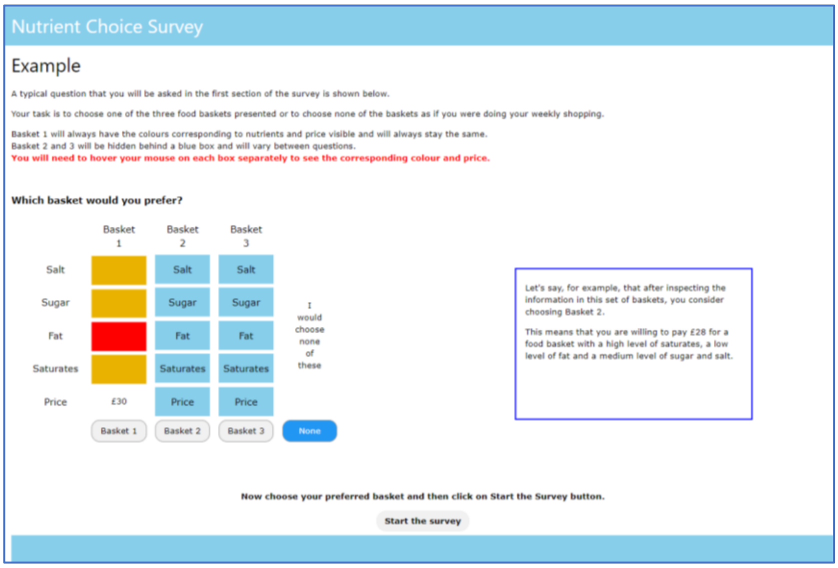
Instructions

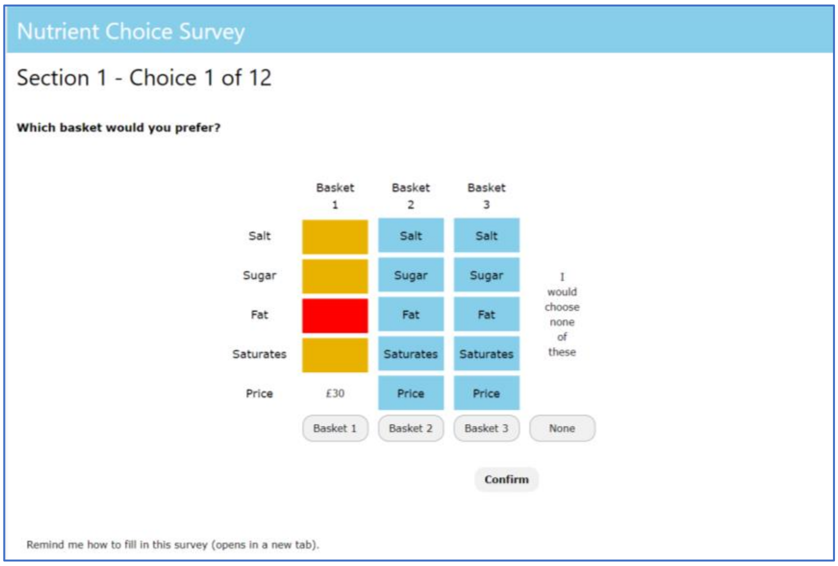
In this survey you will be asked to choose your preferred food basket among three different baskets as if you were doing your weekly shopping. You will also have the option to choose none of the baskets.

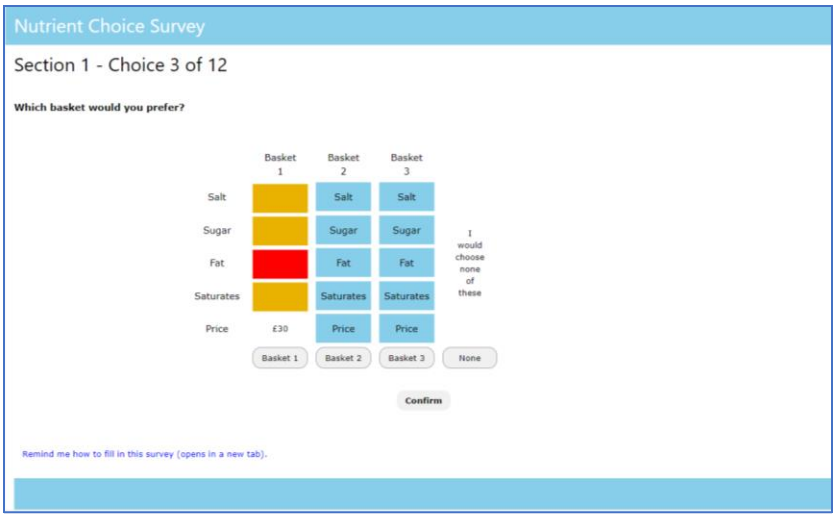
The baskets you will be presented with might include foods such as:
breakfast cereals, cheese, burgers, pizzas, ready meals, sweets, beverages, yogurts, etc. depending on your usual diet.

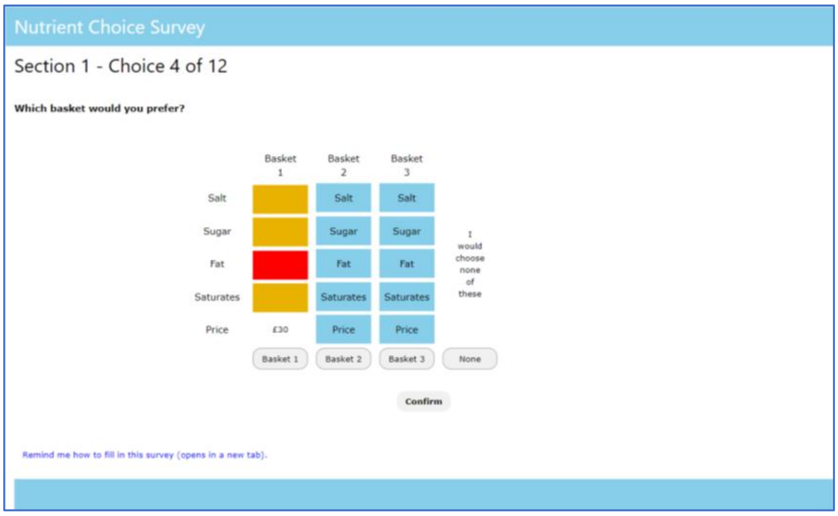
A typical basket is shown below. This basket is described using the Traffic Light System and price only.
That is, the basket is colour-coded in terms of how much salt, sugar, fat and saturates it contains.

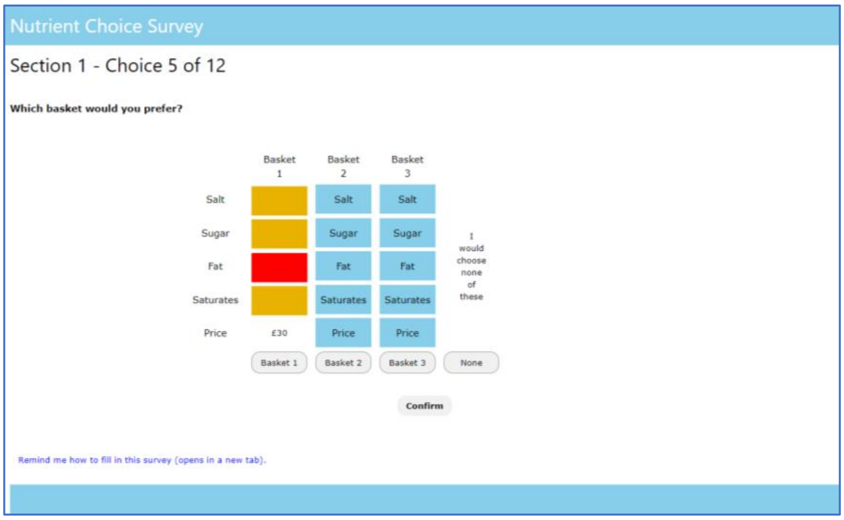
- Red means high.
- Amber means medium.
- Green means low.

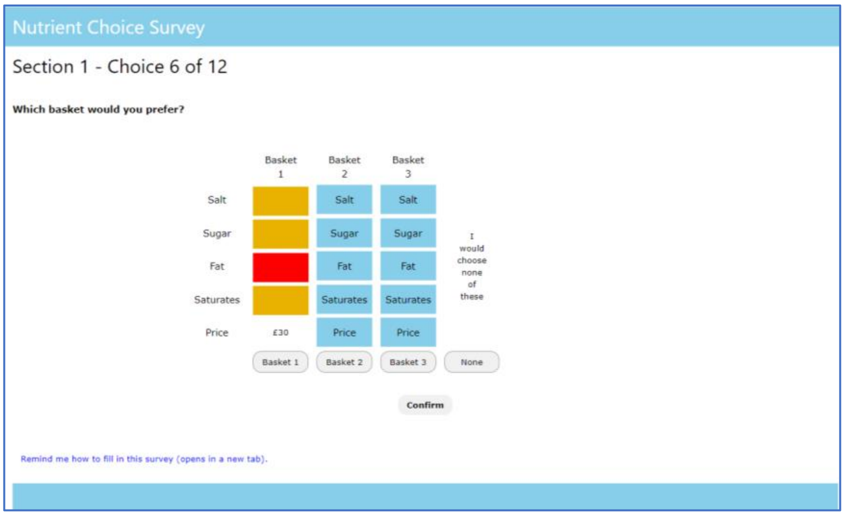

Nutrient Choice Survey
Example
A typical question that you will be asked in the first section of the survey is shown below.
Your task is to choose one of the three food baskets presented or to choose none of the baskets as if you were doing your weekly shopping.
Basket 1 will always have the colours corresponding to nutrients and price visible and will always stay the same.
Basket 2 and 3 will be hidden behind a blue box and will vary between questions.
You will need to hover your mouse on each box separately to see the corresponding colour and price.
Which basket would you prefer?
Basket 1
Basket 2
Basket 3
Salt
Sugar
Fat
Saturates
Price
£30
I would choose none of these
Basket 1
Basket 2
Basket 3
None
Let's say, for example, that after inspecting the information in this set of baskets, you consider choosing Basket 2.
This means that you are willing to pay £28 for a food basket with a high level of saturates, a low level of fat and a medium level of sugar and salt.
Now choose your preferred basket and then click on Start the Survey button.
Start the survey


Nutrient Choice Survey
Section 1 - Choice 1 of 12
Which basket would you prefer?
Basket 1
Basket 2
Basket 3
Salt
Sugar
Fat
Saturates
Price
£30
I would choose none of these
Basket 1
Basket 2
Basket 3
None
Confirm
Remind me how to fill in this survey (opens in a new tab).


Nutrient Choice Survey
Section 1 - Choice 3 of 12
Which basket would you prefer?
Basket 1
Basket 2
Basket 3
Salt
Sugar
Fat
Saturates
Price
£30
I would choose none of these
Basket 1
Basket 2
Basket 3
None
Confirm
Remind me how to fill in this survey (opens in a new tab).


Nutrient Choice Survey
Section 1 - Choice 4 of 12
Which basket would you prefer?
Basket 1
Basket 2
Basket 3
Salt
Sugar
Fat
Saturates
Price
£30
I would choose none of these
Basket 1
Basket 2
Basket 3
None
Confirm
Remind me how to fill in this survey (opens in a new tab).


Nutrient Choice Survey
Section 1 - Choice 5 of 12
Which basket would you prefer?
Basket 1
Basket 2
Basket 3
Salt
Sugar
Fat
Saturates
Price
£30
I would choose none of these
Basket 1
Basket 2
Basket 3
None
Confirm
Remind me how to fill in this survey (opens in a new tab).


Nutrient Choice Survey
Section 1 - Choice 6 of 12
Which basket would you prefer?
Basket 1
Basket 2
Basket 3
Salt
Sugar
Fat
Saturates
Price
£30
I would choose none of these
Basket 1
Basket 2
Basket 3
None
Confirm
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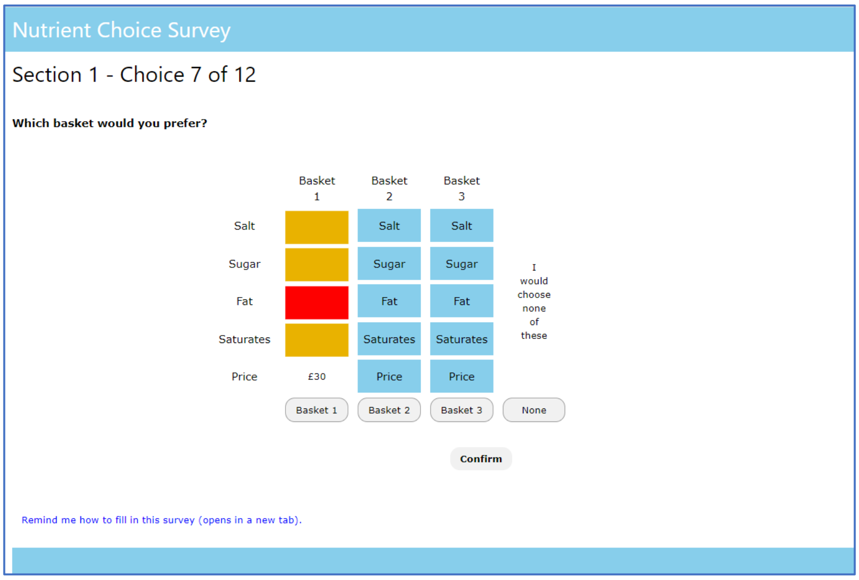
Nutrient Choice Survey
Section 1 - Choice 7 of 12
Which basket would you prefer?
Basket 1
Basket 2
Basket 3
Salt
Sugar
Fat
Saturates
Price
£30
I would choose none of these
Basket 1
Basket 2
Basket 3
None
Confirm
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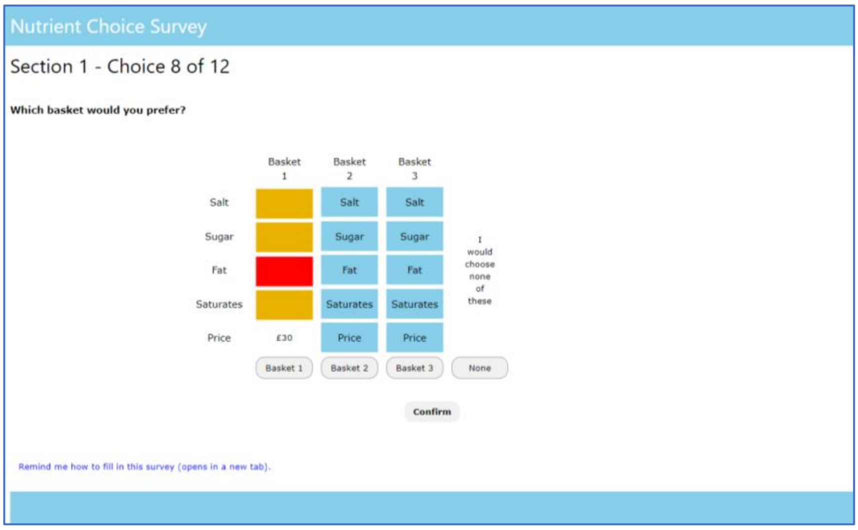
Nutrient Choice Survey
Section 1 - Choice 8 of 12
Which basket would you prefer?
Basket 1
Basket 2
Basket 3
Salt
Sugar
Fat
Saturates
Price
£30
I would choose none of these
Basket 1
Basket 2
Basket 3
None
Confirm
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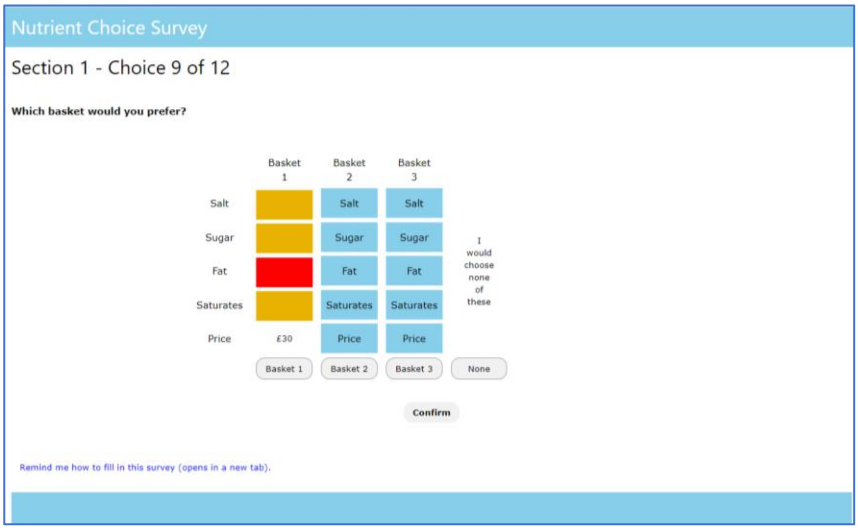
Nutrient Choice Survey
Section 1 - Choice 9 of 12
Which basket would you prefer?
Basket 1
Basket 2
Basket 3
Salt
Sugar
Fat
Saturates
Price
£30
I would choose none of these
Basket 1
Basket 2
Basket 3
None
Confirm
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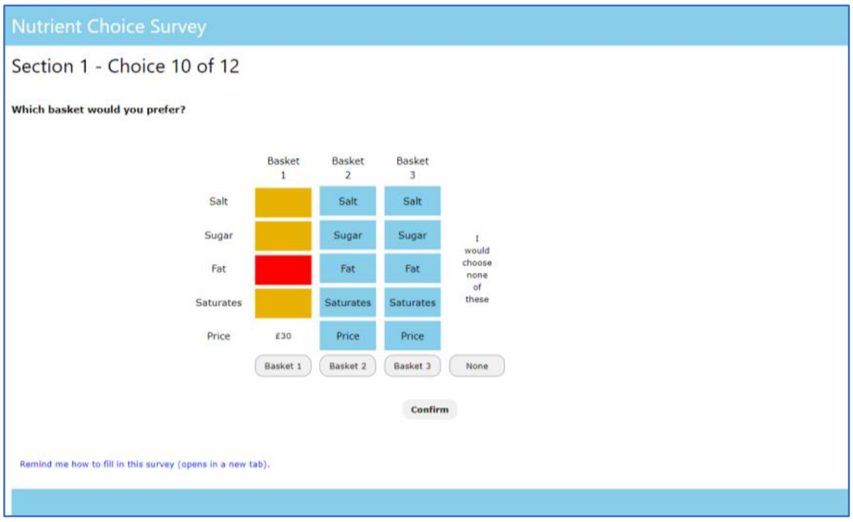
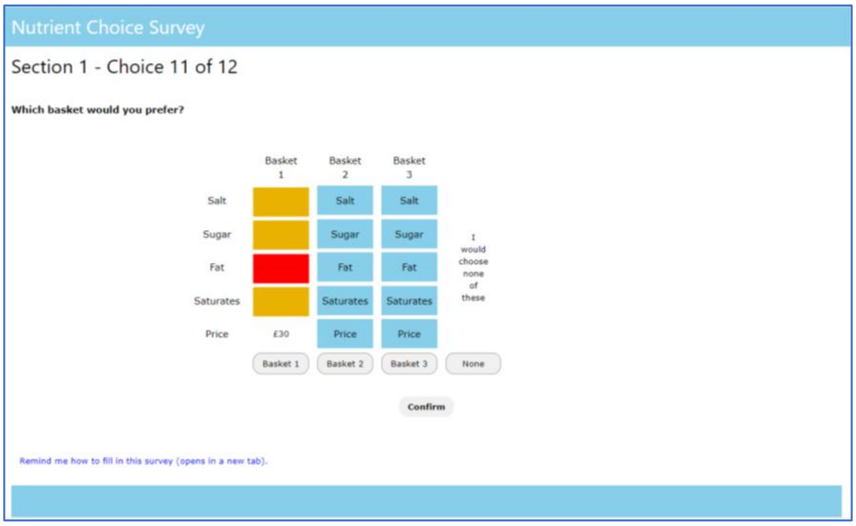
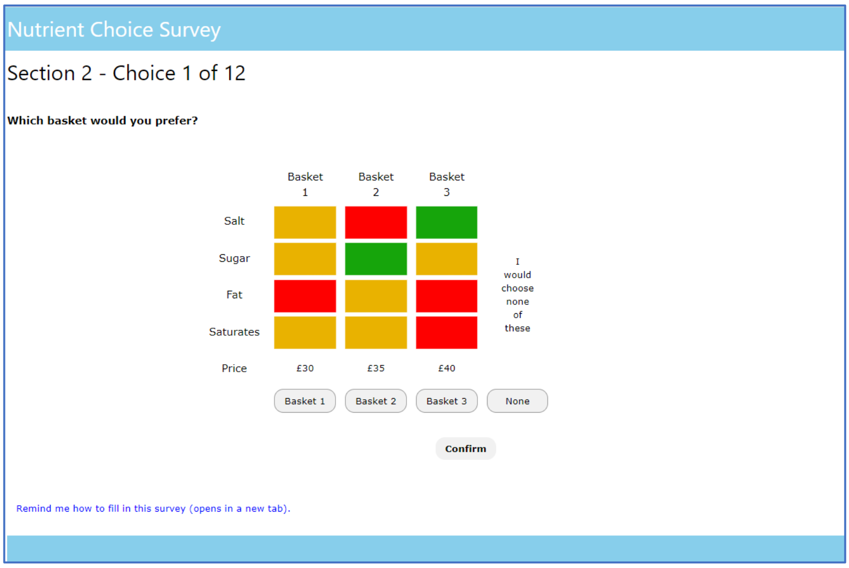
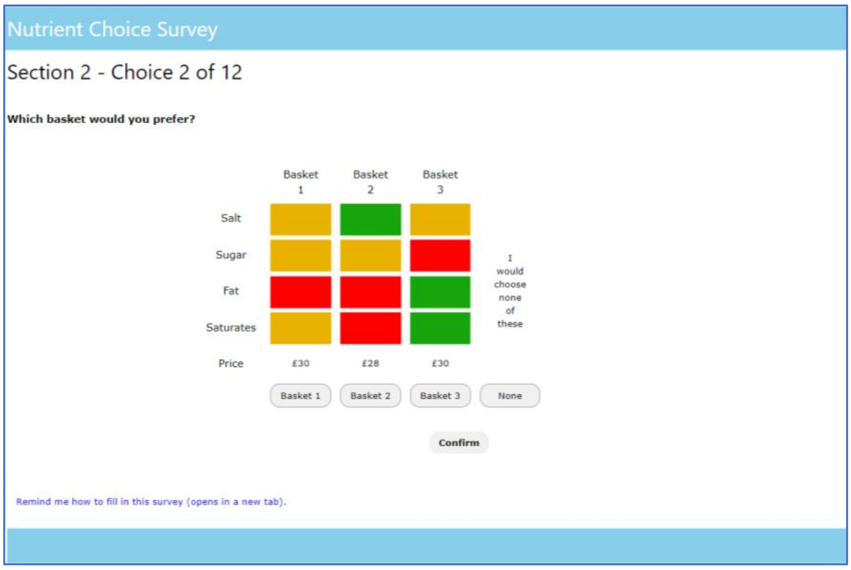

Nutrient Choice Survey
Section 1 - Choice 10 of 12
Which basket would you prefer?
Basket 1
Basket 2
Basket 3
Salt
Sugar
Fat
Saturates
Price
£30
I would choose none of these
Basket 1
Basket 2
Basket 3
None
Confirm
Remind me how to fill in this survey (opens in a new tab).

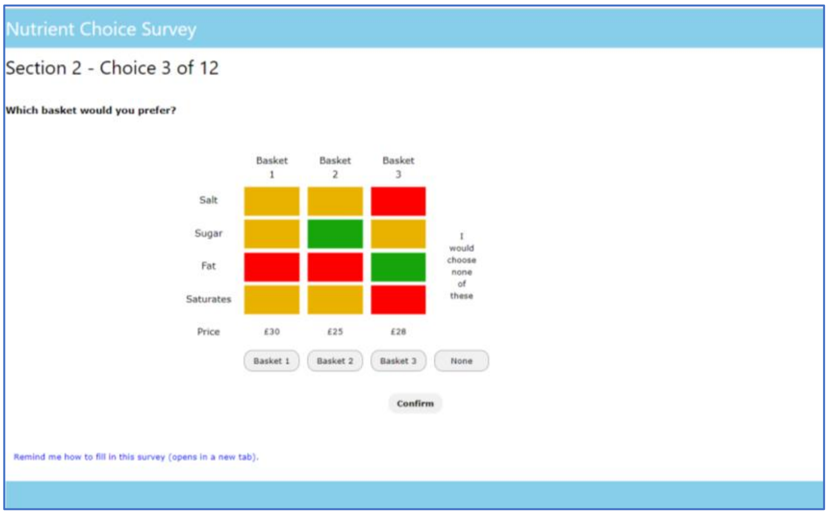

Nutrient Choice Survey
Section 1 - Choice 11 of 12
Which basket would you prefer?
Basket 1
Basket 2
Basket 3
Salt
Sugar
Fat
Saturates
Price
£30
I would choose none of these
Basket 1
Basket 2
Basket 3
None
Confirm
Remind me how to fill in this survey (opens in a new tab).


Nutrient Choice Survey
Section 1 - Choice 12 of 12
Which basket would you prefer?
Basket 1
Basket 2
Basket 3
Salt
Sugar
Fat
Saturates
Price
£30
I would choose none of these
Basket 1
Basket 2
Basket 3
None
Confirm
Remind me how to fill in this survey (opens in a new tab).


Nutrient Choice Survey
Now we would like to ask you 12 more questions concerning food choice.
In this section all nutrients will be visible. You will therefore not have to hover your mouse anymore to see the price or the amount of salt, sugar, fat and saturates each basket contains.
Click on the button below to continue this survey.
Continue survey


Nutrient Choice Survey
Section 2 - Choice 1 of 12
Which basket would you prefer?
Basket 1
Basket 2
Basket 3
Salt
Sugar
Fat
Saturates
Price
£30
£35
£40
I would choose none of these
Basket 1
Basket 2
Basket 3
None
Confirm
Remind me how to fill in this survey (opens in a new tab).


Nutrient Choice Survey
Section 2 - Choice 2 of 12
Which basket would you prefer?
Basket 1
Basket 2
Basket 3
Salt
Sugar
Fat
Saturates
Price
£30
£28
£30
I would choose none of these
Basket 1
Basket 2
Basket 3
None
Confirm
Remind me how to fill in this survey (opens in a new tab).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Basket 2
Basket 3
Salt
Sugar
Fat
Saturates
Price
£30
£25
£28
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Basket 3
None
Confirm
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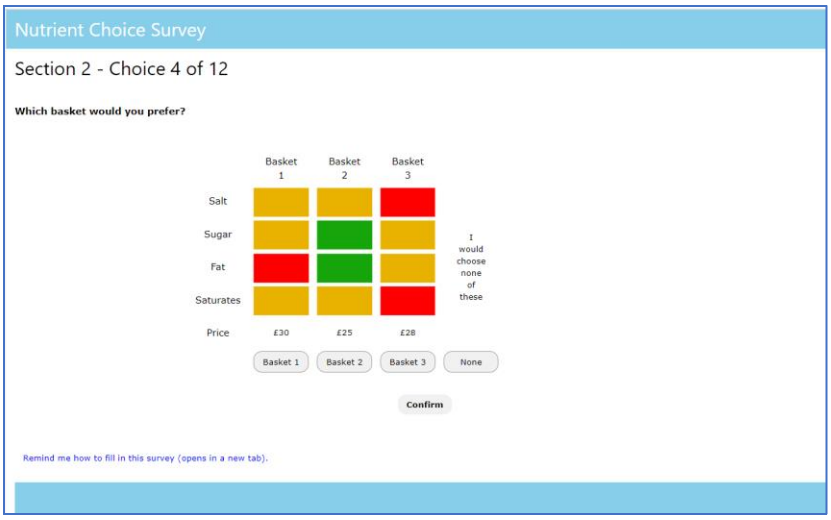
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Sugar
Fat
Saturates
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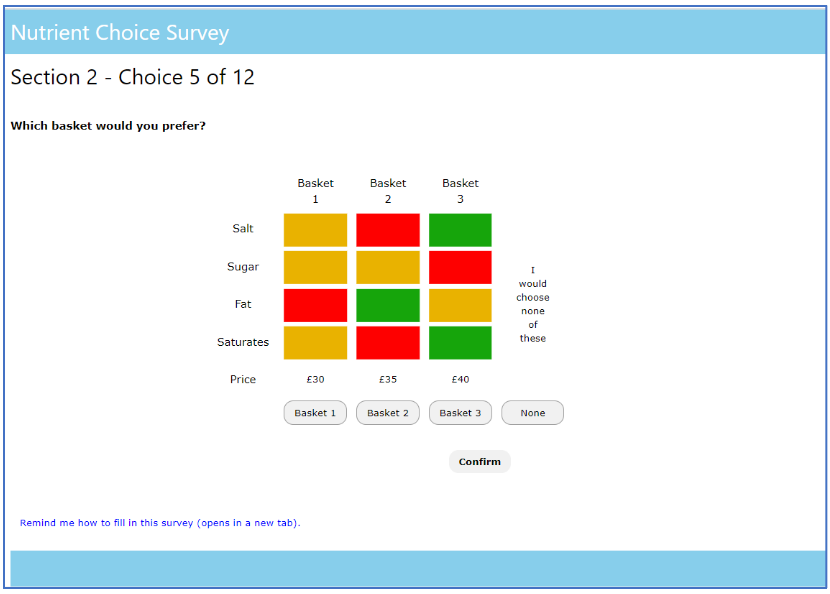
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None
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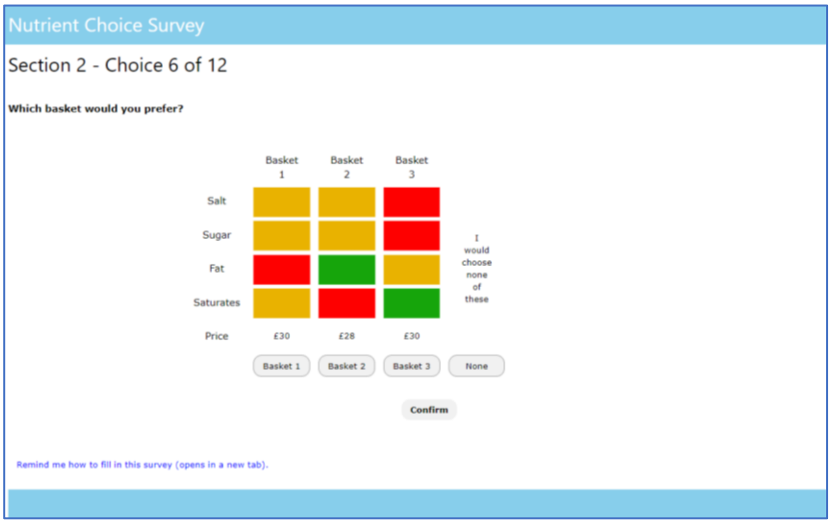
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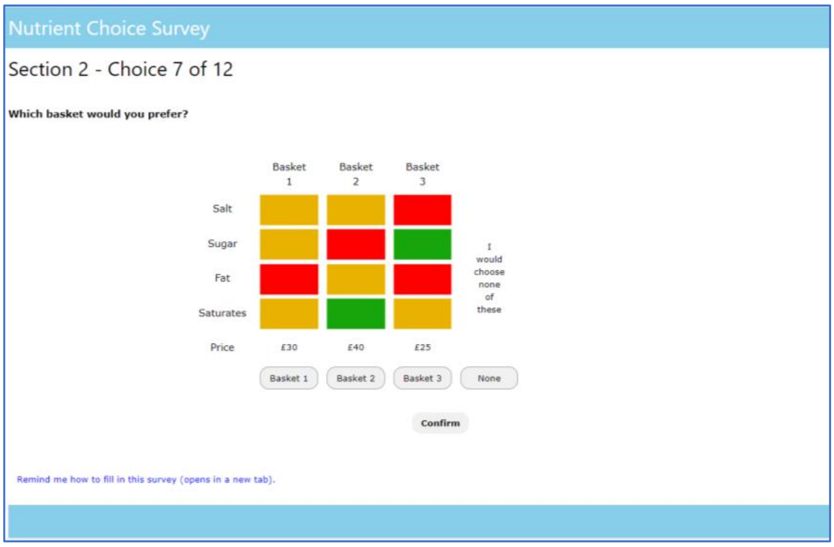
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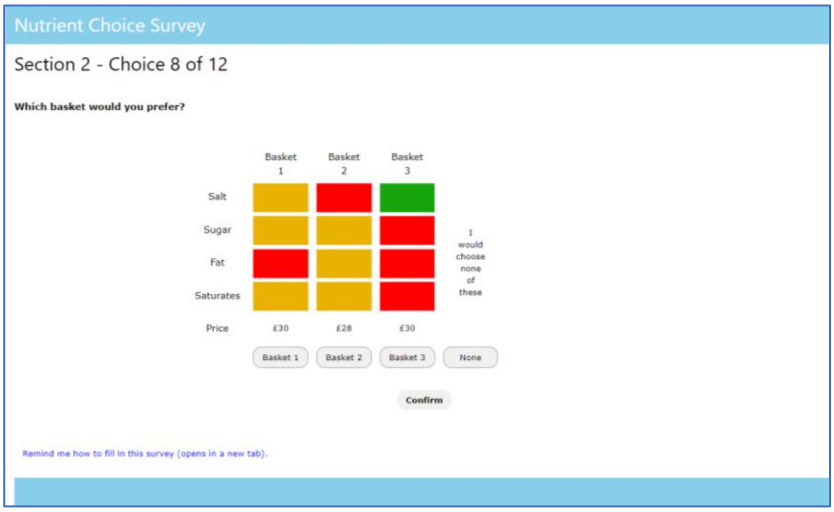
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£30
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Basket 3
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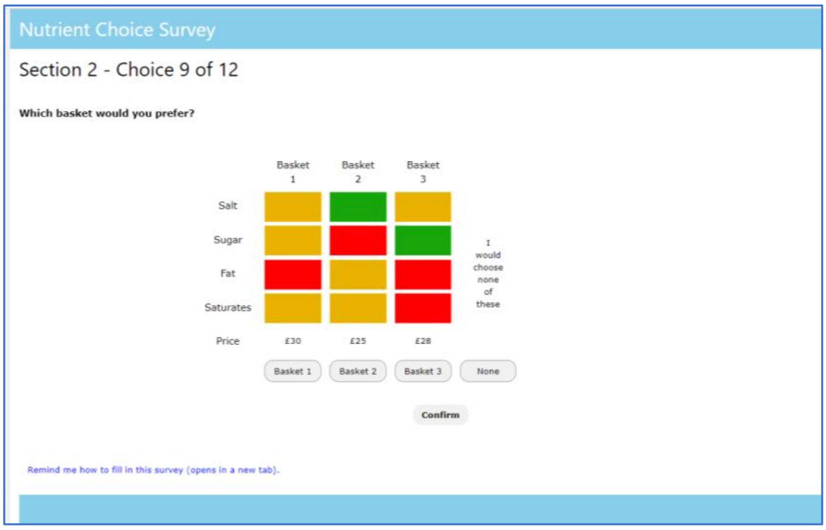
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Saturates
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Basket 3
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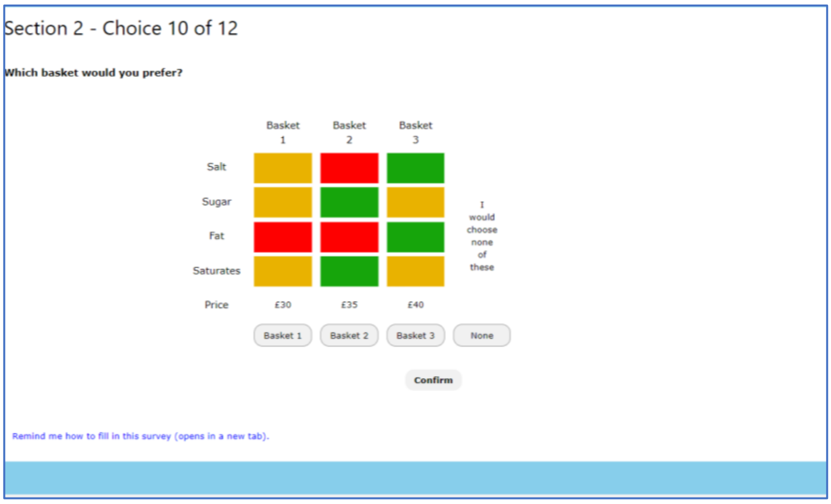
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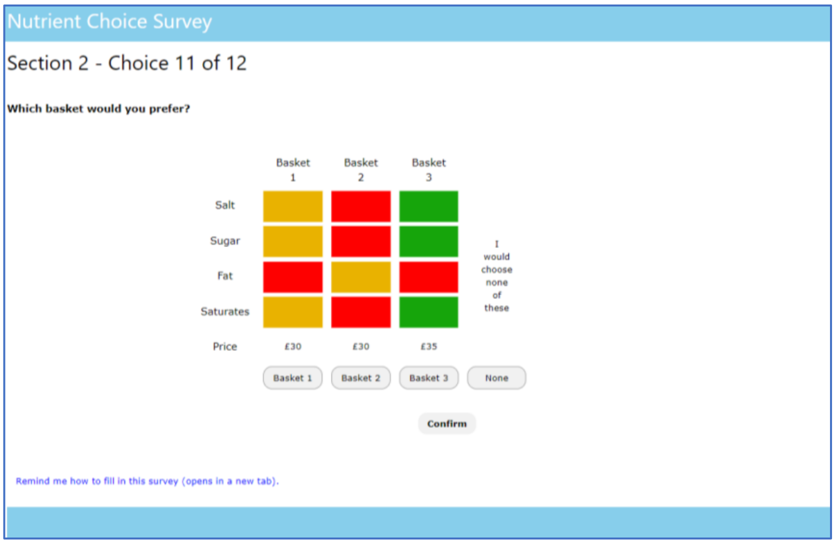
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Basket 2
Basket 3
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Sugar
Fat
Saturates
Price
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£30
£35
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Basket 2
Basket 3
None
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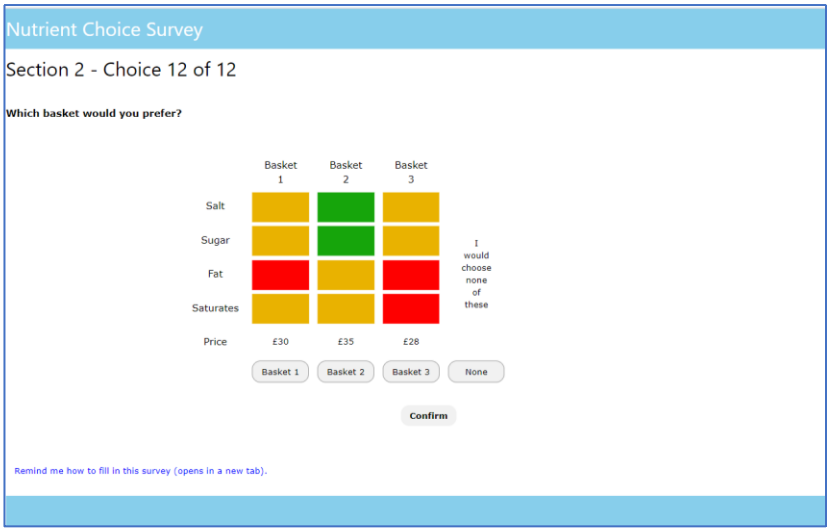


Nutrient Choice Survey

Final Questions

When choosing among the three baskets in the hidden box section, which attribute(s) have you ignored? Choose all that apply.

- ☐ Salt
- ☐ Sugar
- ☐ Fat
- ☐ Saturates
- ☐ Price
- ☐ I haven't ignored any attribute.

When choosing among the three baskets in the open box section, which attribute(s) have you ignored? Choose all that apply.

- ☐ Salt
- ☐ Sugar
- ☐ Fat
- ☐ Saturates
- ☐ Price
- ☐ I haven't ignored any attribute.

Which of the following best describes how you chose between the three baskets?

- ○ I chose the basket with least reds.
- ○ I chose the basket with most greens.
- ○ I chose the basket which had green on my most important nutrient.
- ○ I chose the cheapest basket.
- ○ I based my decision on a combination of factors.
- ○ I based my decision on another factor: ____
- ○ I haven't based my decision on any factor.

How difficult did you find the hidden box section compared to the open box section?

- ○ Easier
- ○ The same
- ○ More difficult
- ○ Much more difficult

In general, how would you assess your computer skills (e.g. Internet search, word processing, email, video games, etc) ?

- ○ Very poor
- ○ Poor
- ○ Moderate
- ○ Good
- ○ Very good

When shopping for food in a supermarket, how much would you agree with the following statements?

It is important to me that the food I shop on a typical day:

Is easy to prepare

○ Strongly disagree ○ Disagree ○ Neither agree nor disagree ○ Agree ○ Strongly agree

Is low in sugar

○ Strongly disagree ○ Disagree ○ Neither agree nor disagree ○ Agree ○ Strongly agree

Is low in calories

○ Strongly disagree ○ Disagree ○ Neither agree nor disagree ○ Agree ○ Strongly agree

Is cheap

○ Strongly disagree ○ Disagree ○ Neither agree nor disagree ○ Agree ○ Strongly agree

Is low in fat

○ Strongly disagree ○ Disagree ○ Neither agree nor disagree ○ Agree ○ Strongly agree

Is high in fibre

○ Strongly disagree ○ Disagree ○ Neither agree nor disagree ○ Agree ○ Strongly agree

Is nutritious

○ Strongly disagree ○ Disagree ○ Neither agree nor disagree ○ Agree ○ Strongly agree

Is low in salt

○ Strongly disagree ○ Disagree ○ Neither agree nor disagree ○ Agree ○ Strongly agree

Helps me control my weight

○ Strongly disagree ○ Disagree ○ Neither agree nor disagree ○ Agree ○ Strongly agree

Contains a lot of vitamins and minerals

○ Strongly disagree ○ Disagree ○ Neither agree nor disagree ○ Agree ○ Strongly agree

Is high in protein

○ Strongly disagree ○ Disagree ○ Neither agree nor disagree ○ Agree ○ Strongly agree

Keeps me healthy

○ Strongly disagree ○ Disagree ○ Neither agree nor disagree ○ Agree ○ Strongly agree

Is low in saturated fat

○ Strongly disagree ○ Disagree ○ Neither agree nor disagree ○ Agree ○ Strongly agree

How familiar are you with the current Traffic Light System (colour-coding) of labelling pre-packaged foods and drinks in the UK?

○ Not at all familiar
○ Slightly familiar
○ Moderately familiar
○ Extremely familiar

How often do you use the information offered by the Traffic Light System when you're shopping for food?

○ Never
○ Almost never
○ Sometimes
○ Almost every time
○ Every time

For which products are you most likely to use the Traffic Light System? Choose all that apply

☐ Ready meals
☐ Pizzas, burgers and sandwiches
☐ Breakfast cereals
☐ Beverages & yogurts
☐ Processed meats and cheese
☐ Sweets & crisps
☐ Other products
☐ I never use the Traffic Light System.

What is your annual household income (before deductions and tax)?

○ Less than £14,000
○ £14,000- £24,999
○ £25,000- £34,999
○ £35,000- £44,999
○ £45,000- £54,999
○ £55,000- £64,999
○ £65,000 - £79,999
○ Over £80,000
○ Rather not say

What is your highest level of education?

○ Secondary school
○ College/Vocational training
○ Undergraduate degree
○ Postgraduate degree
○ Rather not say

How old are you?

○ 18-24
○ 25-34
○ 35-44
○ 45-54
○ 55-64
○ 65-74
○ Over 75
○ Rather not say

What is your gender?

○ Male
○ Female
○ Other
○ Rather not say

Please input your email address if you would like to enter a lottery for a chance to win an Amazon voucher worth £50.

We will not use your email address for any other purposes than to send your voucher in case you have won.

○ I wish to take part in the lottery and here is my email address: ____________
○ I do not wish to take part in the lottery.

12.2 Appendix B. Ethical Clearance for online survey

School of Agriculture, Policy and Development

ETHICAL CLEARANCE GRANTED

Form 2. MSc PhD Staff Ethical Clearance Submission Form

PLEASE allow a minimum of 3 weeks for this process.

You must not begin your research until you have obtained consent as evidenced by this form returned from the APD student Office signed and dated. Ethical Clearance cannot be granted retrospectively.

This form can only be used if the application :

- Does not involve participants who are patients or clients of the health or social services
- Does not involve participants whose capacity to give free and informed consent may be impaired within the meaning of the Mental Capacity Act 2005
- Does not involve patients who are 'vulnerable'
- Does not involve any element of risk to the researchers or participants
- Does not involve any participants who have a special relationship to the researchers/investigators

If any of the above apply, please refer to the APD Ethics Chair to decide whether an application can be made through the APD review process or whether the application needs to be referred to the full University Committee.

It is the applicant's responsibility to check for any particular requirements of a funder regarding ethical review. Some funders may require that the application is reviewed by full University Committee and not the devolved School committee.

Full details of the University Research Ethics procedures are available at http://www.reading.ac.uk/internal/res/ResearchEthics/reas-REethicshomepage.aspx and you are encouraged to access these pages for a fuller understanding. Some helpful advice is available on this link http://www.reading.ac.uk/internal/res/ResearchEthics/reas-REwhatdoIneedtodo.aspx and the FAQs are particularly relevant.

ALL QUESTIONS MUST BE COMPLETED.

APD Ethical Clearance Application Reference Number : 001181

1. APPLICANT DETAILS:

Main applicant name: Oana-Adelina Tanasache

Name of academic supervisor/project investigator: Ariane Kehlbacher

Email Address (decision will be emailed here): oana-

MSc Student ☐ PhD Student

☒ Staff Member ☐

Other (please specify) Click here to enter text.

2. PROJECT DETAILS:

Title of project: Examining Attention in Food Choice: What Can Mouse Movements Tell Us About

Consumer Decision-Making?

Please provide a lay summary of the project, including what is being investigated and why: The purpose of this survey is to investigate consumer attention towards Traffic Light System nutrients such as salt, sugar and fat, and to examine the extent to which this attention plays a role in food shopping decisions. This research will contribute to current understanding into the links between attention and choice and attention and heuristics while also providing further insight into how consumers process nutritional information.

Procedure. Please outline the project's research protocol (what procedures, research methods and analysis methods are being used) : This research is based on an online survey which includes a choice experiment based on the Traffic Light System. Consumers are presented with different choices of food baskets which are described in terms of their price and in terms of UK's Traffic Light System (red, amber or green depending on the level of the nutrient contained). In addition to gathering data about respondents' basket choices, this survey will collect information on mouse movements with the help of MouselabWeb 2.0. MouselabWeb 2.0 allows to track the nutrients consumers have looked at, the time they have spent on inspecting each nutrient and the order in which they have been inspected as well as their preferred food basket. The data will be analysed using econometrical methods.

Period over which the data collection is to be undertaken (note: data collection CANNOT commence until ethical approval has been granted as evidenced by this form signed and returned).

Proposed Start Date: 10/02/2020

Proposed End Date: 10/05/2020

3. THE RESEARCH:

a) Nature and number of participants who are expected to take part in your survey/focus group. Please estimate if uncertain. As ethical clearance involving minors is more complex because of safeguarding and consent issues, please consider carefully whether you need to involve minors under the age of 16 in your research.

Participants	Number participating
Minors under 16 years of age	0
Students	0
Other members of the University	0
Members of the general public	200
Businesses	Click here to enter text.
Government officials	Click here to enter text.
Other *If other please specify:*	Click here to enter text.

b) Funding. Is the research supported by funding from a research council or other external sources for example a charity or business?

Yes ☐ If yes, please specify funder : Click here to enter text.

No ☒

If yes, it is the responsibility of the applicant to check for any particular requirements of the funder regarding ethical review. Some funders may require that the application is reviewed by full University Committee and not the devolved School committee.

c) **Recruitment.** Please describe recruitment procedures. How have participants been selected? Are there any inclusion/exclusion criteria? Participants must be told on the Participant Information Sheet how and why they have been selected. You should attach ay recruitment materials to this application. I will be selecting participants by sending the suvey link to a consumer database. The consumer database is owned
and managed by Sensory Dimensions, a market research company. If the target of 200 consumers is not
met, I will be emailing my friends and work colleagues and send the survey link via social media. Only people aged 18 or over are eligible to take part, as long as they live in the UK, are responsible for their own grocery shopping and are frequent supermarket shoppers.

d) **Exceptions.** Does the research involve minors, medical patients, individuals with learning difficulties, vulnerable adults, participants recruited through social service departments, or anyone in a special relationship with yourself/data collectors? E.g. Supervisor; lecturer to a group of students; or person in a position of responsibility for participants.

Yes ☐

No ☒

If yes, this may result in referral to the University Research Ethics Committee (please note their deadlines). Please provide extra detail here: Click here to enter text.

e) **Where is the data collection to be undertaken?** Specify country(ies) and specific location(s) The data will be collected in the UK.

f) What forms of data collection does the research involve?

Group discussion/ workshop ☐ Personal interviews ☐

Telephone interviews ☐ Questionnaire/paper survey ☐

Postal survey ☐ Email/ online survey ☒

Which software tool will be used, if any? Simple HTML webpage and MouselabWeb 2.0

Other *(specify)*: Click here to enter text.

g) Who will undertake the collection and/or analysis of data?

Myself ☒ Other MSc students

☐ Other Higher degree students ☐ Other contract research and/or academic staff ☐ Individuals outside University ☐ External organisations ☐

If individuals outside the University and/or external organisations are involved in the collection or analysis of data, give brief details below. Indicate how the ethical procedures and standards of the University will be satisfied: The survey link will be sent to a market research company that manages a customer database of 11,000 consumer. The company will not be involved in any way in the data collection process as they will only send the link to their customer database. The company will not have access to the data that is collected during this research.

h) Does the research require participants to consume any food products?

No ☒

Yes ☐

If yes, please provide full details and indicate measures in place to ensure excellent food hygiene standards and ensure participant safety. Click here to enter text.

i) Do you consider there are any potential ethical issues in this project? Does the research require collection of information that might be considered sensitive in terms of confidentiality, potential to cause personal upset, etc.?

No ☒

Yes ☐

If yes, please provide full details and indicate how these issues will be addressed, how researchers will manage participant reaction. Support and de-brief sheets should be attached if relevant. Click here to enter text.

j) Will the research involve any element of intentional deception at any stage? (i.e. providing false or misleading information about the study, or omitting information)?

No ☒

Yes ☐

If yes, this must be justified here. You should also consider including debriefing materials for participants which outline the nature and justification of the deception used. Click here to enter text.

k) Are participants offered a guarantee of anonymity and/or that the information they supply will remain confidential?

Yes ☒

No ☐

If yes, give brief details of the procedures to be used to ensure this and particularly if the data has 'linked'

or 'keyed' anonymity (eg. where published results are anonymous but participant details are recorded and held separately to the responses but keyed with reference number) : At the end of the survey, participants will be asked to provide their e-mail address if they wish so so that they can be sent an Amazon voucher in case they have won the lottery. They will only receive an e-mail if they have won. I will not use their email address for any other purpose than to get in contact with them in case they have won. The email address will not be linked in relation to their survey answers, will not be used to identify the person and will be removed after the voucher has been sent to the winners. In addition to this data, the survey software will automatically collect participants' I.P. address. I will not use their I.P. address to locate participants or identify them or their answers in any way and I will not use it for any research purposes. The I.P. address will be completely removed from the database. The rest of the survey data will be used in anonymised form for statistical purposes only and statistical results and will be reported in a PhD thesis, research papers, conferences, technical reports and academic journals. In the future, the

statistical data may be used for subsequent research in the area of food economics and marketing, as a basis for comparison to future
results, and as an example in teaching. This will not affect respondents' anonymity. Respondents' answers will be kept confidential to the extent allowed by law and University policy and will only be released as summaries. Respondents' name will not be collected as part of your survey response. Responses will not be individually identified or publicised.

l) **Will participants be required to complete a separate consent form?** Many APD applications do not require participants to complete a separate consent form. Please see the templates provided.

☐ Yes. Names, addresses and copies of completed forms will be given to APD student office

☒ No. The data collection is anonymous and a combined information/consent sheet supplied

☐ Neither of the above, or the research involves participants under the age of 16

If 'neither of the above' selected, or the research involves participants under the age of 16, please outline the specific circumstances. Click here to enter text.

m) Will participants be offered any form of incentive for undertaking the research?

No ☐

Yes ☒

If yes, give brief details, including what will happen to the incentive should the participant later withdraw their input or decide not to proceed : The participants will be entered into a lottery for a chance to win an Amazon voucher worth £50.

4. DATA PROTECTION

Data Storage, data protection and confidentiality. Please make sure you are familiar with the
University of Reading's guidelines for data protection and information security.
http://www.reading.ac.uk/internal/imps/

Please outline plans for the handling of data to ensure data protection and confidentiality. Covering the following issues: Will any personal information be stored?

How and where will the data be stored? Who will have access to the data? When will it be deleted?

In this survey, I will collect data on mouse movements as participants choose among three different food baskets. This means that I will track the nutrients participants have looked at, the time they have spent on inspecting each nutrient and the order in which they have been inspected as well as their preferred food basket. At the end of this survey, they will be asked to provide their e-mail address if they wish so so that they can be sent an Amazon voucher in case they have been selected. They will only receive an e-mail if they have won. I will not use their email address for any other purpose than to get in contact with them in case they have won. The email address will not be linked in

relation to their survey answers, will not be used to identify the person and will be removed after the voucher has been sent to the winners. In addition to this data, the survey software will automatically collect participants' I.P. address. I

will not use their I.P. address to locate participants or identify them or their answers in any way and I will not use it for

any research purposes. The I.P. address will be completely removed from the database.

To help me identify the overall demographic of the participants who participated in this survey, they will also be asked some questions about their background, such as their employment status and education level (which they have the option not to answer if you would prefer not to give these details).

The raw data will be temporarily stored on a password-protected secure server (Dreamhost) that features data encryption. Dreamhost is certified under major privacy and security standards and complies with GDPR with regards

to the transfer of personal data from the EU to the US. At the end of the study, the data will be deleted from the survey website and stored securely on a University of Reading computer with restricted access to me and my supervisors

and will not be shared with third parties. The University of Reading is the organisation responsible with the protection

of personal information and any queries should be directed to the University Data Protection Officer at imps@reading.ac.uk. The University of Reading collects, analyses, uses and retains personal data for the purposes of research, and does so in accordance with the Data Protection Act 2018 and the General Data Protection Regulation (GDPR) 2016.

The submitted data will be used in anonymised form for statistical purposes only and statistical results and will be reported in a PhD thesis, research papers, conferences, technical reports and academic journals. In the future, the statistical data may be used for subsequent research in the area of food economics and marketing, as a basis for comparison to future results, and as an example in teaching. This will not affect respondents' anonymity. Respondents' answers will be kept confidential to the extent allowed by law and University policy and will only be released as summaries. Respondents' name will not be collected as part of your survey response. Responses will not

be individually identified or publicised.

Applicants: Please now scroll to Section 7 to input your :

- Information Sheet(s) for Participants (mandatory)
- Data Collection Tools, for example: recruitment materials, interview/focus group protocols (how you are conducting the process), interview/focus group questions, questionnaires, online survey questions, debriefing and fact sheets
- Consent Forms (optional, may not be necessary if consent assumed in Information Sheet)

If the text boxes do not allow input in the desired format, please append documents separately to the email when sending this form.

Please then email your completed form (and any separate supporting documents) to your supervisor/project investigator. Project investigators or independent academics may return form directly to sapdethics@reading.ac.uk

A decision on whether ethical clearance has been granted will be emailed to you via the APD Student Office along with your authorised form.

You may NOT proceed with your data collection until ethical approval has been granted as evidenced by return of this approved form.

Note: The process of obtaining ethical approval does not include an assessment of the scientific merit of the questionnaire. That is the separate responsibility of your supervisor/project investigator in discussion with yourself.

5. Supervisor/project investigator review. Section to be completed by supervisor/PI where relevant.

Participant information sheet(s), data collection tools and any other supporting information may be pasted in section 7 below. Alternatively they may be attached to this email. Please review these documents and then complete the checklist below.

Checklist. Does this application and supporting documents adequately address the following ?

☒ The safety of the researcher(s) and those collecting data, the safety of the participant(s)

☒ Is the language /grammar/content appropriate (i.e. University standards and reputation upheld)

☒ There are no questions that might reasonably be considered impertinent or likely to cause distress to the participants

☒ The researcher has provided the participant information sheet (mandatory)

☒ The researcher has provided the questionnaire or survey/ workshop, focus group or interview questions (mandatory)

☒ The Participant Information Sheet gives sufficient information for the participants to give their
INFORMED consent

☐ A separate consent form has been included (optional)

☒ Data will be handled, stored and deleted appropriately according to University guidelines, and the participants have been adequately informed about this in the Participant Information Sheet

☒ The Participant Information Sheet contains all relevant sections

☒ I am satisfied that this application meets the minimum standards for APD Ethical Clearance to be granted

Supervisor/Project Investigator, please forward this form as a WORD document and any separate supporting documents to sapdethics@reading.ac.uk. The form will be logged by the student office and allocated to an APD ethics committee reviewer. The APD ethics reviewer will review the application and complete section 6.

6. APD ethics committee review. Section to be completed by APD Ethics Committee member.

Decision

Clearance refused ☐Resubmission required

Clearance granted as presented ☒

Clearance granted subject to revisions suggested ☐ No need to resubmit once amended

Referred to APD Research Ethics Chair ☐May require further information

Ethics Committee Member please enter comments, reasons for rejection, summary of revisions required before proceeding (if applicable):

Click here to enter text.

Committee Member Name: Giacomo Zanello **Date Reviewed:** 03/02/2020

APD Ethics Committee member electronic signature (For signature, save document as pdf, then open pdf and
use 'sign' option. Alternatively check here if no electronic signature used ☒)

APD Ethics Committee Member : Now please email this completed form (as signed pdf) to sapdethics@reading.ac.uk together with any separate supporting documents . The student office will record the outcome and return the completed form to the applicant with the decision.

7. Supporting Documents.

Please cut and paste the following documents into the text boxes below.

- Participant Information Sheet(s),
- Protocols (the procedures, how you will conduct and administer the data collection, interviews, surveys)
- Data Collection Instruments (interview questions and survey questions)
- Consent Forms (if Participant Information Sheet does not assume consent)
- Recruitment Materials (if relevant)

It is preferable that all information connected to this application is contained in one document. However, if you find that the text boxes below are not adequate, you may attach and email these supporting documents separately.

Supporting Documents for this application are pasted below. The text boxes cannot accept some types of formatting when pasting in documents. If this is the case, append them separately to the email with this form.

PARTICIPANT INFORMATION SHEET FOR NUTRIENT CHOICE SURVEY

Introduction

Thank you for agreeing to take part in this research. I am a PhD Candidate at the University of Reading, School of Agriculture, Policy and Development. This survey forms part of my PhD thesis which will contribute to my doctorate. **About my research**

The purpose of this survey is to investigate the extent to which consumer attention towards nutrients such as salt,

sugar and fat, plays a role in food shopping decisions. I will be analysing the data from this survey using standard statistical software and all results will be presented in aggregate format. I will write up the results into my PhD thesis and I will use these results to publish articles in academic journals.

What is involved?

You will be asked a number of questions about your food choices and some general questions. I expect that this will take about **12 to 15 minutes to complete**. I am interested in your opinions and there are no right or wrong answers. You do not have to answer any questions that you do not want to, and you may stop completing the questions at any time if you do not wish to proceed. Once you have completed the survey, you will not be required to do anything else.

How have I been selected?

I have selected participants by emailing my friends and work colleagues and sending the survey link to a consumer database as well as via social media. Only people aged 18 or over are eligible to take part, as long as they live in the UK, are responsible for their own grocery shopping and are frequent supermarket shoppers.

Confidentiality, storage and disposal of information

This survey anonymously collects data on survey responses and mouse movements. In addition to this data, the survey software automatically collects I.P. addresses. These will not be used in any way and will be removed from the database. To help me understand the overall demographic of participants, you will also be asked some questions about your background, such as your employment status and education level (which you have the option not to

answer if you prefer not to give these details). The raw data will be temporarily stored on a password-protected secure server that features data encryption. The server provider is certified under major privacy and security standards and complies with GDPR with regards to the transfer of personal data from the EU to the US. After data collection is completed the data will be removed from the secure server and stored securely on a University of Reading computer with access restricted to me and my supervisors and will not be shared with third parties. The University of Reading is the organisation responsible with the protection of personal information and any queries should be directed to the University Data Protection Officer at imps@reading.ac.uk. The University of Reading collects, analyses, uses and retains personal data for the purposes of research, and does so in accordance with the Data Protection Act 2018 and the General Data Protection Regulation (GDPR) 2016. The data will be used in anonymised form for statistical purposes only. The outputs are aggregates and will be reported in a PhD thesis or other research publications. This

will not affect your anonymity.

Can I change my mind at any stage and withdraw from the study?

Absolutely, your participation in this study is voluntary. You are free to change your mind and withdraw from the study without giving a reason during or after completion of this survey. Any contribution can be withdrawn up until the point

at which the data is aggregated before 1/06/2020. Please contact us at oana-adelina.tanasache@pgr.reading.ac.uk if you wish to withdraw by quoting the memorable word that you have chosen at the start of the survey.

How can I receive more information about this research?

If at any stage you wish to receive further information about this research project please to not hesitate to contact me at oana-adelina.tanasache@pgr.reading.ac.uk .

By participating in this survey, you are acknowledging that you understand the terms and conditions of participation in this study and that you consent to these terms.

This project has been reviewed according to the procedures specified by the University Research Ethics Committee

and has been given a favourable ethical opinion for conduct. Thank you very much for taking time to take part in this research! Oana-Adelina Tănăsache

PhD Candidate Contact Details

Oana-Adelina Tănăsache

University of Reading, Whiteknights Campus School of Agriculture, Policy and Development Earley Gate

PO Box 237

Reading RG6 6AR, UK

One of the objectives of this research was to understand consumer engagement with the UK's Traffic Light System, a colour-coded nutritional labelling policy which indicates low, medium, and high levels of each nutrient through the use of green, amber and red colours. As part of this research, measures of attention to nutritional information were collected as part of a mouse-tracked choice experiment. Data in relation to the nutrients that people have looked at, for how long and how many times have been gathered alongside people's actual basket choices. This has made possible an analysis of how UK's Traffic Light System for nutritional labelling is used and the extent to which attention to the TLS nutrients is related to the valuation of these nutrients. The RI model has been used as a framework to examine this relationship.

E-Mail:

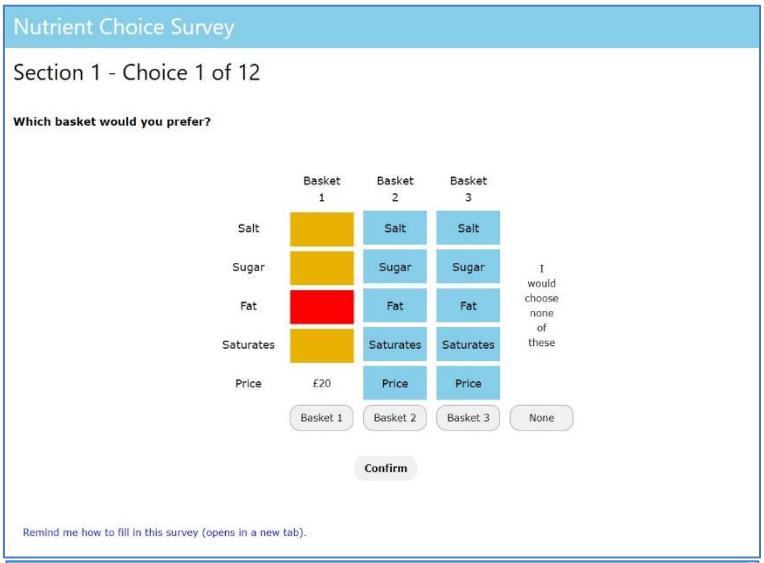
Supervisor Contact Details

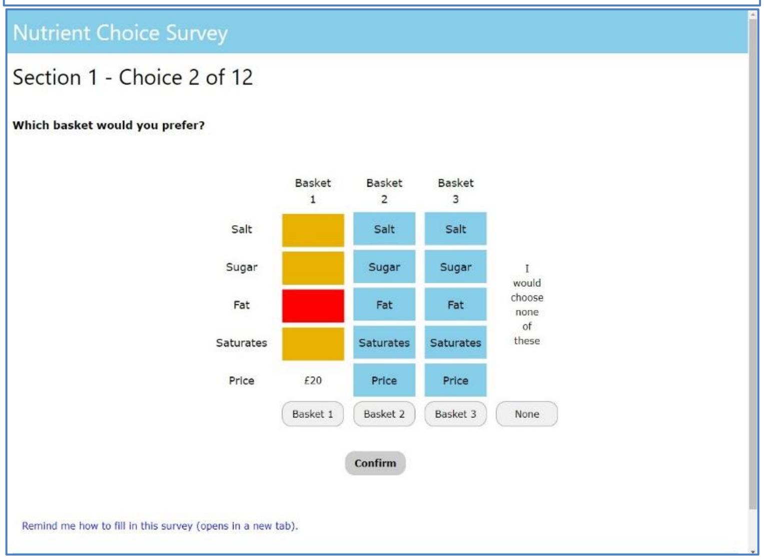
Name: Ariane Kehlbacher
University of Reading, Whiteknights Campus School of Agriculture, Policy and Development E-Mail:

Survey questions

In the first section of the survey, the participants are asked to choose one of the three baskets or none of the baskets as if they are doing their weekly shopping. The baskets are described in terms of the Traffic Light System and price. For the first section of the survey (first 12 questions), the information for basket 2 and 3 is hidden behind a blue box.

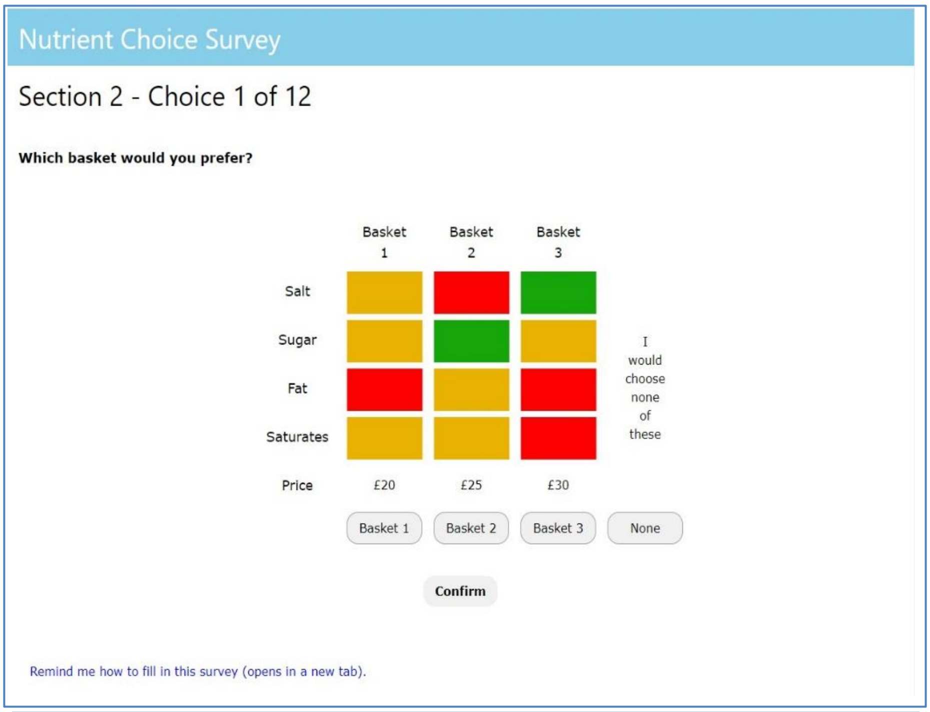
See below, as examples, Choice 1 and Choice 2 of Section 1

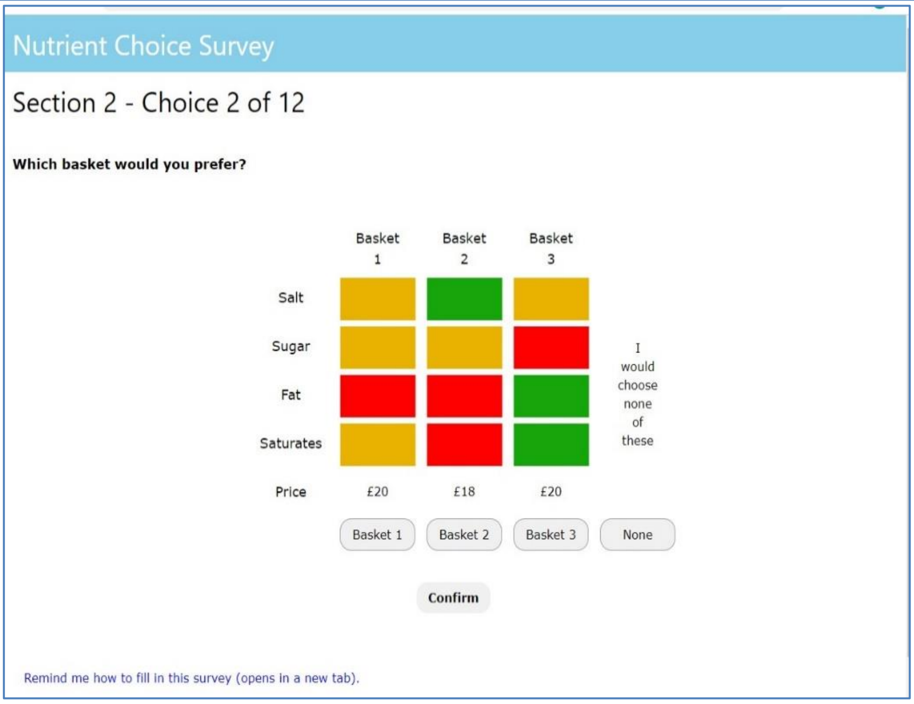




For the second section of the survey, the participants are asked again to choose one of the three baskets or none of the baskets as if they are doing their weekly shopping but this time all baskets are visible.

See below, as examples, choice 1 and 2 for Section 2.





Finally, after making all of their 24 choices, participants are asked some final questions.

When choosing among the three baskets in the hidden box section, which attribute(s) have you ignored? Choose all that apply.

Salt

Sugar

Fat

Saturates

Price

I haven't ignored any attribute.

When choosing among the three baskets in the open box section, which attribute(s) have you ignored? Choose all that apply.

Salt

Sugar

Fat

Saturates

Price

I haven't ignored any attribute.

Which of the following best describes how you chose between the three baskets?

I chose the basket with least reds.

I chose the basket with most greens.

I chose the basket which had green on my most important nutrient. I chose the cheapest basket.

I based my decision on a combination of factors. I based my decision on another factor.

I haven't based my decision on any factor.

How difficult did you find the hidden box section compared to the open box section?

Easier

The same

More difficult

Much more difficult

In general, how would you assess your computer skills (e.g. Internet search, word processing, email, video games, etc)?

Very poor

Poor

Moderate

Good

Very good

When shopping for food in a supermarket, how much would you agree with the following statements?

It is important to me that the food I shop on a typical day:

Is easy to prepare

Strongly disagree

Disagree

Neither agree nor disagree

Agree

Strongly agree

Is low in sugar

Is low in calories

Strongly disagree

Disagree

Neither agree nor disagree

Agree

Strongly agree

Is low in sugar

Is cheap

Strongly disagree

Disagree

Neither agree nor disagree

Agree

Strongly agree

Is low in sugar

Strongly disagree

Disagree

Neither agree nor disagree

Agree

Strongly agree

Is low in sugar

Is low in fat

Strongly disagree

Disagree

Neither agree nor disagree

Agree

Strongly agree

Is low in sugar

Strongly disagree

Disagree

Neither agree nor disagree

Agree

Strongly agree

Is high in fibre

Strongly disagree

Disagree

Neither agree nor disagree

Agree

Strongly agree

Is nutritious

Strongly disagree

Disagree

Neither agree nor disagree

Agree

Strongly agree

Is low in salt

Strongly disagree

Disagree

Neither agree nor disagree

Agree

Strongly agree

Helps me control my weight

Strongly disagree

Disagree

Neither agree nor disagree

Agree

Strongly agree

Contains a lot of vitamins and minerals

Strongly disagree

Disagree

Neither agree nor disagree

Agree

Strongly agree

Is high in protein

Strongly disagree

Disagree

Neither agree nor disagree

Agree

Strongly agree

Keeps me healthy

Strongly disagree

Disagree

Neither agree nor disagree

Agree

Strongly agree

Is low in saturated fat

Strongly disagree

Disagree

Neither agree nor disagree

Agree

Strongly agree

How familiar are you with the current Traffic Light System (colour-coding) of labelling pre-packaged foods and drinks in the UK?

Not at all familiar

Slightly familiar

Somewhat familiar

Moderately familiar

Extremely familiar

How often are you likely to use the information offered by the Traffic Light System when you're shopping for food?

Never

Almost never

Sometimes

Almost every time

Every time

For which products are you most likely to use the Traffic Light System? Choose all that apply.

Ready meals

Pizzas, burgers, and sandwiches

Breakfast cereals

Beverages & yogurts

Processed meats and cheese

Sweets and crisps

Other products

I never use the Traffic Light System

What is your annual household income (before deductions and tax)?

Less than £14,000

£14,000- £24,999

£25,000- £34,999

£35,000- £44,999

£45,000- £54,999

£55,000- £64,999

£65,000 - £79,999

Over £80,000

Rather not say

What is your highest level of education?

Secondary school

College/Vocational training

Undergraduate degree

Postgraduate degree

Rather not say

How old are you?

18-24

25-34

35-44

45-54

55-64

65-74

Over 75

Rather not say

What is your gender?

Male

Female

Other

Rather not say

Please input your email address if you would like to enter a lottery for a chance to win an Amazon voucher worth £50.
We will not use your email address for any other purposes than to send your voucher in case you have won.

I wish to take part in the lottery and here is my email address: I do not wish to take part in the lottery.

Return to top of form
Return to Supervisor Ethical Review, Section 5

12.3 Appendix C. User testing recording consent form

Recording consent form

Thank you for participating in this user testing session.
I will be audio recording your session to allow me to better understand your opinions and comments on the web survey design which is part of my PhD research at the University of Reading, School of Agriculture, Policy and Development.
Please read the statement below and sign where indicated.

- -

I understand that my usability test session will be audio recorded.
I grant Oana-Adelina Tanasache permission to use this recording for her use only, for the purpose of improving the survey design being tested.

Signature: ________________________________

Print your name: ___________________________

Date: ___________________

12.4 Appendix D. Usability test script for online survey

Usability test script – Choice Experiment with Mouselab

Adapted from *Rocket Surgery Made Easy by Steve Krug*

THE INSTRUCTIONS

Web browser should be open to Google or some other "neutral" page

Thank you for agreeing to take part in this user testing session today.

Before I begin, may I ask for your permission to record this meeting? I am going to record what happens on the screen and our conversation. The recording will only be used to help me figure out how to improve the website, and it won't be seen by anyone except me. And it helps me, because I don't have to take as many notes. If you agree, I'm going to ask you to sign this consent form. It just says that I have your permission to record you, and that the recording will only be seen by me.

Give them a recording permission form and a pen While they sign it, START the SCREEN RECORDER

First, I have some information for you, and I'm going to read it to make sure that I cover everything.

You probably already have a good idea of why I asked you here but let me go over it again briefly. I am asking people to try to respond to an online survey that I am working on as part of my PhD research so that I can understand whether it works as intended and whether I need to make any adjustments. My research tries to understand how people make their food choices in a shopping environment. To this end, the survey allows me to tracks people's mouse movements as they choose between different food baskets. The session should take about an hour.

The first thing I want to make clear right away is that I will be testing the *web survey*, not you. You can't do anything wrong here. In fact, this is probably the one place where you don't have to worry about making mistakes.

As you go through the survey, I'm going to ask you as much as possible to try to think out loud: to say what you're looking at, what you're trying to do, and what you're thinking. This will be a big help to me.

Also, please don't worry that you're going to hurt my feelings. I am doing this to improve the survey, so I need to hear your honest reactions.

If you have any questions as we go along, just ask them. I may not be able to answer them right away, since I am interested in how people do when they don't have someone sitting next to them to help. But if you still have any questions when we're done, I'll try to answer them then. And if you need to take a break at any point, just let me know. Do you have any questions so far?

THE QUESTIONS

OK. Before we look at the web survey, I'd like to ask you just a few quick questions.

- Roughly how many hours a day—just a rough estimate— would you say you spend using the Internet, including Web browsing and email, at work and at home?
- (optional) What kinds of sites (work and personal) are you looking at when you browse the Web?
- Do you play any video games?

THE INTRODUCTORY PAGES

OK, great. We're done with the questions, and we can start looking at things.

START the SCREEN RECORDER Open the survey's Introduction page.

First, I'm going to ask you to look at this page and tell me whether the instructions are clear and whether from this you understand what you are being asked to do in the survey. Just look around and do a little narrative.

- What are your thoughts on the instructions?
- What are your thoughts about the visual presentation of this page?
- What are your thoughts about the wording of the instructions? Do they make sense? Are they clear?

Take as much time as you need to but don't click on anything yet.

Open the Example page

Next, I'm going to ask you to look at this example page and tell me whether the instructions are clear and whether from this you understand what you are being asked to do in the survey. Just look around and do a little narrative.

- What are your thoughts about the visual presentation of this page?
- What are your thoughts about the wording of the instructions? Do they make sense? Are they clear?

THE TASKS

Thanks. Now I'm going to ask you to try to go through the survey and respond to the questions as if you were a survey participant yourself.

And again, as much as possible, it will help me if you can try to think out loud as you go along.

PROBING

Thanks, that was very helpful. Now a few more questions.

- Was it clear what you had to do? Is the survey self-explanatory?
- How difficult it was to fill in the survey ? What about the section with the hidden boxes?
- How did you find the length of the survey? Too long/too short?
- Did you feel any need for additional guidance or instructions on how to fill in the survey?

- Can you imagine what difficulties other people might have, i.e. your mother or an older person?

WRAPPING UP

Do you have any questions for me, now that we're done?

Do you have any suggestions on how this web survey could be improved?

Give them their incentive, or remind them it will be sent to them. Stop the screen recorder and save the file. Thank them and escort them out.

12.5 Appendix E. User testing feedback

12.5.1 First testing round: July – September 2019

Participant no. 1, 22 July 2019

Introduction page

- Survey is split into three sections: Section 1, 2, and 3. Need to specify that at the very beginning
- Replace with "Click on any basket and then on confirm to start the survey"
- Replace first page statement with: "A typical question would be…"
- Reformulate with "While basket 1 will stay the same, basket 2 and 3 will vary…"

Other pages

- Table on Choice 2 needs to be centered
- 1st survey page should show mention long the survey will take.
- Add extra option on the heuristic question
- Add section 1 and 2 on different pages
- Food choice survey instead of final questions at the top.
- Replace "contrary" with another word and "please click on the button"
- User has chosen none on several occasions because none of the options were acceptable to them. Basket 1 is never an acceptable option for the user.
- Blue box should fit the text irrespective of the size of the window
- Check the scrolling on the page – if it works on the laptop without scrolling, does it also work on the desktop?
- How will the lottery be done? Explain more about how you are going to choose the winner
- No "we" on the instructions or if used, need to be consistent with previous instructions.
- Less gap at the top on the thanks page
- What is the effect of a user going back to the previous page?
- If participants scroll down, need to see the table and the question at the same time.
- Add an extra page with reminder about the instructions or a link to the introduction page.
- Make font bigger.

Participant no. 2, 3, 4 (July 2019)

- In general, participants understand what they have to do in the survey, and they find it easy to fill in the survey.
- Comments about the wording of some sentences.
- Issues raised about the difficulty of choosing between baskets when the actual foods are not known.
- Suggestions to make it more interactive, i.e. through a video were made by a few participants.

Participant no. 5, 25 July 2019

- Explain what it means to choose none of the baskets.
- ‘Your task is to choose’ needs to be in bold
- Needs more detail on what the basket contains
- “Are you usually looking at the nutritional content of the basket?” – should add this question
- To add something like “imagine they all contain the same products?” Let’s say you are doing your weekly shopping” – make it a bit clearer that it is not a one-off thing when people buy more impulsively, but a weekly shop.
- Difficult to make choice when there’s no information on the actual foods contained in the basket
- Give a sense of which kind of foods map to which colours
- Problem signalled that he thinks about the foods themselves, and knows whether they are healthy or not, and thereby doesn’t actually look at the nutritional content.

Participant no. 6, 25 July 2019

- Make clear it's a food basket
- Add that it will not contain specific foods in the ONLY section on intro.php
- Make a box together with the instructions to show they are together on intro page
- What is difference between fat and saturates?
- "information" replaced with nutrients on intro page
- Frames around the text, more interactivity
- Text should not fill in the whole width of the page
- Instructions should be like "you are about to…."
- Make more explicit – don't put the name of the nutrients on the boxes on the intro page
- Needs an example of a food basket. Difficult to imagine what the basket will be.
- More colour
- Likes box on the side in intro2
- Change the text above in intro2 and put it in a box
- Change the scrolling thing on at least the choices pages so they can see the choice number and the choice set at the same time
- Don't need to say click on confirm
- Put logo of the University to give some reassurance to participants
- More design, make it more appealing
- An email to confirm and give thanks to participants
- A demo video to show how people can do the survey so that I can get rid of the text
- Too many instructions – video is better.

Participant no.6, 27 August 2019

- Intro page to be reformulated into: "The baskets you will be presented with will be colour-coded: green, amber or red". Link this with the basket below.
- Needs to be more visual, less text. Maybe make basket A visible and then on page 2 make them hidden and explain the two sections and the hovering
- Needs a reminder about what the different colours stand for.
- Hard to relate, doesn't feel like dealing with food. Hard to choose when you don't know the foods each basket contains.
- Need to add question about education
- Excited about the incentive.
- Some screens are bigger, so the pages look smaller on bigger screens.

Participant no.7, 27th August 2019

- Questionnaire sounds too academic, i.e. nutrients should be replaced with something else and it sounds a bit complicated.
- Needs to reread to correctly understand what it means. Maybe less text
- Too much detail about the different sections
- "in this survey you will be asked to choose….."
- Too much reading at the start.
- The box on the first page: first sentence should be after the second paragraph
- Replace choice set with something else, less academic
- Not everyone is a supermarket shopper, need to put it as a condition for taking part in the survey.
- Problem that he doesn't know what he is buying, the foods that are included in the basket.
- A reminder that Basket 1 is always the same
- Put incentive at the beginning.
- Problem that Basket 1 is never appealing and rarely chosen.
- Need to write on the first page the purpose of the research and that mouse movements will be tracked. The same page should contain how long the survey lasts, where the data will be stored, that it has the ethical clearance of university, etc. Not clear what the objective of the survey is. Maybe need to put that on the very first page.
- Choice 6 and 7 seem to be the same

Participant no.8, 30 August 2019

Hi Oana,

The survey takes 13 minutes.

Very good. Well done.

I have just minor feedbacks;

1. when you ask which basket you would choose or which basket you prefer, it might be slightly clearer, depends on your intention though, if you say "which basket would you buy"?. I might be wrong. I know there is 1 place you said "willing to pay" but it's kind of hidden.
2. The first session when I have to hover, sometimes I completely forget about basket 1 and no basket. Somehow I unconsciously compared only between basket 2 and 3.
3. Maybe if you frame choice 4 no basket with like a square or something, it might look like another choice to choose?

Participant no.10, 30 August 2019

Hi Oana,

No problem. Think it took around 15 minutes. Just one question, is it possible to do this survey on a mobile phone?

As for feedback I did find myself focusing on options 2-3 more than 1 & 4 in the first section. For the first couple questions I had actually forgotten about them and didn't think of them as options.

Participant no. 11, 1 September 2019

Dear Oana

I was happy to receive your email, with your questions about the survey. My apologies for replying so late, we have family visiting and so I have not been at my computer.

I will try my best and go through each question and give my thoughts and opinions.

1. Initially I found it slightly difficult, mainly because a) I probably didn't read the instructions as well as I should, scanned them to quickly, and b) I have not consciously thought very much about the nutrients in my food, other than knowing overall those that are good or bad for me.
2. With regards to the instructions in the first two pages, there were clear and understandable. It may be useful to know that when selecting my basket I did not at any time in the survey take the price into account. I was mainly concerned by the level of nutrients in the basket.
3. My overall impression of the pages was good, the colours used are very clear and the font and white background make the page very open and easy to view. Looking at the pages again now, as a second read through it is very understandable, and well written.
4. It was clear about how you should complete the questionnaire, and yes it was self explanatory. The only problem I had was deciding whether a lower level of fat was better or worse than a lower level of saturates. For people like myself it would be useful to have a small very easy to view bar chart showing the four nutrients in percentages of which is better or worse. Would just have been useful for me.
5. I did find the number of baskets a little too many, but this may have purely been because I completed the questionnaire late at night. If, as you mentioned, the questionnaire was conducted in a personal one to one interview, then I am sure the number of baskets would be ok.
6. I think the only difficulties would be dependent on the knowledge of the respondent about nutients and diet, and therefore their ability to answer the questions, they may then take the price of the basket into account or not.
7. Other than suggesting a bar chart showing which nutrients are better or worse for an average person I think the survey is very well planned and formatted.

I hope my comments are of help. As I mentioned I think in the survey, I was applying a low sugar diet as the priority throughout my answers.

Good luck with the survey and your thesis.

Kind regards

Participants no. 12 and 13 September 2019

- Instructions too wordy
- Difficult to make choice since there is no info on actual foods.
- Price is too low and hence didn't look at price at all
- Difficult to make choice since not a supermarket shopper.

Participant no.14, 21 September 2019

- Didn’t choose any basket most of the time because not good enough for her
- Understood the instructions in general but didn’t look very carefully at the example page
- Didn’t read the hovering instructions so I had to point it out to her.
- Got the gist of the questionnaire anyway
- Confused about income being for a household or an individual

12.5.2 Second testing round: January – February 2020

- General comments about logo visibility issues, adding a textbox field, etc.
- Reformulating some questions on the final page of the questionnaire

12.6 Appendix F. Logit results from Chapter 6 Results Part 1

Table 22 Logit Results for Stated ANA vs. Dwell proportions for each attribute

Attribute	Parameters	Coefficient	Std. error	P-value	Pseudo-R^2	LLR p-value
Salt	Intercept	-1.351	0.341	0.000	0.018	0.058
	Dwell	-2.09	1.31	0.111		
Sugar	Intercept	-1.901	0.433	0.000	0.014	0.157
	Dwell	-2.136	1.67	0.201		
Fat	Intercept	-0.014	0.440	0.021	0.059	0.002**
	Fixations	<-0.001	<0.001	0.008*		
Saturates	Intercept	-1.715	0.426	0.000	0.016	0.116
	Dwell	<-0.001	<0.001	0.174		
Price	Intercept	0.418	0.290	0.149	0.061	<0.001***
	Dwell	<-0.001	<0.001	0.000***		

*** significant at 1% level of significance, **significant at 5% level of significance

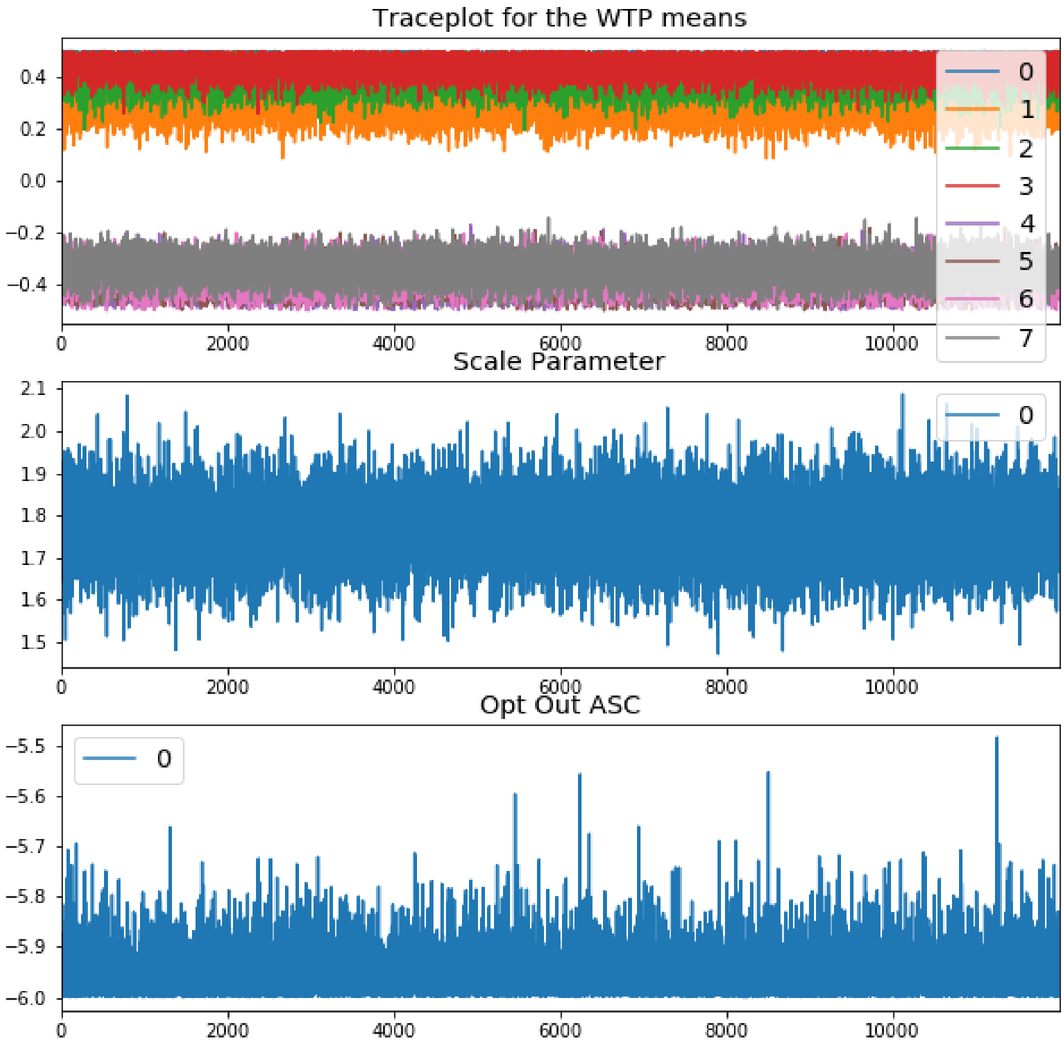
Table 23 Logit Results for Stated attribute importance vs. Dwell proportions for each attribute

Attribute	Parameters	Coefficient	Std. error	P-value	Pseudo-R^2	LLR p-value
Salt	Intercept	-1.531	0.489	0.002	0.043	0.000
	Dwell	0.079	0.023	0.001***		
Sugar	Intercept	-0.338	0.461	0.463	0.012	0.043
	Dwell	0.042	0.022	0.050**		
Fat	Intercept	-0.015	0.394	0.968	0.001	0.461
	Fixations	0.014	0.020	0.481		
Saturates	Intercept	-0.339	0.477	0.477	0.009	0.072
	Dwell	0.039	0.023	0.081		
Price	Intercept	-1.446	0.283	0.000	0.052	<0.001
	Dwell	0.047	0.013	0.000***		

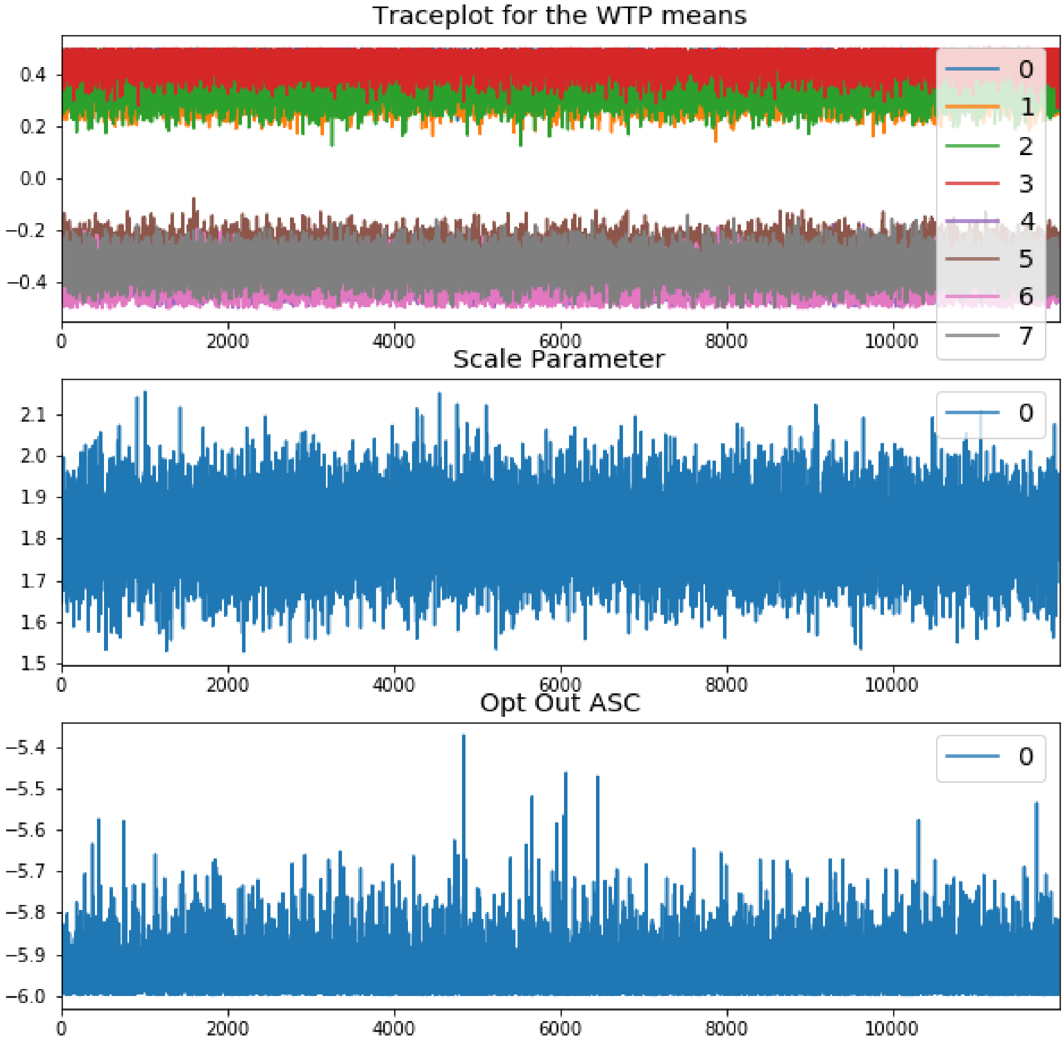
*** significant at 1% level of significance, **significant at 5% level of significance

12.7 Appendix G. Trace plots for WTP estimates

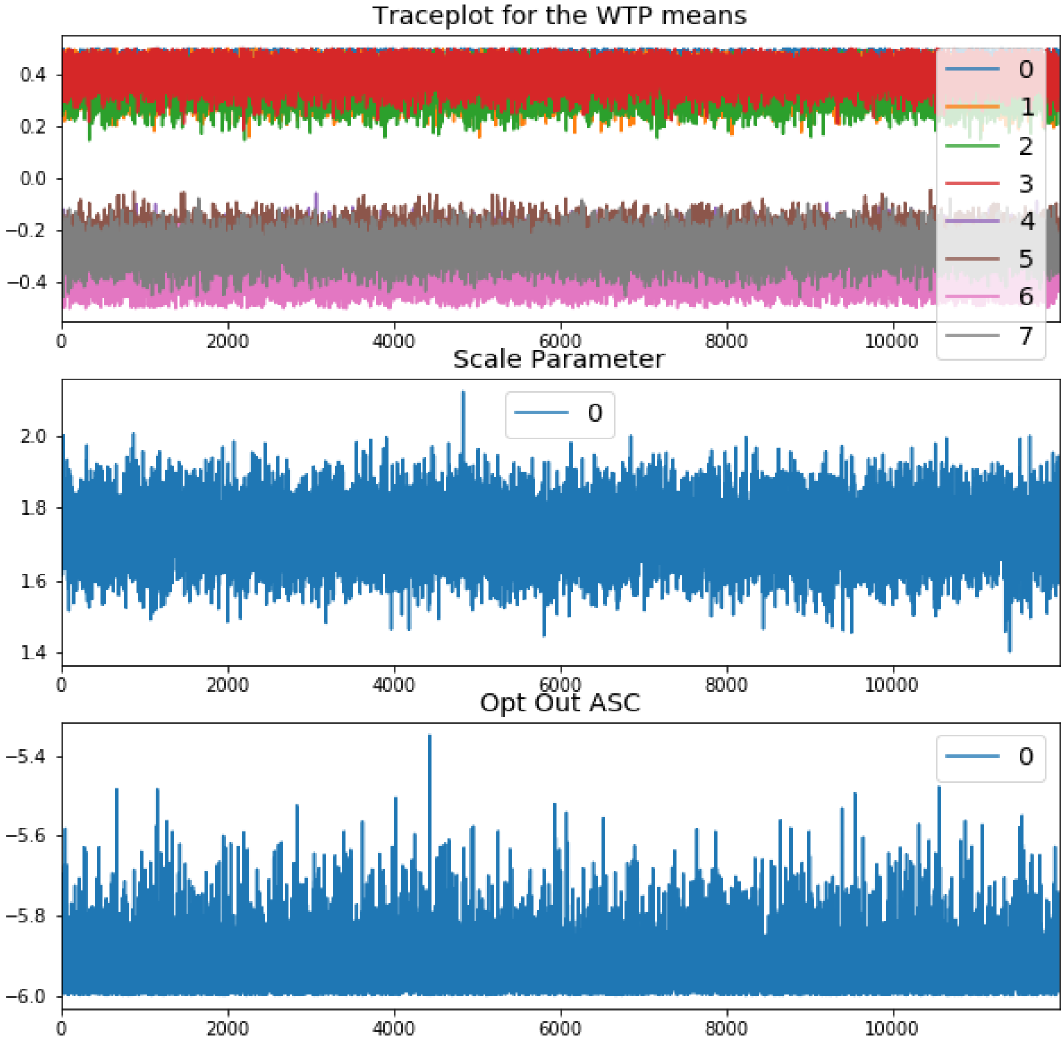
12.7.1 Trace plot for WTP estimates (set A, hidden)



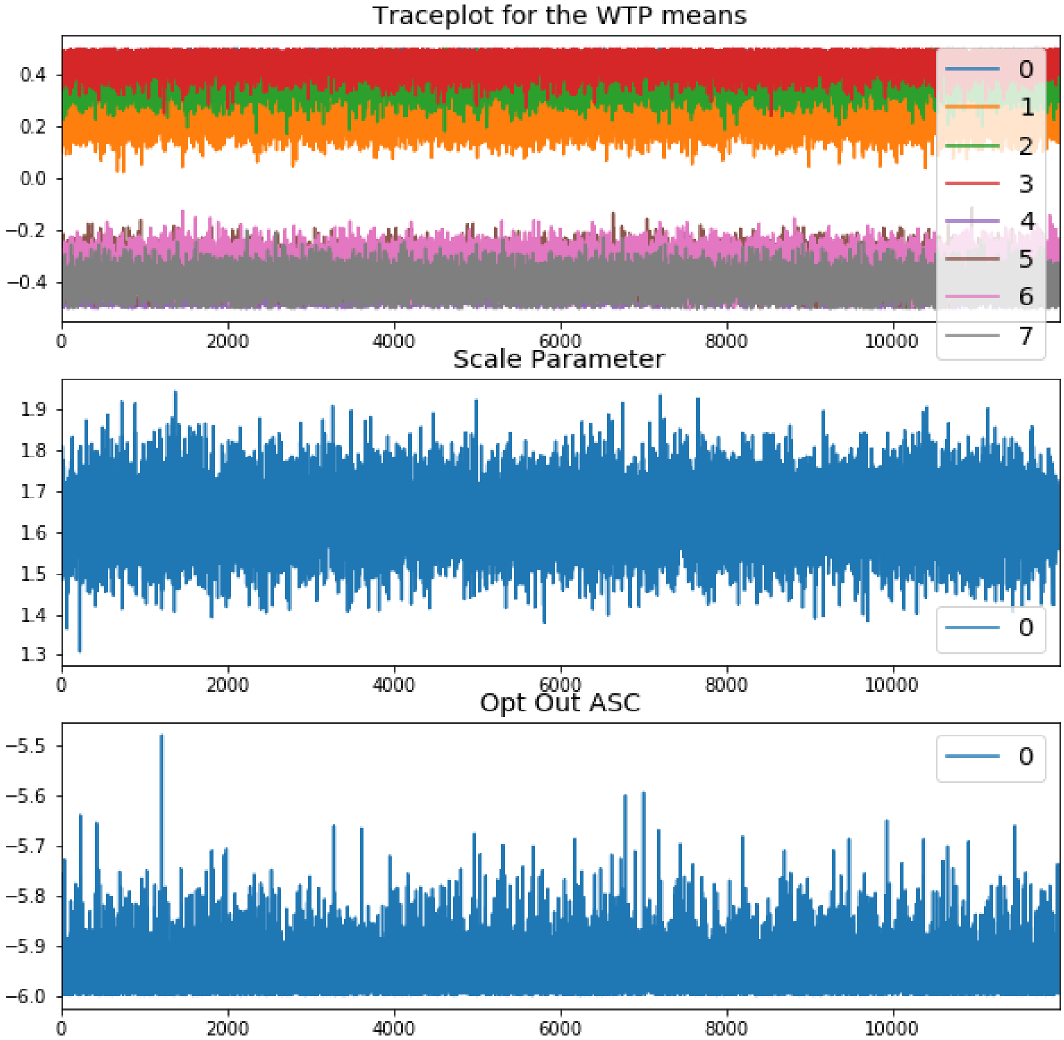
12.7.2 Trace plot for WTP (set A, open)



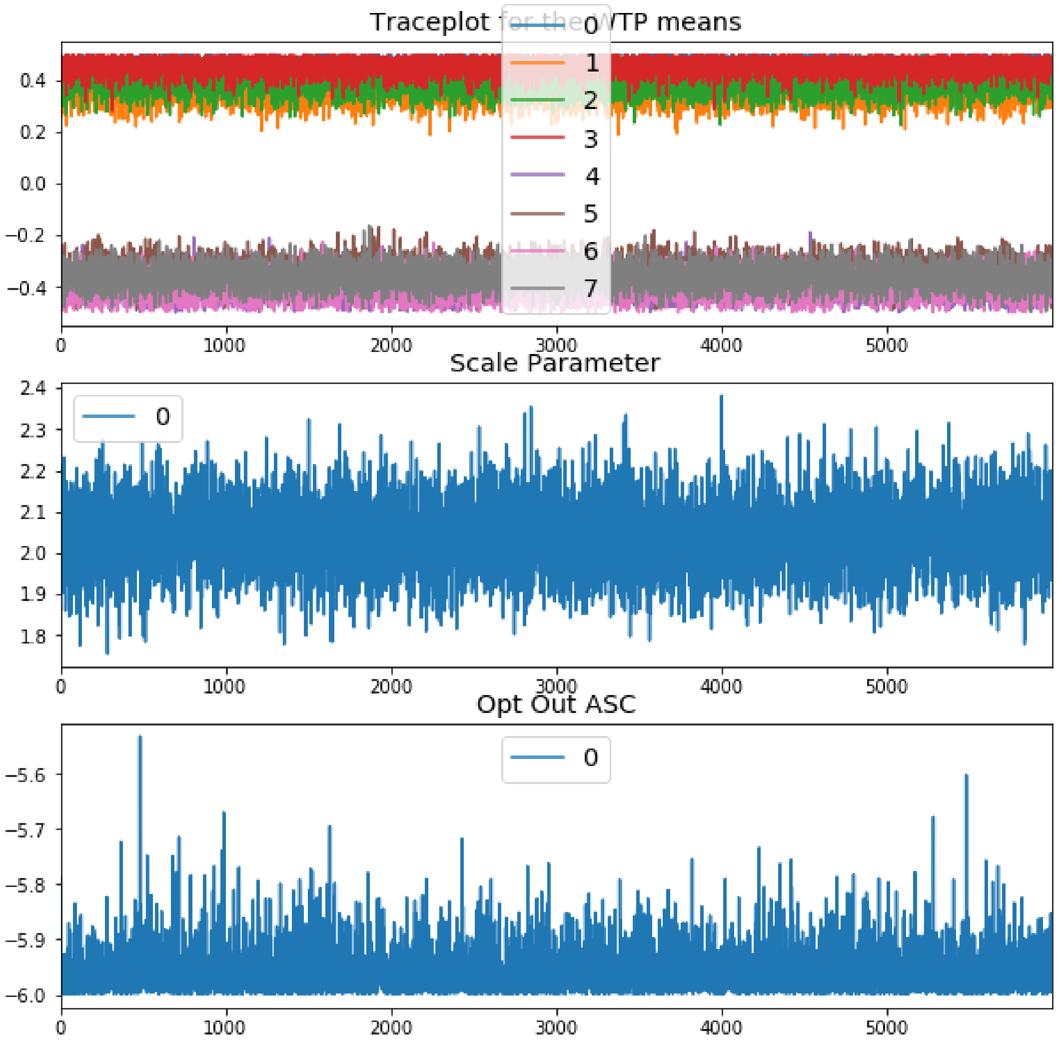
12.7.3 Trace plot for WTP (set B, hidden)



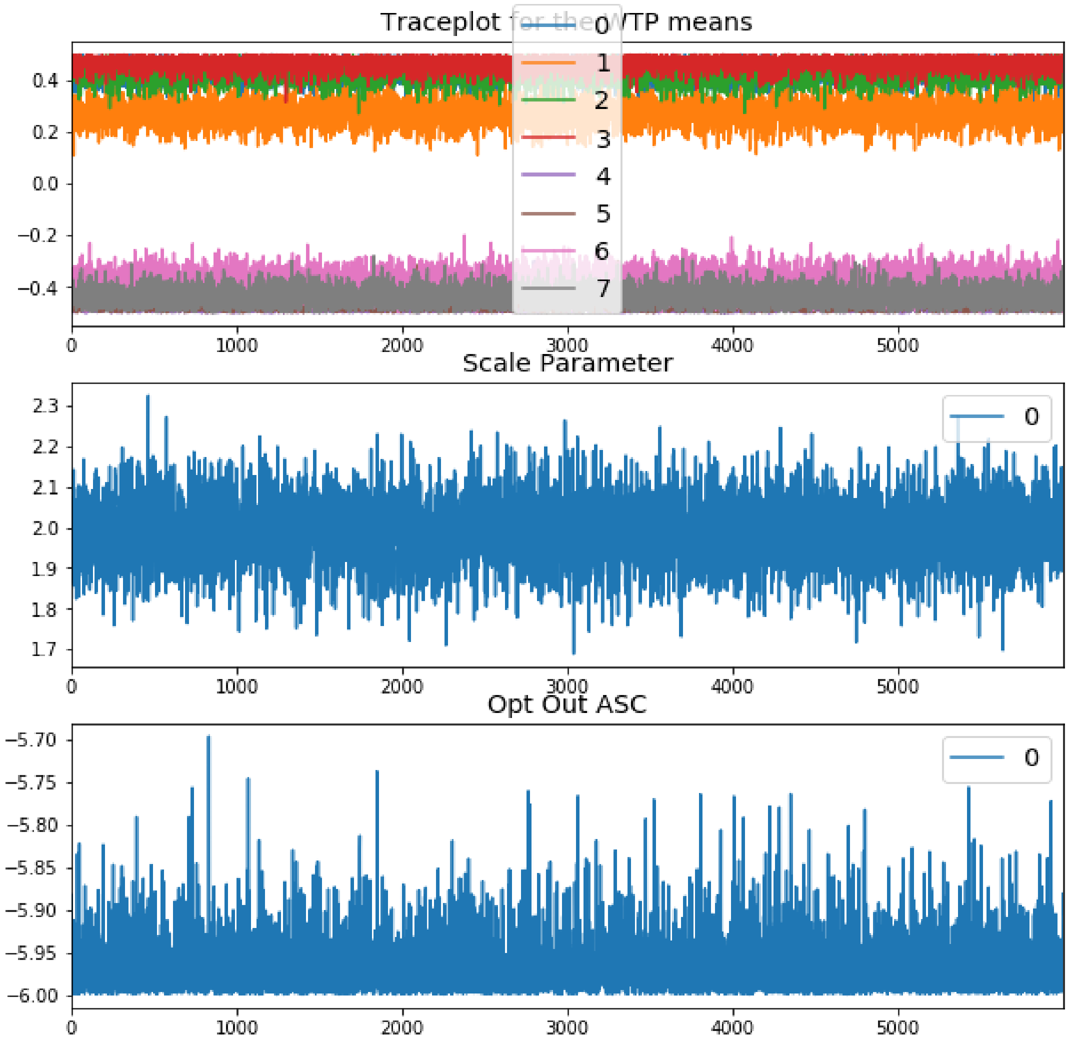
12.7.4 Trace plot for WTP estimates (set B, open)



12.7.5 Trace plot for WTP estimates (set A, merged)



12.7.6 Trace plot for WTP estimates (set B, merged)



12.8 Appendix H. Stan code for estimating Hierarchical Bayes Mixed Logit model[4]

```
#Standard Mixed Logit in WTP Space with fixed ASC as the last attribute in data set
#This is a parameterisation of the standard mixed logit with negative price being the
first variable

hcode2 = """

data { // the declaration of variables that are read in as data
int<lower=0> N;     //total number of people
int<lower=0> T;     // total number of observations
int<lower=0> M;     //number of choice sets
int<lower=0> K;     //number of attributes
int<lower=0> ids[T]; //group id
int y[T];
row_vector[K] x[M,T];


real alpha_mean;          //Priors for the mean log of the price coefficient
real<lower=0> alpha_sigma; //Priors for the standard devation of the log of price
coefficient

real beta_mean[K-2];     //Priors for the mean of beta
real<lower=0> beta_sigma[K-2]; //Priors for standard deviation of beta

real theta_mean;          //Priors for the mean of the last coefficient
real<lower=0> theta_sigma; //Piors for the standard deviation of the last coefficient

real<lower=0> a[K-2];    //Gamma Priors for the beta coefficients, 1st param
real<lower=0> b[K-2];    //Gamma Priors for the beta coefficients, 2nd param


real<lower=0> a_alpha;   //Gamma Priors for the price coefficient, 1st param
real<lower=0> b_alpha;   //Gamma Priors for the price coefficient, 2nd param


real<lower=0> a_theta;    //Gamma Priors for the ASC, last variable in data set, 1st
param
real<lower=0> b_theta;    //Gamma Priors for the ASC, last variable in data set, 2nd
param

}
```

[4] I acknowledge my supervisor, Kelvin Balcombe for providing me with this code.

```
parameters { // variables being sampled by Stan's samplers (HMC and NUTS)

vector<lower=-1,upper=1>[K-2] beta[N];          // N K-vectors
vector<lower=-.5,upper=.5>[K-2] beta_mu;        // means for beta
vector<lower=0.5>[K-2] beta_ivar;               // var parameters for beta

real<lower=-2,upper=2> alpha[N];
real<lower=-1,upper=1> alpha_mu;
real<lower=0.5>alpha_ivar;

real<lower=-12,upper=12> theta[N];
real<lower=-6,upper=6> theta_mu;
real<lower=0.1>theta_ivar;
}

transformed parameters
{
   vector[M] mu[T];
   vector[K] coef[N];
   real beta_std[K-2];
   real alpha_std;
   real theta_std;

   alpha_std=1/sqrt(alpha_ivar);
   theta_std=1/sqrt(theta_ivar);

   for(k in 1:K-2) {beta_std[k]=1/sqrt(beta_ivar[k]);}

   for(n in 1:N)
     {
      coef[n,1]=exp(alpha[n]);
      coef[n,2:K-1]=exp(alpha[n])*beta[n];
      coef[n,K]=theta[n];
      }

   for(t in 1:T)
   {
      for(m in 1:M) {
         mu[t,m]=x[m,t]*coef[ids[t]];
                 }
   }

}

model
{
alpha_mu ~   normal(alpha_mean,alpha_sigma);
```

```
alpha_ivar ~ gamma(a_alpha,b_alpha);
theta_mu ~   normal(theta_mean,theta_sigma);
theta_ivar ~ gamma(a_theta,b_theta);

for(k in 1:K-2)
{
   beta_mu[k] ~ normal(beta_mean[k],beta_sigma[k]);
   beta_ivar[k] ~ gamma(a[k],b[k]);
}

for(n in 1:N)

{  alpha[n]  ~ normal(alpha_mu, alpha_std);
  theta[n]  ~ normal(theta_mu, theta_std);

  for(k in 1:K-2) {beta[n,k] ~ normal(beta_mu[k], beta_std[k]);}

}

   for(t in 1:T) {
      y[t] ~ categorical_logit(mu[t]);
   }
}

generated quantities { vector[T] log_lik;
for (t in 1:T){log_lik[t]=log_softmax(mu[t])[y[t]];}

}

""""
```

12.9 Appendix I. Full statistical output after estimation (set A open)

Inference for Stan model: anon_model_ed815ef4241bc56b8c67a326a686ece9.

2 chains, each with iter=4000; warmup=1000; thin=1;

post-warmup draws per chain=3000, total post-warmup draws=6000.

	mean	se_mean	sd	2.5%	25%	50%	75%	97.5%	n_eff	Rhat
beta_mu[1]	0.44	7.2e-4	0.04	0.35	0.41	0.44	0.47	0.5	2984	1.0
beta_mu[2]	0.35	1.2e-3	0.05	0.24	0.31	0.35	0.39	0.45	1996	1.0
beta_mu[3]	0.36	1.2e-3	0.05	0.25	0.32	0.36	0.4	0.46	2044	1.0
beta_mu[4]	0.45	6.7e-4	0.04	0.36	0.42	0.45	0.48	0.5	3023	1.0
beta_mu[5]	-0.38	1.0e-3	0.05	-0.47	-0.41	-0.38	-0.34	-0.27	2372	1.0
beta_mu[6]	-0.3	1.2e-3	0.05	-0.4	-0.33	-0.3	-0.26	-0.19	2100	1.0
beta_mu[7]	-0.39	1.2e-3	0.05	-0.48	-0.43	-0.39	-0.36	-0.29	1853	1.0
beta_mu[8]	-0.34	1.1e-3	0.05	-0.44	-0.38	-0.34	-0.31	-0.24	2193	1.0
beta_std[1]	0.31	6.4e-4	0.03	0.25	0.29	0.31	0.33	0.38	2593	1.0
beta_std[2]	0.35	9.6e-4	0.04	0.28	0.32	0.35	0.38	0.43	1719	1.0
beta_std[3]	0.33	9.4e-4	0.04	0.27	0.31	0.33	0.36	0.41	1522	1.0
beta_std[4]	0.31	6.6e-4	0.03	0.25	0.29	0.31	0.33	0.38	2432	1.0
beta_std[5]	0.32	7.4e-4	0.04	0.26	0.3	0.32	0.35	0.4	2252	1.0
beta_std[6]	0.35	9.8e-4	0.04	0.28	0.33	0.35	0.38	0.43	1599	1.0
beta_std[7]	0.35	8.3e-4	0.04	0.28	0.32	0.35	0.37	0.43	2071	1.0
beta_std[8]	0.33	8.2e-4	0.04	0.27	0.31	0.33	0.35	0.41	1897	1.0
alpha_mu	0.59	1.1e-3	0.05	0.5	0.56	0.59	0.63	0.68	1776	1.0
alpha_std	0.32	8.8e-4	0.04	0.26	0.3	0.32	0.34	0.4	1657	1.0
theta_mu	-5.94	6.4e-4	0.05	-6.0	-5.98	-5.96	-5.92	-5.79	7349	1.0
theta_std	1.91	0.01	0.29	1.35	1.71	1.91	2.11	2.47	596	1.0
beta[1,1]	0.66	2.7e-3	0.22	0.18	0.51	0.69	0.83	0.98	6877	1.0
beta[2,1]	0.62	2.4e-3	0.22	0.14	0.48	0.64	0.79	0.97	8689	1.0
beta[3,1]	0.41	2.9e-3	0.26	-0.13	0.24	0.42	0.6	0.88	8278	1.0
beta[4,1]	0.33	3.2e-3	0.27	-0.21	0.15	0.34	0.52	0.84	6987	1.0
beta[5,1]	0.58	2.8e-3	0.24	0.07	0.43	0.6	0.77	0.97	6936	1.0
beta[6,1]	0.4	3.2e-3	0.27	-0.15	0.23	0.41	0.6	0.91	7222	1.0
beta[7,1]	0.34	3.3e-3	0.26	-0.18	0.17	0.35	0.52	0.83	6168	1.0

beta[8,1]	0.13	3.7e-3	0.29	-0.45	-0.05	0.14	0.32	0.69	5945	1.0
beta[9,1]	0.2	3.7e-3	0.28	-0.34	0.03	0.21	0.39	0.71	5597	1.0
beta[10,1]	0.57	2.7e-3	0.25	0.04	0.42	0.6	0.77	0.96	8299	1.0
beta[11,1]	0.32	3.0e-3	0.27	-0.23	0.15	0.34	0.51	0.83	7868	1.0
beta[12,1]	0.58	3.0e-3	0.24	0.08	0.42	0.6	0.76	0.96	6293	1.0
beta[13,1]	0.56	2.6e-3	0.24	0.05	0.4	0.57	0.74	0.96	8099	1.0
beta[14,1]	0.41	3.1e-3	0.26	-0.12	0.24	0.42	0.59	0.89	6967	1.0
beta[15,1]	0.7	2.3e-3	0.2	0.25	0.57	0.73	0.86	0.99	7371	1.0
beta[16,1]	0.36	3.3e-3	0.26	-0.17	0.19	0.36	0.53	0.84	6063	1.0
beta[17,1]	0.34	3.1e-3	0.28	-0.23	0.15	0.35	0.53	0.85	7878	1.0
beta[18,1]	0.56	2.7e-3	0.24	0.04	0.41	0.57	0.74	0.95	7564	1.0
beta[19,1]	0.58	2.6e-3	0.24	0.05	0.42	0.6	0.77	0.97	8789	1.0
beta[20,1]	0.3	3.3e-3	0.27	-0.25	0.12	0.31	0.49	0.82	6928	1.0
beta[21,1]	0.57	2.4e-3	0.23	0.08	0.42	0.59	0.76	0.96	9294	1.0
beta[22,1]	0.52	3.0e-3	0.25	1.8e-3	0.36	0.53	0.71	0.94	6876	1.0
beta[23,1]	0.65	2.4e-3	0.22	0.16	0.51	0.67	0.82	0.98	8395	1.0
beta[24,1]	0.47	2.7e-3	0.25	-0.07	0.31	0.49	0.65	0.91	8815	1.0
beta[25,1]	0.39	3.0e-3	0.27	-0.17	0.2	0.4	0.58	0.9	8132	1.0
beta[26,1]	0.63	2.8e-3	0.22	0.16	0.49	0.66	0.8	0.98	6028	1.0
beta[27,1]	0.65	2.4e-3	0.22	0.17	0.52	0.68	0.82	0.98	8405	1.0
beta[28,1]	0.56	2.6e-3	0.24	0.04	0.4	0.57	0.73	0.96	8537	1.0
beta[29,1]	0.61	3.0e-3	0.24	0.1	0.46	0.63	0.79	0.98	6050	1.0
beta[30,1]	0.49	3.2e-3	0.25	-0.03	0.32	0.5	0.67	0.93	5837	1.0
beta[31,1]	0.59	2.5e-3	0.22	0.12	0.44	0.6	0.76	0.96	8270	1.0
beta[32,1]	0.58	2.7e-3	0.24	0.07	0.42	0.59	0.76	0.96	8073	1.0
beta[33,1]	0.57	2.8e-3	0.23	0.08	0.41	0.59	0.75	0.96	7087	1.0
beta[34,1]	0.35	3.1e-3	0.25	-0.17	0.18	0.35	0.52	0.83	6756	1.0
beta[35,1]	0.58	2.6e-3	0.23	0.07	0.42	0.6	0.75	0.96	7835	1.0
beta[36,1]	0.41	2.8e-3	0.25	-0.1	0.24	0.41	0.59	0.87	7993	1.0
beta[37,1]	0.69	2.3e-3	0.2	0.26	0.56	0.71	0.84	0.98	7440	1.0
beta[38,1]	0.56	3.3e-3	0.23	0.08	0.41	0.58	0.74	0.96	5129	1.0
beta[39,1]	0.44	3.1e-3	0.26	-0.08	0.27	0.45	0.63	0.91	6808	1.0
beta[40,1]	0.64	2.3e-3	0.22	0.16	0.49	0.66	0.8	0.97	8619	1.0
beta[41,1]	0.56	2.9e-3	0.24	0.06	0.4	0.58	0.74	0.96	6762	1.0

beta[42,1]	0.57	2.7e-3	0.24	0.07	0.42	0.59	0.75	0.96	7673	1.0
beta[43,1]	0.49	2.8e-3	0.24	-0.02	0.32	0.5	0.67	0.92	7729	1.0
beta[44,1]	0.56	2.8e-3	0.24	0.06	0.4	0.58	0.74	0.95	7453	1.0
beta[45,1]	0.59	2.5e-3	0.23	0.08	0.43	0.61	0.76	0.96	8553	1.0
beta[46,1]	0.35	4.0e-3	0.27	-0.18	0.17	0.35	0.53	0.87	4516	1.0
beta[47,1]	0.62	2.5e-3	0.22	0.13	0.48	0.64	0.8	0.97	7860	1.0
beta[48,1]	0.29	3.2e-3	0.28	-0.27	0.1	0.3	0.49	0.8	7578	1.0
beta[49,1]	0.62	2.7e-3	0.22	0.15	0.48	0.64	0.78	0.97	6516	1.0
beta[50,1]	0.54	3.1e-3	0.24	0.04	0.38	0.56	0.73	0.96	6299	1.0
beta[51,1]	0.59	2.7e-3	0.23	0.11	0.44	0.61	0.76	0.96	7265	1.0
beta[52,1]	0.58	3.0e-3	0.24	0.07	0.42	0.59	0.75	0.96	6001	1.0
beta[53,1]	0.65	2.4e-3	0.22	0.16	0.51	0.67	0.82	0.98	8114	1.0
beta[54,1]	0.61	2.6e-3	0.23	0.12	0.46	0.63	0.79	0.97	7481	1.0
beta[55,1]	0.48	3.4e-3	0.25	-0.04	0.3	0.49	0.67	0.94	5533	1.0
beta[56,1]	0.39	3.3e-3	0.28	-0.19	0.21	0.4	0.59	0.9	7129	1.0
beta[57,1]	0.46	2.7e-3	0.26	-0.07	0.29	0.47	0.65	0.91	8974	1.0
beta[58,1]	0.41	3.0e-3	0.27	-0.15	0.23	0.42	0.59	0.89	7709	1.0
beta[59,1]	0.43	3.2e-3	0.26	-0.07	0.25	0.44	0.62	0.91	6310	1.0
beta[60,1]	0.43	3.1e-3	0.25	-0.08	0.26	0.44	0.61	0.89	6706	1.0
beta[61,1]	0.46	3.0e-3	0.25	-0.05	0.28	0.46	0.63	0.92	7046	1.0
beta[62,1]	0.28	3.1e-3	0.27	-0.25	0.1	0.28	0.46	0.8	7565	1.0
beta[63,1]	0.43	2.8e-3	0.25	-0.07	0.26	0.44	0.62	0.89	8062	1.0
beta[64,1]	0.34	3.5e-3	0.26	-0.18	0.17	0.35	0.52	0.86	5592	1.0
beta[65,1]	0.46	3.5e-3	0.25	-0.06	0.29	0.46	0.63	0.9	5207	1.0
beta[66,1]	0.45	3.4e-3	0.24	-0.04	0.29	0.45	0.62	0.9	5091	1.0
beta[67,1]	0.6	3.0e-3	0.23	0.09	0.45	0.63	0.78	0.97	6300	1.0
beta[68,1]	0.27	3.0e-3	0.27	-0.29	0.09	0.28	0.46	0.8	8207	1.0
beta[69,1]	0.38	2.9e-3	0.26	-0.15	0.21	0.39	0.57	0.87	8128	1.0
beta[70,1]	0.36	3.8e-3	0.27	-0.18	0.19	0.37	0.55	0.87	5111	1.0
beta[71,1]	0.51	2.7e-3	0.24	-0.01	0.35	0.52	0.69	0.94	8417	1.0
beta[72,1]	0.53	2.6e-3	0.24	0.03	0.37	0.55	0.71	0.95	8442	1.0
beta[73,1]	0.14	3.7e-3	0.28	-0.43	-0.05	0.14	0.33	0.68	5899	1.0
beta[74,1]	0.55	2.9e-3	0.24	0.03	0.38	0.56	0.73	0.96	7027	1.0
beta[75,1]	0.66	2.1e-3	0.2	0.21	0.53	0.68	0.82	0.97	9062	1.0

beta[76,1]	0.35	2.8e-3	0.26	-0.19	0.17	0.35	0.53	0.84	8666	1.0
beta[77,1]	0.39	2.9e-3	0.27	-0.16	0.21	0.4	0.58	0.88	8652	1.0
beta[78,1]	0.33	3.1e-3	0.27	-0.2	0.15	0.34	0.52	0.84	7700	1.0
beta[79,1]	0.44	3.6e-3	0.26	-0.1	0.25	0.45	0.62	0.92	5130	1.0
beta[80,1]	0.6	2.6e-3	0.23	0.1	0.45	0.62	0.78	0.97	8099	1.0
beta[81,1]	0.67	2.2e-3	0.21	0.21	0.54	0.7	0.83	0.98	8594	1.0
beta[82,1]	0.34	3.0e-3	0.27	-0.21	0.17	0.35	0.53	0.86	8079	1.0
beta[83,1]	0.6	2.7e-3	0.23	0.1	0.45	0.62	0.78	0.97	7193	1.0
beta[84,1]	0.63	3.0e-3	0.22	0.16	0.49	0.65	0.8	0.98	5416	1.0
beta[85,1]	0.58	2.7e-3	0.23	0.09	0.42	0.59	0.75	0.97	7642	1.0
beta[86,1]	0.19	3.3e-3	0.28	-0.38	0.01	0.2	0.39	0.71	7011	1.0
beta[87,1]	0.33	3.3e-3	0.27	-0.21	0.15	0.34	0.52	0.84	6736	1.0
beta[88,1]	0.27	3.5e-3	0.28	-0.3	0.09	0.28	0.47	0.81	6376	1.0
beta[89,1]	0.47	3.5e-3	0.27	-0.08	0.29	0.48	0.67	0.93	5834	1.0
beta[90,1]	0.55	2.9e-3	0.23	0.06	0.39	0.57	0.73	0.95	6480	1.0
beta[91,1]	0.49	2.8e-3	0.24	-0.02	0.33	0.49	0.66	0.92	7410	1.0
beta[92,1]	0.44	3.4e-3	0.25	-0.08	0.27	0.44	0.62	0.91	5607	1.0
beta[93,1]	0.65	2.5e-3	0.21	0.18	0.51	0.67	0.82	0.98	7170	1.0
beta[94,1]	0.34	3.1e-3	0.27	-0.19	0.17	0.35	0.53	0.84	7447	1.0
beta[95,1]	0.54	3.3e-3	0.24	0.02	0.37	0.56	0.72	0.95	5503	1.0
beta[96,1]	0.46	3.0e-3	0.25	-0.05	0.29	0.48	0.64	0.9	7166	1.0
beta[97,1]	0.5	3.4e-3	0.26	-0.04	0.32	0.51	0.68	0.94	5552	1.0
beta[98,1]	0.59	2.8e-3	0.23	0.1	0.43	0.6	0.76	0.96	6728	1.0
beta[99,1]	0.51	3.1e-3	0.25	5.1e-4	0.35	0.52	0.7	0.95	6459	1.0
beta[100,1]	0.67	2.4e-3	0.2	0.23	0.54	0.69	0.83	0.97	7312	1.0
beta[101,1]	0.53	3.1e-3	0.25	9.3e-3	0.37	0.55	0.71	0.95	6280	1.0
beta[102,1]	0.41	3.1e-3	0.26	-0.1	0.24	0.41	0.59	0.9	6680	1.0
beta[103,1]	0.39	3.1e-3	0.27	-0.17	0.21	0.39	0.58	0.88	7376	1.0
beta[104,1]	0.34	3.2e-3	0.27	-0.21	0.17	0.35	0.52	0.86	7132	1.0
beta[105,1]	0.39	3.1e-3	0.26	-0.15	0.22	0.4	0.58	0.88	7393	1.0
beta[106,1]	0.66	2.5e-3	0.21	0.19	0.52	0.68	0.83	0.98	7530	1.0
beta[107,1]	0.39	3.2e-3	0.26	-0.12	0.22	0.4	0.57	0.88	6421	1.0
beta[108,1]	0.78	1.9e-3	0.17	0.37	0.68	0.81	0.91	0.99	7680	1.0
beta[109,1]	0.45	3.3e-3	0.26	-0.09	0.28	0.45	0.63	0.91	6269	1.0

beta[110,1]	0.49	2.8e-3	0.25	-0.03	0.32	0.5	0.67	0.92	7959	1.0
beta[111,1]	0.45	2.8e-3	0.26	-0.08	0.28	0.46	0.63	0.91	8427	1.0
beta[112,1]	0.33	3.3e-3	0.27	-0.21	0.15	0.34	0.52	0.85	6776	1.0
beta[113,1]	0.27	3.5e-3	0.27	-0.29	0.08	0.27	0.46	0.78	6006	1.0
beta[1,2]	-0.11	4.8e-3	0.31	-0.73	-0.31	-0.1	0.1	0.49	4264	1.0
beta[2,2]	0.36	3.1e-3	0.27	-0.19	0.18	0.37	0.55	0.88	7817	1.0
beta[3,2]	0.23	4.0e-3	0.3	-0.36	0.03	0.23	0.43	0.8	5594	1.0
beta[4,2]	0.11	4.1e-3	0.31	-0.5	-0.1	0.12	0.32	0.71	5906	1.0
beta[5,2]	0.41	3.2e-3	0.27	-0.13	0.24	0.42	0.6	0.91	7184	1.0
beta[6,2]	-0.02	4.8e-3	0.32	-0.63	-0.24	-0.02	0.2	0.59	4400	1.0
beta[7,2]	0.43	3.0e-3	0.27	-0.12	0.25	0.44	0.62	0.91	7626	1.0
beta[8,2]	0.11	3.7e-3	0.3	-0.48	-0.09	0.11	0.32	0.71	6727	1.0
beta[9,2]	0.1	4.2e-3	0.3	-0.51	-0.09	0.11	0.31	0.69	5069	1.0
beta[10,2]	0.43	3.8e-3	0.29	-0.19	0.24	0.44	0.64	0.94	5786	1.0
beta[11,2]	0.47	3.2e-3	0.26	-0.08	0.3	0.49	0.66	0.93	6770	1.0
beta[12,2]	0.46	3.0e-3	0.27	-0.11	0.28	0.47	0.66	0.93	7876	1.0
beta[13,2]	0.46	3.1e-3	0.26	-0.08	0.28	0.47	0.65	0.93	7168	1.0
beta[14,2]	0.36	3.7e-3	0.28	-0.21	0.17	0.37	0.55	0.88	5793	1.0
beta[15,2]	0.49	3.6e-3	0.26	-0.05	0.32	0.5	0.69	0.95	5487	1.0
beta[16,2]	0.41	3.4e-3	0.26	-0.12	0.23	0.42	0.59	0.9	6060	1.0
beta[17,2]	0.26	3.8e-3	0.3	-0.34	0.06	0.27	0.48	0.83	6183	1.0
beta[18,2]	0.46	3.2e-3	0.27	-0.09	0.28	0.47	0.66	0.93	7250	1.0
beta[19,2]	0.43	3.6e-3	0.28	-0.15	0.24	0.44	0.63	0.93	6036	1.0
beta[20,2]	0.49	3.0e-3	0.26	-0.05	0.31	0.5	0.68	0.94	7643	1.0
beta[21,2]	0.46	3.2e-3	0.27	-0.1	0.28	0.47	0.66	0.93	7123	1.0
beta[22,2]	0.51	3.0e-3	0.26	-0.03	0.33	0.52	0.7	0.95	7664	1.0
beta[23,2]	0.52	3.0e-3	0.26	-0.02	0.34	0.53	0.72	0.96	7491	1.0
beta[24,2]	0.64	2.6e-3	0.22	0.15	0.5	0.66	0.82	0.98	7221	1.0
beta[25,2]	0.34	3.4e-3	0.3	-0.27	0.15	0.35	0.55	0.88	7667	1.0
beta[26,2]	0.52	2.9e-3	0.26	-0.03	0.35	0.53	0.71	0.95	7551	1.0
beta[27,2]	0.51	2.6e-3	0.26	-0.02	0.34	0.53	0.71	0.94	9401	1.0
beta[28,2]	0.47	3.4e-3	0.27	-0.1	0.29	0.48	0.68	0.94	6633	1.0
beta[29,2]	0.59	2.8e-3	0.25	0.05	0.43	0.61	0.78	0.97	7871	1.0
beta[30,2]	0.35	3.5e-3	0.28	-0.23	0.16	0.36	0.55	0.88	6475	1.0

beta[31,2]	0.59	2.6e-3	0.24	0.07	0.43	0.61	0.77	0.96	8678	1.0
beta[32,2]	0.46	3.0e-3	0.26	-0.08	0.28	0.46	0.65	0.93	7769	1.0
beta[33,2]	0.46	3.3e-3	0.27	-0.1	0.29	0.47	0.66	0.93	6522	1.0
beta[34,2]	0.48	2.9e-3	0.26	-0.05	0.31	0.5	0.67	0.93	7756	1.0
beta[35,2]	0.45	3.1e-3	0.27	-0.12	0.27	0.46	0.65	0.93	7903	1.0
beta[36,2]	0.74	2.0e-3	0.19	0.3	0.63	0.77	0.89	0.99	8912	1.0
beta[37,2]	0.35	3.6e-3	0.28	-0.22	0.16	0.35	0.55	0.88	6034	1.0
beta[38,2]	0.21	3.6e-3	0.29	-0.36	9.7e-3	0.22	0.42	0.78	6559	1.0
beta[39,2]	0.36	4.7e-3	0.29	-0.23	0.17	0.36	0.56	0.9	3741	1.0
beta[40,2]	0.36	3.3e-3	0.28	-0.22	0.17	0.36	0.55	0.89	7451	1.0
beta[41,2]	0.35	3.2e-3	0.28	-0.23	0.17	0.36	0.55	0.89	7924	1.0
beta[42,2]	0.35	3.7e-3	0.29	-0.23	0.16	0.36	0.55	0.89	6033	1.0
beta[43,2]	0.46	3.3e-3	0.27	-0.12	0.28	0.47	0.66	0.95	7030	1.0
beta[44,2]	0.45	3.3e-3	0.27	-0.1	0.27	0.46	0.65	0.93	6350	1.0
beta[45,2]	0.33	3.4e-3	0.29	-0.26	0.13	0.34	0.53	0.86	7267	1.0
beta[46,2]	0.23	3.8e-3	0.29	-0.35	0.03	0.24	0.43	0.79	6013	1.0
beta[47,2]	0.54	3.1e-3	0.25	9.1e-3	0.38	0.56	0.73	0.96	6411	1.0
beta[48,2]	0.62	2.5e-3	0.23	0.11	0.47	0.65	0.8	0.97	8591	1.0
beta[49,2]	0.6	2.7e-3	0.23	0.1	0.45	0.62	0.78	0.97	7256	1.0
beta[50,2]	0.44	3.5e-3	0.27	-0.13	0.26	0.45	0.64	0.93	6124	1.0
beta[51,2]	0.46	3.4e-3	0.27	-0.1	0.28	0.48	0.66	0.94	6682	1.0
beta[52,2]	0.65	2.3e-3	0.22	0.15	0.52	0.69	0.83	0.98	9396	1.0
beta[53,2]	0.29	3.4e-3	0.28	-0.28	0.1	0.3	0.49	0.84	6851	1.0
beta[54,2]	0.58	2.5e-3	0.24	0.07	0.42	0.6	0.76	0.96	8549	1.0
beta[55,2]	0.35	3.3e-3	0.28	-0.24	0.16	0.35	0.55	0.87	7431	1.0
beta[56,2]	0.11	4.0e-3	0.32	-0.54	-0.1	0.12	0.33	0.72	6277	1.0
beta[57,2]	0.2	4.1e-3	0.32	-0.43	-0.02	0.2	0.42	0.82	5844	1.0
beta[58,2]	0.22	4.1e-3	0.31	-0.42	0.02	0.23	0.44	0.82	5924	1.0
beta[59,2]	0.47	3.5e-3	0.27	-0.09	0.3	0.49	0.66	0.94	5663	1.0
beta[60,2]	0.35	3.9e-3	0.28	-0.21	0.16	0.35	0.55	0.87	5273	1.0
beta[61,2]	0.49	3.1e-3	0.26	-0.07	0.31	0.51	0.68	0.94	7180	1.0
beta[62,2]	0.22	4.1e-3	0.3	-0.38	0.03	0.23	0.42	0.79	5211	1.0
beta[63,2]	0.48	3.0e-3	0.26	-0.08	0.3	0.49	0.67	0.93	7681	1.0
beta[64,2]	0.62	2.9e-3	0.24	0.08	0.47	0.65	0.81	0.98	6814	1.0

beta[65,2]	0.39	3.5e-3	0.28	-0.19	0.2	0.4	0.59	0.91	6439	1.0
beta[66,2]	0.38	3.5e-3	0.29	-0.2	0.18	0.38	0.58	0.9	6511	1.0
beta[67,2]	0.63	2.7e-3	0.23	0.12	0.48	0.66	0.81	0.98	7189	1.0
beta[68,2]	0.46	3.3e-3	0.28	-0.12	0.28	0.48	0.67	0.93	6981	1.0
beta[69,2]	0.3	3.8e-3	0.31	-0.32	0.09	0.31	0.53	0.85	6370	1.0
beta[70,2]	0.3	4.1e-3	0.29	-0.3	0.11	0.31	0.51	0.85	5253	1.0
beta[71,2]	0.63	2.6e-3	0.24	0.12	0.47	0.66	0.82	0.98	8495	1.0
beta[72,2]	0.59	2.9e-3	0.24	0.08	0.43	0.61	0.77	0.97	6895	1.0
beta[73,2]	0.28	3.6e-3	0.3	-0.35	0.07	0.28	0.49	0.85	7105	1.0
beta[74,2]	0.31	4.0e-3	0.29	-0.28	0.11	0.32	0.51	0.84	5247	1.0
beta[75,2]	0.13	4.2e-3	0.29	-0.48	-0.07	0.14	0.33	0.67	4978	1.0
beta[76,2]	0.43	3.1e-3	0.27	-0.13	0.24	0.44	0.63	0.91	7758	1.0
beta[77,2]	0.11	4.2e-3	0.31	-0.54	-0.09	0.12	0.33	0.71	5503	1.0
beta[78,2]	0.08	4.8e-3	0.31	-0.55	-0.13	0.09	0.29	0.67	4244	1.0
beta[79,2]	0.47	3.2e-3	0.27	-0.08	0.29	0.49	0.67	0.94	7079	1.0
beta[80,2]	0.63	2.9e-3	0.23	0.11	0.48	0.66	0.81	0.98	6582	1.0
beta[81,2]	0.35	4.2e-3	0.28	-0.21	0.16	0.36	0.55	0.89	4359	1.0
beta[82,2]	0.4	3.4e-3	0.29	-0.21	0.21	0.41	0.6	0.91	6979	1.0
beta[83,2]	0.63	2.8e-3	0.23	0.11	0.48	0.65	0.81	0.98	6766	1.0
beta[84,2]	0.57	2.9e-3	0.25	0.02	0.41	0.6	0.77	0.97	7489	1.0
beta[85,2]	0.69	2.3e-3	0.21	0.22	0.56	0.72	0.85	0.98	7916	1.0
beta[86,2]	0.22	4.3e-3	0.3	-0.4	0.03	0.23	0.42	0.79	4834	1.0
beta[87,2]	2.2e-3	4.2e-3	0.3	-0.62	-0.2	0.01	0.21	0.58	5165	1.0
beta[88,2]	0.49	3.6e-3	0.27	-0.09	0.3	0.5	0.7	0.95	5798	1.0
beta[89,2]	0.46	3.3e-3	0.28	-0.15	0.27	0.47	0.67	0.95	7488	1.0
beta[90,2]	0.38	3.3e-3	0.28	-0.18	0.19	0.39	0.58	0.89	7047	1.0
beta[91,2]	0.42	3.1e-3	0.26	-0.14	0.25	0.44	0.61	0.89	7389	1.0
beta[92,2]	0.45	3.3e-3	0.27	-0.11	0.27	0.46	0.65	0.93	6872	1.0
beta[93,2]	0.72	2.2e-3	0.2	0.25	0.59	0.75	0.88	0.99	8504	1.0
beta[94,2]	0.24	4.1e-3	0.3	-0.38	0.04	0.25	0.45	0.8	5249	1.0
beta[95,2]	0.35	3.4e-3	0.29	-0.25	0.16	0.36	0.56	0.89	7429	1.0
beta[96,2]	-0.05	4.4e-3	0.32	-0.71	-0.26	-0.05	0.17	0.55	5390	1.0
beta[97,2]	0.09	4.2e-3	0.32	-0.55	-0.12	0.1	0.32	0.7	5837	1.0
beta[98,2]	0.52	3.3e-3	0.26	-0.02	0.35	0.53	0.71	0.95	6117	1.0

beta[99,2]	0.34	3.1e-3	0.29	-0.24	0.15	0.35	0.54	0.86	8254	1.0
beta[100,2]	0.61	2.7e-3	0.23	0.11	0.46	0.63	0.79	0.97	7347	1.0
beta[101,2]	0.47	3.2e-3	0.27	-0.09	0.28	0.48	0.66	0.93	6995	1.0
beta[102,2]	0.43	3.3e-3	0.27	-0.11	0.26	0.44	0.63	0.91	6673	1.0
beta[103,2]	0.11	4.0e-3	0.32	-0.55	-0.1	0.12	0.33	0.73	6488	1.0
beta[104,2]	0.28	3.6e-3	0.29	-0.3	0.08	0.28	0.48	0.84	6760	1.0
beta[105,2]	0.11	3.8e-3	0.31	-0.54	-0.1	0.11	0.33	0.71	6819	1.0
beta[106,2]	0.5	3.6e-3	0.26	-0.07	0.33	0.51	0.69	0.95	5337	1.0
beta[107,2]	0.36	3.3e-3	0.28	-0.2	0.17	0.37	0.56	0.87	6876	1.0
beta[108,2]	0.46	3.1e-3	0.27	-0.1	0.28	0.47	0.65	0.94	7356	1.0
beta[109,2]	0.38	3.4e-3	0.28	-0.2	0.19	0.39	0.58	0.89	6876	1.0
beta[110,2]	0.32	3.5e-3	0.29	-0.28	0.13	0.33	0.53	0.85	6902	1.0
beta[111,2]	0.15	3.6e-3	0.32	-0.51	-0.06	0.16	0.37	0.76	7836	1.0
beta[112,2]	0.48	3.4e-3	0.27	-0.1	0.3	0.49	0.67	0.95	6171	1.0
beta[113,2]	0.18	3.9e-3	0.31	-0.46	-0.02	0.19	0.4	0.78	6402	1.0
beta[1,3]	0.07	4.3e-3	0.31	-0.57	-0.14	0.07	0.28	0.67	5286	1.0
beta[2,3]	0.48	3.0e-3	0.27	-0.1	0.3	0.49	0.68	0.94	8263	1.0
beta[3,3]	0.4	3.4e-3	0.28	-0.19	0.2	0.41	0.6	0.9	6886	1.0
beta[4,3]	0.28	3.7e-3	0.29	-0.31	0.09	0.29	0.48	0.84	6314	1.0
beta[5,3]	0.19	3.3e-3	0.3	-0.42	-0.01	0.19	0.39	0.75	7805	1.0
beta[6,3]	0.27	3.2e-3	0.29	-0.32	0.08	0.28	0.47	0.81	8126	1.0
beta[7,3]	0.43	3.6e-3	0.27	-0.12	0.24	0.44	0.63	0.92	5829	1.0
beta[8,3]	0.31	3.2e-3	0.29	-0.27	0.12	0.32	0.52	0.85	8005	1.0
beta[9,3]	0.41	3.9e-3	0.29	-0.19	0.22	0.42	0.62	0.92	5424	1.0
beta[10,3]	0.48	3.1e-3	0.27	-0.08	0.31	0.5	0.68	0.94	7606	1.0
beta[11,3]	0.31	3.3e-3	0.29	-0.27	0.12	0.32	0.51	0.86	7745	1.0
beta[12,3]	0.39	3.1e-3	0.28	-0.19	0.19	0.4	0.59	0.9	8399	1.0
beta[13,3]	0.47	3.4e-3	0.27	-0.08	0.29	0.49	0.67	0.95	6216	1.0
beta[14,3]	0.63	2.6e-3	0.22	0.13	0.49	0.65	0.81	0.98	7257	1.0
beta[15,3]	0.46	3.0e-3	0.26	-0.09	0.28	0.47	0.65	0.92	7622	1.0
beta[16,3]	0.33	3.7e-3	0.29	-0.24	0.14	0.33	0.53	0.88	5892	1.0
beta[17,3]	0.35	3.9e-3	0.3	-0.25	0.15	0.37	0.56	0.92	6026	1.0
beta[18,3]	0.47	3.3e-3	0.26	-0.09	0.29	0.48	0.66	0.92	6278	1.0
beta[19,3]	0.49	3.4e-3	0.27	-0.1	0.31	0.5	0.69	0.95	6405	1.0

beta[20,3]	0.24	4.0e-3	0.3	-0.39	0.03	0.24	0.45	0.79	5866	1.0
beta[21,3]	0.47	3.0e-3	0.26	-0.07	0.3	0.49	0.66	0.93	7676	1.0
beta[22,3]	0.4	3.5e-3	0.28	-0.17	0.21	0.4	0.59	0.91	6112	1.0
beta[23,3]	0.45	3.1e-3	0.27	-0.09	0.27	0.47	0.64	0.93	7243	1.0
beta[24,3]	0.09	3.8e-3	0.29	-0.49	-0.09	0.1	0.29	0.65	5781	1.0
beta[25,3]	0.39	3.6e-3	0.29	-0.21	0.2	0.4	0.6	0.9	6422	1.0
beta[26,3]	0.4	3.7e-3	0.27	-0.15	0.21	0.41	0.59	0.91	5529	1.0
beta[27,3]	0.45	3.3e-3	0.28	-0.12	0.27	0.47	0.65	0.94	6751	1.0
beta[28,3]	0.47	2.9e-3	0.27	-0.1	0.28	0.49	0.67	0.94	8550	1.0
beta[29,3]	0.41	3.4e-3	0.28	-0.19	0.22	0.41	0.61	0.92	7115	1.0
beta[30,3]	0.39	3.2e-3	0.28	-0.21	0.2	0.4	0.59	0.91	7558	1.0
beta[31,3]	0.45	3.1e-3	0.27	-0.1	0.28	0.47	0.65	0.94	7683	1.0
beta[32,3]	0.48	3.1e-3	0.27	-0.09	0.3	0.49	0.68	0.94	7765	1.0
beta[33,3]	0.49	3.0e-3	0.26	-0.07	0.31	0.5	0.68	0.94	7488	1.0
beta[34,3]	0.41	3.0e-3	0.28	-0.18	0.22	0.42	0.61	0.91	8601	1.0
beta[35,3]	0.3	3.3e-3	0.28	-0.26	0.12	0.31	0.5	0.82	7246	1.0
beta[36,3]	0.19	3.8e-3	0.3	-0.43	-1.5e-3	0.2	0.39	0.78	6265	1.0
beta[37,3]	0.57	2.9e-3	0.24	0.04	0.41	0.59	0.75	0.97	7315	1.0
beta[38,3]	0.47	3.3e-3	0.27	-0.09	0.29	0.48	0.67	0.94	6715	1.0
beta[39,3]	0.32	3.2e-3	0.29	-0.27	0.13	0.34	0.52	0.85	8034	1.0
beta[40,3]	0.47	3.0e-3	0.27	-0.08	0.29	0.49	0.67	0.94	7885	1.0
beta[41,3]	0.49	2.9e-3	0.27	-0.08	0.31	0.5	0.68	0.94	8310	1.0
beta[42,3]	0.5	3.1e-3	0.26	-0.06	0.32	0.51	0.7	0.94	7517	1.0
beta[43,3]	0.48	3.1e-3	0.26	-0.07	0.3	0.5	0.68	0.94	7405	1.0
beta[44,3]	0.36	3.2e-3	0.29	-0.22	0.17	0.37	0.56	0.89	7781	1.0
beta[45,3]	0.38	3.3e-3	0.28	-0.2	0.19	0.39	0.58	0.9	6999	1.0
beta[46,3]	0.34	3.3e-3	0.29	-0.25	0.15	0.35	0.55	0.87	7390	1.0
beta[47,3]	0.52	3.1e-3	0.25	-0.01	0.35	0.54	0.71	0.95	6819	1.0
beta[48,3]	0.27	3.2e-3	0.3	-0.34	0.07	0.27	0.49	0.82	8589	1.0
beta[49,3]	0.43	3.1e-3	0.27	-0.12	0.25	0.44	0.62	0.91	7428	1.0
beta[50,3]	0.52	3.3e-3	0.26	-0.04	0.35	0.54	0.72	0.96	6362	1.0
beta[51,3]	0.32	3.2e-3	0.29	-0.27	0.13	0.32	0.51	0.85	8030	1.0
beta[52,3]	0.38	3.3e-3	0.28	-0.18	0.2	0.4	0.59	0.9	7165	1.0
beta[53,3]	0.41	3.5e-3	0.27	-0.14	0.23	0.41	0.6	0.92	5760	1.0

beta[54,3]	0.17	3.8e-3	0.29	-0.41	-0.03	0.17	0.36	0.73	5761	1.0
beta[55,3]	0.43	3.4e-3	0.27	-0.12	0.25	0.43	0.62	0.92	6295	1.0
beta[56,3]	0.27	3.4e-3	0.29	-0.32	0.08	0.28	0.47	0.83	7070	1.0
beta[57,3]	0.4	3.2e-3	0.28	-0.17	0.21	0.41	0.6	0.91	7764	1.0
beta[58,3]	0.13	3.8e-3	0.3	-0.47	-0.06	0.14	0.34	0.7	6094	1.0
beta[59,3]	0.48	2.7e-3	0.25	-0.03	0.32	0.5	0.67	0.91	8767	1.0
beta[60,3]	0.27	3.6e-3	0.28	-0.28	0.08	0.28	0.46	0.79	5977	1.0
beta[61,3]	0.43	3.2e-3	0.26	-0.1	0.25	0.43	0.61	0.9	6602	1.0
beta[62,3]	0.58	2.7e-3	0.23	0.09	0.43	0.6	0.76	0.97	7326	1.0
beta[63,3]	0.34	3.4e-3	0.28	-0.24	0.15	0.34	0.53	0.87	6878	1.0
beta[64,3]	0.33	3.5e-3	0.27	-0.22	0.15	0.34	0.52	0.83	6090	1.0
beta[65,3]	0.24	3.4e-3	0.28	-0.35	0.06	0.25	0.43	0.79	7052	1.0
beta[66,3]	0.3	3.4e-3	0.27	-0.26	0.13	0.31	0.5	0.82	6425	1.0
beta[67,3]	0.65	2.6e-3	0.22	0.17	0.51	0.67	0.82	0.98	7238	1.0
beta[68,3]	0.23	4.1e-3	0.3	-0.36	0.04	0.24	0.43	0.8	5350	1.0
beta[69,3]	0.45	3.0e-3	0.27	-0.11	0.27	0.46	0.64	0.92	8067	1.0
beta[70,3]	0.24	3.6e-3	0.28	-0.32	0.05	0.25	0.44	0.79	6167	1.0
beta[71,3]	0.7	2.2e-3	0.2	0.23	0.57	0.73	0.86	0.99	8883	1.0
beta[72,3]	0.74	2.1e-3	0.18	0.31	0.63	0.78	0.89	0.99	7988	1.0
beta[73,3]	0.23	3.6e-3	0.28	-0.33	0.05	0.24	0.43	0.77	6056	1.0
beta[74,3]	0.3	3.7e-3	0.28	-0.27	0.11	0.31	0.5	0.83	5859	1.0
beta[75,3]	0.17	3.1e-3	0.28	-0.38	-9.3e-3	0.18	0.36	0.71	7887	1.0
beta[76,3]	0.19	5.0e-3	0.28	-0.38	0.02	0.2	0.38	0.74	3253	1.0
beta[77,3]	0.27	3.3e-3	0.29	-0.32	0.09	0.28	0.47	0.82	7604	1.0
beta[78,3]	0.37	3.2e-3	0.27	-0.17	0.18	0.38	0.57	0.87	7382	1.0
beta[79,3]	0.34	3.5e-3	0.28	-0.23	0.15	0.34	0.53	0.87	6420	1.0
beta[80,3]	0.65	2.6e-3	0.22	0.17	0.51	0.68	0.83	0.98	7134	1.0
beta[81,3]	0.32	3.1e-3	0.28	-0.24	0.13	0.32	0.51	0.82	7706	1.0
beta[82,3]	0.35	3.2e-3	0.28	-0.21	0.17	0.36	0.56	0.85	7763	1.0
beta[83,3]	0.65	2.6e-3	0.22	0.17	0.51	0.68	0.83	0.98	7214	1.0
beta[84,3]	0.7	2.4e-3	0.21	0.23	0.57	0.73	0.86	0.98	7094	1.0
beta[85,3]	0.66	2.2e-3	0.21	0.19	0.52	0.69	0.83	0.98	8957	1.0
beta[86,3]	0.23	3.6e-3	0.29	-0.36	0.05	0.24	0.43	0.79	6317	1.0
beta[87,3]	0.57	2.6e-3	0.24	0.05	0.41	0.59	0.75	0.96	8631	1.0

beta[88,3]	0.16	3.7e-3	0.29	-0.44	-0.04	0.16	0.36	0.72	6412	1.0
beta[89,3]	0.26	3.8e-3	0.3	-0.35	0.06	0.27	0.48	0.83	6330	1.0
beta[90,3]	0.53	3.0e-3	0.25	-4.8e-3	0.36	0.54	0.71	0.95	7011	1.0
beta[91,3]	0.35	3.1e-3	0.27	-0.19	0.18	0.36	0.53	0.85	7180	1.0
beta[92,3]	0.4	3.3e-3	0.27	-0.16	0.22	0.4	0.59	0.9	6603	1.0
beta[93,3]	0.53	3.0e-3	0.24	0.01	0.37	0.55	0.71	0.95	6425	1.0
beta[94,3]	0.38	3.5e-3	0.28	-0.19	0.2	0.39	0.58	0.9	6230	1.0
beta[95,3]	0.65	2.7e-3	0.22	0.16	0.5	0.68	0.82	0.98	6650	1.0
beta[96,3]	0.3	3.4e-3	0.28	-0.27	0.11	0.3	0.5	0.83	6905	1.0
beta[97,3]	0.08	3.5e-3	0.29	-0.53	-0.11	0.09	0.28	0.66	7172	1.0
beta[98,3]	0.57	3.0e-3	0.24	0.05	0.42	0.59	0.76	0.97	6712	1.0
beta[99,3]	0.59	2.8e-3	0.24	0.09	0.43	0.61	0.77	0.97	7144	1.0
beta[100,3]	0.56	2.8e-3	0.23	0.07	0.4	0.57	0.73	0.96	6820	1.0
beta[101,3]	0.41	3.1e-3	0.26	-0.13	0.24	0.41	0.59	0.9	7114	1.0
beta[102,3]	0.37	3.7e-3	0.27	-0.18	0.19	0.37	0.55	0.87	5249	1.0
beta[103,3]	0.27	3.2e-3	0.29	-0.31	0.08	0.28	0.48	0.81	8020	1.0
beta[104,3]	0.34	3.1e-3	0.28	-0.24	0.16	0.35	0.53	0.86	7830	1.0
beta[105,3]	0.27	3.1e-3	0.29	-0.3	0.08	0.28	0.47	0.82	8852	1.0
beta[106,3]	0.55	2.9e-3	0.24	0.04	0.38	0.57	0.72	0.95	6786	1.0
beta[107,3]	0.31	3.7e-3	0.27	-0.25	0.14	0.32	0.5	0.83	5563	1.0
beta[108,3]	0.57	3.0e-3	0.24	0.07	0.41	0.59	0.76	0.97	6319	1.0
beta[109,3]	0.33	3.7e-3	0.28	-0.23	0.14	0.33	0.52	0.86	5791	1.0
beta[110,3]	0.47	2.9e-3	0.26	-0.06	0.3	0.48	0.65	0.93	7686	1.0
beta[111,3]	0.34	3.4e-3	0.28	-0.23	0.16	0.35	0.54	0.87	6838	1.0
beta[112,3]	0.35	3.9e-3	0.28	-0.21	0.17	0.36	0.55	0.86	5026	1.0
beta[113,3]	0.12	3.6e-3	0.28	-0.43	-0.06	0.13	0.31	0.65	5974	1.0
beta[1,4]	0.36	3.2e-3	0.27	-0.2	0.18	0.36	0.54	0.86	7067	1.0
beta[2,4]	0.59	2.6e-3	0.23	0.09	0.44	0.61	0.77	0.96	8150	1.0
beta[3,4]	0.41	3.4e-3	0.28	-0.18	0.22	0.41	0.61	0.92	7045	1.0
beta[4,4]	0.22	3.7e-3	0.29	-0.36	0.03	0.22	0.42	0.78	6274	1.0
beta[5,4]	0.47	3.4e-3	0.26	-0.07	0.3	0.48	0.66	0.93	5949	1.0
beta[6,4]	0.58	2.8e-3	0.24	0.06	0.42	0.59	0.76	0.97	7385	1.0
beta[7,4]	0.46	3.7e-3	0.26	-0.09	0.29	0.47	0.65	0.93	5119	1.0
beta[8,4]	0.23	3.4e-3	0.3	-0.37	0.04	0.24	0.44	0.8	7606	1.0

beta[9,4]	0.31	3.6e-3	0.28	-0.27	0.13	0.32	0.5	0.87	6216	1.0
beta[10,4]	0.32	3.3e-3	0.28	-0.26	0.14	0.33	0.51	0.84	7268	1.0
beta[11,4]	0.33	3.9e-3	0.29	-0.26	0.14	0.35	0.54	0.88	5585	1.0
beta[12,4]	0.43	3.1e-3	0.27	-0.12	0.26	0.44	0.62	0.93	7356	1.0
beta[13,4]	0.57	3.0e-3	0.24	0.05	0.4	0.58	0.75	0.96	6365	1.0
beta[14,4]	0.23	3.7e-3	0.28	-0.35	0.04	0.23	0.43	0.77	5766	1.0
beta[15,4]	0.57	3.0e-3	0.24	0.04	0.4	0.58	0.75	0.97	6539	1.0
beta[16,4]	0.44	3.0e-3	0.26	-0.09	0.26	0.45	0.63	0.92	7584	1.0
beta[17,4]	0.32	3.1e-3	0.28	-0.27	0.14	0.33	0.52	0.84	8094	1.0
beta[18,4]	0.56	2.9e-3	0.25	0.03	0.4	0.58	0.75	0.96	7403	1.0
beta[19,4]	0.31	3.0e-3	0.29	-0.29	0.13	0.32	0.51	0.84	9114	1.0
beta[20,4]	0.38	3.0e-3	0.27	-0.17	0.21	0.39	0.58	0.89	8546	1.0
beta[21,4]	0.47	2.9e-3	0.26	-0.07	0.31	0.49	0.66	0.92	7754	1.0
beta[22,4]	0.6	2.7e-3	0.23	0.11	0.45	0.63	0.77	0.97	7212	1.0
beta[23,4]	0.45	3.1e-3	0.27	-0.1	0.27	0.46	0.65	0.94	7794	1.0
beta[24,4]	0.56	2.7e-3	0.24	0.04	0.4	0.58	0.74	0.96	8095	1.0
beta[25,4]	0.63	2.7e-3	0.24	0.1	0.48	0.66	0.82	0.98	7597	1.0
beta[26,4]	0.5	3.2e-3	0.26	-0.03	0.34	0.52	0.69	0.95	6363	1.0
beta[27,4]	0.45	3.2e-3	0.27	-0.11	0.28	0.47	0.64	0.94	6895	1.0
beta[28,4]	0.56	2.8e-3	0.24	0.05	0.4	0.58	0.74	0.96	7417	1.0
beta[29,4]	0.42	3.1e-3	0.27	-0.14	0.23	0.43	0.61	0.91	7421	1.0
beta[30,4]	0.49	3.0e-3	0.25	-0.04	0.32	0.51	0.68	0.93	7189	1.0
beta[31,4]	0.57	2.5e-3	0.24	0.05	0.41	0.59	0.75	0.95	9080	1.0
beta[32,4]	0.48	3.8e-3	0.26	-0.06	0.3	0.49	0.67	0.94	4769	1.0
beta[33,4]	0.48	3.6e-3	0.26	-0.06	0.3	0.49	0.67	0.94	5338	1.0
beta[34,4]	0.25	3.5e-3	0.29	-0.35	0.06	0.27	0.45	0.79	6844	1.0
beta[35,4]	0.31	3.8e-3	0.29	-0.28	0.11	0.32	0.52	0.84	5915	1.0
beta[36,4]	0.47	2.9e-3	0.25	-0.06	0.3	0.48	0.65	0.92	7583	1.0
beta[37,4]	0.58	2.6e-3	0.23	0.09	0.43	0.59	0.74	0.96	7447	1.0
beta[38,4]	0.57	2.8e-3	0.24	0.06	0.41	0.59	0.75	0.96	7333	1.0
beta[39,4]	0.33	3.9e-3	0.28	-0.26	0.14	0.34	0.53	0.87	5385	1.0
beta[40,4]	0.58	2.7e-3	0.24	0.05	0.41	0.59	0.76	0.97	7787	1.0
beta[41,4]	0.57	2.7e-3	0.24	0.06	0.41	0.59	0.75	0.96	7544	1.0
beta[42,4]	0.49	3.3e-3	0.26	-0.07	0.32	0.5	0.68	0.94	6273	1.0

beta[43,4]	0.38	3.1e-3	0.27	-0.16	0.2	0.39	0.57	0.88	7188	1.0
beta[44,4]	0.63	2.8e-3	0.23	0.13	0.48	0.65	0.81	0.98	6712	1.0
beta[45,4]	0.39	3.3e-3	0.28	-0.19	0.21	0.4	0.6	0.9	7324	1.0
beta[46,4]	0.35	3.4e-3	0.28	-0.25	0.16	0.36	0.55	0.87	6888	1.0
beta[47,4]	0.52	2.9e-3	0.25	-0.01	0.35	0.53	0.7	0.95	7462	1.0
beta[48,4]	0.65	2.8e-3	0.22	0.18	0.51	0.67	0.82	0.98	6132	1.0
beta[49,4]	0.42	3.1e-3	0.26	-0.12	0.25	0.43	0.6	0.9	6998	1.0
beta[50,4]	0.63	2.9e-3	0.23	0.14	0.49	0.66	0.81	0.98	5928	1.0
beta[51,4]	0.45	3.3e-3	0.26	-0.09	0.28	0.46	0.65	0.93	6598	1.0
beta[52,4]	0.39	3.3e-3	0.27	-0.16	0.21	0.4	0.57	0.89	6797	1.0
beta[53,4]	0.62	2.5e-3	0.23	0.13	0.47	0.64	0.8	0.97	8088	1.0
beta[54,4]	0.34	3.1e-3	0.27	-0.22	0.16	0.34	0.52	0.86	7748	1.0
beta[55,4]	0.43	3.0e-3	0.26	-0.11	0.26	0.44	0.62	0.9	7512	1.0
beta[56,4]	0.58	2.9e-3	0.24	0.07	0.42	0.6	0.77	0.96	6615	1.0
beta[57,4]	0.4	2.9e-3	0.26	-0.13	0.23	0.41	0.59	0.88	8215	1.0
beta[58,4]	0.25	3.5e-3	0.28	-0.32	0.07	0.26	0.44	0.79	6439	1.0
beta[59,4]	0.77	2.0e-3	0.17	0.37	0.67	0.81	0.91	0.99	7233	1.0
beta[60,4]	0.61	2.6e-3	0.22	0.13	0.46	0.63	0.78	0.96	7249	1.0
beta[61,4]	0.62	2.3e-3	0.21	0.16	0.48	0.63	0.78	0.97	8387	1.0
beta[62,4]	0.73	2.0e-3	0.18	0.32	0.62	0.76	0.88	0.99	8483	1.0
beta[63,4]	0.45	3.0e-3	0.25	-0.06	0.28	0.45	0.62	0.9	6597	1.0
beta[64,4]	0.33	4.5e-3	0.27	-0.21	0.15	0.34	0.51	0.88	3586	1.0
beta[65,4]	0.47	3.6e-3	0.26	-0.07	0.29	0.48	0.66	0.92	5232	1.0
beta[66,4]	0.6	2.4e-3	0.23	0.11	0.45	0.62	0.78	0.96	8730	1.0
beta[67,4]	0.67	2.4e-3	0.2	0.21	0.54	0.69	0.83	0.98	7477	1.0
beta[68,4]	0.6	2.5e-3	0.23	0.12	0.44	0.62	0.77	0.96	8232	1.0
beta[69,4]	0.58	3.0e-3	0.24	0.06	0.42	0.6	0.77	0.98	6565	1.0
beta[70,4]	0.46	3.0e-3	0.25	-0.05	0.29	0.47	0.64	0.92	6830	1.0
beta[71,4]	0.59	2.7e-3	0.23	0.11	0.43	0.6	0.77	0.97	7167	1.0
beta[72,4]	0.52	2.8e-3	0.24	0.01	0.36	0.53	0.7	0.94	7457	1.0
beta[73,4]	0.38	2.9e-3	0.26	-0.14	0.21	0.39	0.56	0.86	7797	1.0
beta[74,4]	0.3	3.1e-3	0.26	-0.23	0.12	0.3	0.48	0.81	7288	1.0
beta[75,4]	0.57	2.8e-3	0.23	0.08	0.41	0.59	0.74	0.96	6709	1.0
beta[76,4]	0.55	2.9e-3	0.23	0.06	0.4	0.57	0.73	0.95	6636	1.0

beta[77,4]	0.58	2.7e-3	0.24	0.07	0.43	0.6	0.77	0.97	7835	1.0
beta[78,4]	0.63	2.3e-3	0.22	0.15	0.49	0.65	0.8	0.97	8696	1.0
beta[79,4]	0.45	2.8e-3	0.25	-0.08	0.28	0.46	0.63	0.9	8174	1.0
beta[80,4]	0.67	2.5e-3	0.21	0.21	0.53	0.7	0.84	0.98	6755	1.0
beta[81,4]	0.5	3.1e-3	0.25	2.4e-3	0.34	0.51	0.69	0.94	6265	1.0
beta[82,4]	0.46	3.1e-3	0.25	-0.06	0.29	0.47	0.64	0.92	6803	1.0
beta[83,4]	0.67	2.4e-3	0.21	0.2	0.54	0.7	0.83	0.98	7402	1.0
beta[84,4]	0.63	2.4e-3	0.21	0.18	0.49	0.65	0.8	0.97	8039	1.0
beta[85,4]	0.47	3.1e-3	0.24	-0.03	0.3	0.47	0.64	0.92	6096	1.0
beta[86,4]	0.55	2.9e-3	0.24	0.04	0.39	0.56	0.72	0.95	6975	1.0
beta[87,4]	0.66	2.3e-3	0.21	0.21	0.53	0.68	0.83	0.98	8146	1.0
beta[88,4]	0.38	3.3e-3	0.27	-0.15	0.19	0.39	0.56	0.87	6552	1.0
beta[89,4]	0.3	3.2e-3	0.28	-0.28	0.11	0.3	0.5	0.84	7928	1.0
beta[90,4]	0.69	2.3e-3	0.2	0.24	0.56	0.72	0.85	0.98	7487	1.0
beta[91,4]	0.58	2.9e-3	0.23	0.1	0.43	0.59	0.75	0.96	6069	1.0
beta[92,4]	0.67	2.3e-3	0.2	0.21	0.54	0.7	0.83	0.98	7593	1.0
beta[93,4]	0.42	3.1e-3	0.25	-0.07	0.25	0.43	0.6	0.89	6387	1.0
beta[94,4]	0.62	2.3e-3	0.22	0.13	0.48	0.65	0.8	0.97	9741	1.0
beta[95,4]	0.55	2.6e-3	0.24	0.06	0.39	0.56	0.73	0.95	7997	1.0
beta[96,4]	0.57	2.7e-3	0.23	0.08	0.42	0.59	0.75	0.96	7470	1.0
beta[97,4]	0.43	3.3e-3	0.26	-0.11	0.25	0.44	0.62	0.91	6175	1.0
beta[98,4]	0.68	2.7e-3	0.21	0.23	0.54	0.7	0.84	0.98	6008	1.0
beta[99,4]	0.73	2.0e-3	0.19	0.31	0.62	0.76	0.88	0.99	8628	1.0
beta[100,4]	0.47	3.2e-3	0.24	-0.02	0.31	0.48	0.64	0.91	5449	1.0
beta[101,4]	0.52	3.0e-3	0.24	7.7e-3	0.36	0.53	0.7	0.95	6451	1.0
beta[102,4]	0.49	2.8e-3	0.25	-0.01	0.33	0.51	0.67	0.93	7516	1.0
beta[103,4]	0.59	3.0e-3	0.24	0.09	0.43	0.61	0.77	0.97	6155	1.0
beta[104,4]	0.53	2.6e-3	0.24	0.03	0.37	0.55	0.71	0.95	8621	1.0
beta[105,4]	0.58	2.7e-3	0.23	0.08	0.42	0.6	0.76	0.96	7517	1.0
beta[106,4]	0.65	2.4e-3	0.21	0.18	0.52	0.68	0.82	0.98	7596	1.0
beta[107,4]	0.55	3.1e-3	0.23	0.05	0.39	0.56	0.72	0.95	5683	1.0
beta[108,4]	0.34	2.7e-3	0.25	-0.18	0.17	0.35	0.52	0.82	8637	1.0
beta[109,4]	0.53	3.2e-3	0.24	0.03	0.37	0.54	0.71	0.95	5498	1.0
beta[110,4]	0.05	4.0e-3	0.29	-0.55	-0.14	0.06	0.25	0.62	5335	1.0

beta[111,4]	0.53	2.9e-3	0.25	-1.7e-3	0.36	0.54	0.71	0.95	7234	1.0
beta[112,4]	0.35	2.9e-3	0.26	-0.17	0.17	0.35	0.53	0.85	7713	1.0
beta[113,4]	0.38	2.8e-3	0.25	-0.11	0.21	0.39	0.56	0.86	7835	1.0
beta[1,5]	-0.54	3.3e-3	0.26	-0.96	-0.73	-0.55	-0.36	3.9e-4	6018	1.0
beta[2,5]	-0.53	2.9e-3	0.25	-0.95	-0.72	-0.54	-0.36	-0.03	7250	1.0
beta[3,5]	-0.41	3.1e-3	0.28	-0.91	-0.61	-0.41	-0.22	0.16	8121	1.0
beta[4,5]	-0.49	3.0e-3	0.26	-0.93	-0.68	-0.5	-0.32	0.04	7449	1.0
beta[5,5]	-0.56	2.5e-3	0.23	-0.95	-0.74	-0.58	-0.41	-0.06	8871	1.0
beta[6,5]	-0.39	3.6e-3	0.27	-0.89	-0.58	-0.4	-0.21	0.17	5539	1.0
beta[7,5]	-0.35	3.2e-3	0.26	-0.86	-0.54	-0.35	-0.17	0.16	6566	1.0
beta[8,5]	-0.48	3.0e-3	0.26	-0.93	-0.66	-0.48	-0.3	0.05	7141	1.0
beta[9,5]	-0.49	3.0e-3	0.25	-0.93	-0.68	-0.51	-0.32	0.02	6984	1.0
beta[10,5]	-0.44	3.0e-3	0.27	-0.93	-0.64	-0.45	-0.26	0.13	8423	1.0
beta[11,5]	-0.59	2.8e-3	0.24	-0.98	-0.78	-0.61	-0.44	-0.08	7005	1.0
beta[12,5]	-0.59	2.9e-3	0.24	-0.97	-0.78	-0.62	-0.44	-0.09	6908	1.0
beta[13,5]	-0.45	3.4e-3	0.26	-0.93	-0.63	-0.46	-0.28	0.08	5977	1.0
beta[14,5]	-0.07	3.2e-3	0.28	-0.6	-0.26	-0.07	0.13	0.49	7459	1.0
beta[15,5]	-0.57	3.2e-3	0.23	-0.96	-0.74	-0.58	-0.42	-0.08	5280	1.0
beta[16,5]	-0.33	3.5e-3	0.28	-0.87	-0.52	-0.34	-0.15	0.21	6202	1.0
beta[17,5]	0.05	3.9e-3	0.3	-0.54	-0.15	0.05	0.25	0.65	5968	1.0
beta[18,5]	-0.45	3.1e-3	0.26	-0.9	-0.63	-0.45	-0.28	0.09	6958	1.0
beta[19,5]	-0.44	3.3e-3	0.27	-0.94	-0.63	-0.44	-0.26	0.11	6487	1.0
beta[20,5]	-0.41	3.3e-3	0.27	-0.91	-0.6	-0.42	-0.23	0.12	6477	1.0
beta[21,5]	-0.44	3.0e-3	0.25	-0.9	-0.62	-0.45	-0.27	0.07	7275	1.0
beta[22,5]	-0.4	2.9e-3	0.26	-0.88	-0.58	-0.4	-0.22	0.13	8053	1.0
beta[23,5]	-0.47	3.0e-3	0.27	-0.94	-0.67	-0.48	-0.29	0.07	7779	1.0
beta[24,5]	-0.2	3.7e-3	0.28	-0.75	-0.38	-0.2	-0.02	0.36	5659	1.0
beta[25,5]	-0.43	3.4e-3	0.28	-0.92	-0.63	-0.44	-0.24	0.13	6745	1.0
beta[26,5]	-0.38	3.0e-3	0.26	-0.87	-0.56	-0.38	-0.2	0.15	7502	1.0
beta[27,5]	-0.47	3.5e-3	0.27	-0.94	-0.67	-0.48	-0.28	0.09	6037	1.0
beta[28,5]	-0.45	2.8e-3	0.26	-0.92	-0.64	-0.45	-0.27	0.09	8765	1.0
beta[29,5]	-0.35	3.4e-3	0.28	-0.88	-0.55	-0.36	-0.16	0.23	6779	1.0
beta[30,5]	-0.61	2.8e-3	0.24	-0.97	-0.79	-0.63	-0.45	-0.1	6993	1.0
beta[31,5]	-0.45	3.0e-3	0.26	-0.91	-0.64	-0.46	-0.27	0.08	7175	1.0

beta[32,5]	-0.44	3.0e-3	0.26	-0.9	-0.62	-0.45	-0.27	0.1	7573	1.0
beta[33,5]	-0.53	2.9e-3	0.25	-0.96	-0.72	-0.55	-0.37	-6.8e-3	7170	1.0
beta[34,5]	-0.34	3.1e-3	0.27	-0.86	-0.54	-0.35	-0.16	0.2	7808	1.0
beta[35,5]	-0.45	3.3e-3	0.27	-0.94	-0.64	-0.45	-0.27	0.13	6960	1.0
beta[36,5]	-4.1e-3	3.9e-3	0.29	-0.55	-0.2	-3.6e-3	0.19	0.57	5354	1.0
beta[37,5]	-0.57	3.0e-3	0.24	-0.97	-0.75	-0.58	-0.4	-0.04	6637	1.0
beta[38,5]	-0.52	2.6e-3	0.25	-0.94	-0.71	-0.54	-0.36	-7.9e-3	9306	1.0
beta[39,5]	-0.58	3.0e-3	0.24	-0.97	-0.76	-0.6	-0.42	-0.06	6457	1.0
beta[40,5]	-0.61	2.7e-3	0.24	-0.98	-0.79	-0.63	-0.45	-0.1	7729	1.0
beta[41,5]	-0.62	2.7e-3	0.23	-0.97	-0.8	-0.64	-0.47	-0.12	7223	1.0
beta[42,5]	-0.61	2.7e-3	0.23	-0.97	-0.79	-0.63	-0.46	-0.12	7249	1.0
beta[43,5]	-0.43	3.6e-3	0.26	-0.91	-0.62	-0.44	-0.26	0.09	5191	1.0
beta[44,5]	-0.33	3.3e-3	0.26	-0.84	-0.52	-0.34	-0.16	0.19	6584	1.0
beta[45,5]	-0.5	3.3e-3	0.26	-0.96	-0.69	-0.51	-0.33	0.05	6430	1.0
beta[46,5]	-0.57	3.1e-3	0.25	-0.96	-0.76	-0.59	-0.4	-0.03	6549	1.0
beta[47,5]	-0.51	3.0e-3	0.24	-0.94	-0.68	-0.51	-0.34	-0.02	6440	1.0
beta[48,5]	-0.1	3.4e-3	0.28	-0.64	-0.3	-0.11	0.08	0.45	6726	1.0
beta[49,5]	-0.5	3.3e-3	0.26	-0.95	-0.7	-0.52	-0.33	0.04	6091	1.0
beta[50,5]	-0.48	3.1e-3	0.25	-0.93	-0.67	-0.49	-0.31	0.04	6700	1.0
beta[51,5]	-0.56	2.9e-3	0.24	-0.96	-0.75	-0.58	-0.4	-0.05	6910	1.0
beta[52,5]	-0.38	3.5e-3	0.27	-0.9	-0.56	-0.39	-0.2	0.15	5689	1.0
beta[53,5]	-0.47	3.2e-3	0.26	-0.94	-0.66	-0.48	-0.29	0.07	6480	1.0
beta[54,5]	-0.44	3.0e-3	0.25	-0.9	-0.62	-0.44	-0.26	0.07	7088	1.0
beta[55,5]	-0.32	3.1e-3	0.27	-0.83	-0.51	-0.32	-0.13	0.22	7486	1.0
beta[56,5]	-0.47	3.3e-3	0.28	-0.95	-0.68	-0.49	-0.28	0.1	6797	1.0
beta[57,5]	-0.51	3.3e-3	0.26	-0.94	-0.7	-0.52	-0.34	0.05	6279	1.0
beta[58,5]	-0.34	3.1e-3	0.28	-0.87	-0.54	-0.35	-0.15	0.22	8048	1.0
beta[59,5]	-0.34	3.5e-3	0.28	-0.86	-0.54	-0.35	-0.15	0.23	6666	1.0
beta[60,5]	-0.43	3.0e-3	0.27	-0.91	-0.62	-0.43	-0.25	0.12	7928	1.0
beta[61,5]	-0.31	3.2e-3	0.28	-0.83	-0.5	-0.31	-0.12	0.26	7590	1.0
beta[62,5]	-0.39	3.1e-3	0.28	-0.89	-0.6	-0.4	-0.21	0.18	8076	1.0
beta[63,5]	-0.43	2.9e-3	0.27	-0.91	-0.62	-0.44	-0.26	0.12	8111	1.0
beta[64,5]	-0.23	3.6e-3	0.3	-0.8	-0.44	-0.23	-0.04	0.38	6824	1.0
beta[65,5]	-0.41	3.6e-3	0.27	-0.92	-0.6	-0.42	-0.22	0.14	5735	1.0

beta[66,5]	-0.38	3.3e-3	0.27	-0.89	-0.58	-0.39	-0.2	0.16	6652	1.0
beta[67,5]	-0.33	3.5e-3	0.29	-0.87	-0.53	-0.33	-0.14	0.24	6771	1.0
beta[68,5]	-0.11	3.1e-3	0.29	-0.66	-0.3	-0.11	0.09	0.46	8475	1.0
beta[69,5]	-0.31	3.5e-3	0.28	-0.85	-0.5	-0.32	-0.12	0.24	6443	1.0
beta[70,5]	-0.4	3.6e-3	0.28	-0.9	-0.59	-0.4	-0.21	0.16	5790	1.0
beta[71,5]	-0.33	3.2e-3	0.27	-0.85	-0.52	-0.34	-0.15	0.23	7525	1.0
beta[72,5]	-0.44	3.6e-3	0.27	-0.92	-0.63	-0.45	-0.26	0.14	5833	1.0
beta[73,5]	-0.14	3.6e-3	0.3	-0.72	-0.35	-0.15	0.05	0.47	6813	1.0
beta[74,5]	-0.58	3.2e-3	0.25	-0.97	-0.77	-0.61	-0.42	-0.06	5926	1.0
beta[75,5]	-0.54	2.8e-3	0.25	-0.96	-0.74	-0.57	-0.38	-0.01	8010	1.0
beta[76,5]	-0.37	3.9e-3	0.27	-0.88	-0.56	-0.37	-0.18	0.18	5003	1.0
beta[77,5]	-0.47	3.6e-3	0.28	-0.94	-0.68	-0.49	-0.29	0.1	5930	1.0
beta[78,5]	-0.49	2.9e-3	0.26	-0.94	-0.68	-0.51	-0.32	0.05	7767	1.0
beta[79,5]	-0.43	2.9e-3	0.27	-0.91	-0.62	-0.44	-0.25	0.13	8346	1.0
beta[80,5]	-0.32	3.5e-3	0.28	-0.85	-0.52	-0.33	-0.14	0.23	6322	1.0
beta[81,5]	-0.52	3.2e-3	0.26	-0.96	-0.72	-0.54	-0.34	0.02	6372	1.0
beta[82,5]	-0.51	3.2e-3	0.26	-0.95	-0.71	-0.53	-0.34	0.03	6719	1.0
beta[83,5]	-0.33	3.5e-3	0.28	-0.86	-0.53	-0.33	-0.14	0.24	6462	1.0
beta[84,5]	-0.43	3.0e-3	0.27	-0.91	-0.63	-0.44	-0.24	0.13	8026	1.0
beta[85,5]	-0.27	3.6e-3	0.28	-0.82	-0.46	-0.27	-0.08	0.29	6091	1.0
beta[86,5]	-0.17	3.7e-3	0.29	-0.74	-0.37	-0.17	0.02	0.4	6181	1.0
beta[87,5]	-0.56	3.3e-3	0.25	-0.97	-0.76	-0.58	-0.4	-0.04	5596	1.0
beta[88,5]	-0.32	3.1e-3	0.29	-0.87	-0.52	-0.33	-0.13	0.26	8540	1.0
beta[89,5]	-0.21	3.5e-3	0.31	-0.79	-0.42	-0.21	-3.2e-3	0.43	7485	1.0
beta[90,5]	-0.41	3.1e-3	0.26	-0.87	-0.59	-0.42	-0.23	0.13	7237	1.0
beta[91,5]	-0.4	3.2e-3	0.26	-0.89	-0.59	-0.4	-0.22	0.13	6985	1.0
beta[92,5]	-0.33	3.6e-3	0.28	-0.86	-0.52	-0.33	-0.15	0.23	5833	1.0
beta[93,5]	-0.17	4.0e-3	0.3	-0.75	-0.37	-0.18	0.02	0.4	5361	1.0
beta[94,5]	-0.36	3.2e-3	0.27	-0.88	-0.55	-0.36	-0.17	0.2	7180	1.0
beta[95,5]	-0.38	3.6e-3	0.28	-0.9	-0.57	-0.39	-0.19	0.2	6283	1.0
beta[96,5]	-0.56	2.8e-3	0.25	-0.96	-0.74	-0.57	-0.39	-0.04	7454	1.0
beta[97,5]	-0.55	2.6e-3	0.25	-0.96	-0.74	-0.57	-0.38	-0.02	9001	1.0
beta[98,5]	-0.4	3.1e-3	0.26	-0.89	-0.59	-0.41	-0.22	0.13	7168	1.0
beta[99,5]	-0.36	3.3e-3	0.27	-0.86	-0.55	-0.37	-0.18	0.18	6843	1.0

beta[100,5]	-0.4	3.7e-3	0.27	-0.9	-0.59	-0.4	-0.21	0.16	5387	1.0
beta[101,5]	-0.44	3.5e-3	0.27	-0.92	-0.64	-0.44	-0.25	0.13	6143	1.0
beta[102,5]	-0.39	3.1e-3	0.27	-0.89	-0.59	-0.4	-0.21	0.16	7660	1.0
beta[103,5]	-0.47	3.5e-3	0.27	-0.94	-0.68	-0.49	-0.28	0.1	6197	1.0
beta[104,5]	-0.51	3.3e-3	0.26	-0.96	-0.71	-0.53	-0.34	0.05	6097	1.0
beta[105,5]	-0.47	3.1e-3	0.27	-0.94	-0.68	-0.48	-0.28	0.1	8012	1.0
beta[106,5]	-0.31	2.9e-3	0.26	-0.82	-0.5	-0.31	-0.13	0.22	8302	1.0
beta[107,5]	-0.49	3.5e-3	0.27	-0.95	-0.69	-0.5	-0.31	0.05	5875	1.0
beta[108,5]	-0.56	2.8e-3	0.24	-0.96	-0.74	-0.57	-0.4	-0.04	7210	1.0
beta[109,5]	-0.42	3.3e-3	0.27	-0.91	-0.61	-0.43	-0.23	0.14	6614	1.0
beta[110,5]	-0.34	3.0e-3	0.28	-0.86	-0.54	-0.34	-0.15	0.22	8570	1.0
beta[111,5]	-0.44	3.3e-3	0.28	-0.93	-0.64	-0.45	-0.25	0.13	7270	1.0
beta[112,5]	-0.43	3.1e-3	0.27	-0.91	-0.63	-0.44	-0.25	0.11	7419	1.0
beta[113,5]	-0.1	3.7e-3	0.3	-0.69	-0.31	-0.11	0.09	0.51	6671	1.0
beta[1,6]	-0.1	3.6e-3	0.32	-0.72	-0.31	-0.11	0.11	0.53	7946	1.0
beta[2,6]	-0.27	3.4e-3	0.3	-0.83	-0.48	-0.28	-0.08	0.32	7574	1.0
beta[3,6]	-0.33	3.8e-3	0.31	-0.9	-0.55	-0.34	-0.13	0.29	6439	1.0
beta[4,6]	-0.4	3.4e-3	0.29	-0.91	-0.61	-0.41	-0.21	0.21	7239	1.0
beta[5,6]	-0.41	3.4e-3	0.28	-0.91	-0.61	-0.42	-0.21	0.17	7037	1.0
beta[6,6]	0.04	4.2e-3	0.31	-0.56	-0.17	0.03	0.24	0.68	5420	1.0
beta[7,6]	-0.26	3.9e-3	0.29	-0.83	-0.46	-0.26	-0.06	0.32	5627	1.0
beta[8,6]	-0.5	3.3e-3	0.28	-0.95	-0.72	-0.52	-0.32	0.08	7082	1.0
beta[9,6]	-0.29	3.5e-3	0.31	-0.87	-0.5	-0.29	-0.08	0.33	7599	1.0
beta[10,6]	-0.44	3.2e-3	0.28	-0.93	-0.65	-0.46	-0.26	0.13	7537	1.0
beta[11,6]	-0.51	3.0e-3	0.28	-0.95	-0.72	-0.53	-0.32	0.07	8625	1.0
beta[12,6]	-0.43	3.7e-3	0.29	-0.94	-0.64	-0.44	-0.23	0.17	5961	1.0
beta[13,6]	-0.12	3.9e-3	0.32	-0.72	-0.34	-0.13	0.09	0.53	6776	1.0
beta[14,6]	-0.56	2.9e-3	0.26	-0.96	-0.75	-0.58	-0.39	-6.4e-6	7981	1.0
beta[15,6]	-0.13	4.1e-3	0.3	-0.71	-0.32	-0.13	0.07	0.46	5305	1.0
beta[16,6]	-0.25	3.9e-3	0.3	-0.82	-0.45	-0.25	-0.05	0.35	5855	1.0
beta[17,6]	-0.19	4.1e-3	0.31	-0.79	-0.41	-0.19	0.02	0.44	5820	1.0
beta[18,6]	-0.12	3.9e-3	0.31	-0.72	-0.33	-0.13	0.09	0.52	6368	1.0
beta[19,6]	-0.45	3.3e-3	0.28	-0.94	-0.66	-0.46	-0.26	0.15	7345	1.0
beta[20,6]	-0.48	3.3e-3	0.28	-0.94	-0.69	-0.49	-0.29	0.12	7330	1.0

beta[21,6]	-0.24	3.7e-3	0.29	-0.82	-0.44	-0.24	-0.05	0.34	6342	1.0
beta[22,6]	-0.22	3.9e-3	0.31	-0.81	-0.43	-0.22	-3.7e-3	0.39	6200	1.0
beta[23,6]	-0.49	3.0e-3	0.28	-0.95	-0.7	-0.5	-0.3	0.11	8537	1.0
beta[24,6]	-0.44	3.6e-3	0.28	-0.94	-0.65	-0.44	-0.25	0.14	6014	1.0
beta[25,6]	-0.11	4.2e-3	0.32	-0.73	-0.33	-0.11	0.11	0.55	5839	1.0
beta[26,6]	-0.2	3.8e-3	0.29	-0.78	-0.41	-0.21	-0.01	0.38	5802	1.0
beta[27,6]	-0.48	3.1e-3	0.28	-0.95	-0.68	-0.5	-0.3	0.11	7812	1.0
beta[28,6]	-0.12	3.6e-3	0.3	-0.72	-0.32	-0.12	0.08	0.49	6957	1.0
beta[29,6]	-0.5	3.1e-3	0.28	-0.95	-0.71	-0.52	-0.31	0.09	7704	1.0
beta[30,6]	-0.21	4.1e-3	0.32	-0.84	-0.43	-0.21	-5.6e-3	0.43	5954	1.0
beta[31,6]	-0.29	3.6e-3	0.3	-0.87	-0.5	-0.3	-0.09	0.31	6950	1.0
beta[32,6]	-0.25	3.7e-3	0.3	-0.82	-0.45	-0.25	-0.05	0.38	6688	1.0
beta[33,6]	-0.23	3.3e-3	0.3	-0.8	-0.44	-0.24	-0.03	0.37	8318	1.0
beta[34,6]	-0.28	3.6e-3	0.31	-0.86	-0.5	-0.29	-0.08	0.34	7144	1.0
beta[35,6]	-0.24	3.9e-3	0.31	-0.82	-0.45	-0.24	-0.03	0.37	6054	1.0
beta[36,6]	-0.54	3.2e-3	0.26	-0.96	-0.74	-0.56	-0.37	0.01	6623	1.0
beta[37,6]	-0.14	4.0e-3	0.3	-0.72	-0.35	-0.15	0.06	0.46	5591	1.0
beta[38,6]	-0.13	3.8e-3	0.31	-0.73	-0.34	-0.14	0.07	0.48	6646	1.0
beta[39,6]	-0.52	3.2e-3	0.29	-0.97	-0.75	-0.54	-0.33	0.09	7729	1.0
beta[40,6]	-0.12	4.3e-3	0.32	-0.73	-0.34	-0.13	0.09	0.51	5345	1.0
beta[41,6]	-0.1	3.8e-3	0.3	-0.69	-0.31	-0.11	0.1	0.51	6187	1.0
beta[42,6]	-0.23	3.8e-3	0.31	-0.8	-0.44	-0.23	-0.02	0.4	6410	1.0
beta[43,6]	-0.35	3.3e-3	0.29	-0.89	-0.56	-0.36	-0.15	0.25	7697	1.0
beta[44,6]	0.02	3.7e-3	0.31	-0.6	-0.2	0.01	0.22	0.67	7243	1.0
beta[45,6]	-0.18	3.7e-3	0.31	-0.77	-0.39	-0.19	0.02	0.43	6660	1.0
beta[46,6]	-0.51	3.2e-3	0.27	-0.95	-0.71	-0.53	-0.32	0.08	7322	1.0
beta[47,6]	-0.19	3.4e-3	0.3	-0.76	-0.4	-0.2	6.3e-3	0.41	7827	1.0
beta[48,6]	-0.19	3.8e-3	0.31	-0.78	-0.39	-0.19	0.02	0.42	6386	1.0
beta[49,6]	-0.5	3.0e-3	0.28	-0.95	-0.71	-0.52	-0.31	0.08	8771	1.0
beta[50,6]	-0.2	4.3e-3	0.3	-0.8	-0.4	-0.2	8.3e-3	0.4	5030	1.0
beta[51,6]	-0.27	3.7e-3	0.3	-0.85	-0.48	-0.27	-0.07	0.33	6662	1.0
beta[52,6]	-0.51	3.2e-3	0.27	-0.96	-0.72	-0.52	-0.33	0.08	7259	1.0
beta[53,6]	-0.05	3.6e-3	0.3	-0.64	-0.25	-0.06	0.15	0.55	6823	1.0
beta[54,6]	-0.39	3.7e-3	0.29	-0.91	-0.59	-0.4	-0.19	0.19	6076	1.0

beta[55,6]	-0.14	3.6e-3	0.31	-0.74	-0.35	-0.14	0.07	0.47	7441	1.0
beta[56,6]	-0.48	3.2e-3	0.28	-0.96	-0.69	-0.49	-0.29	0.12	7530	1.0
beta[57,6]	-0.29	3.2e-3	0.3	-0.85	-0.5	-0.3	-0.08	0.31	8913	1.0
beta[58,6]	-0.55	3.0e-3	0.27	-0.97	-0.76	-0.58	-0.38	0.04	7943	1.0
beta[59,6]	-0.3	3.7e-3	0.29	-0.85	-0.5	-0.31	-0.1	0.29	6180	1.0
beta[60,6]	-0.31	4.1e-3	0.29	-0.86	-0.5	-0.31	-0.11	0.28	5136	1.0
beta[61,6]	-0.4	3.6e-3	0.27	-0.91	-0.59	-0.41	-0.22	0.13	5481	1.0
beta[62,6]	-0.11	3.4e-3	0.3	-0.7	-0.31	-0.11	0.09	0.5	7460	1.0
beta[63,6]	-0.52	3.4e-3	0.26	-0.94	-0.71	-0.54	-0.34	0.02	5815	1.0
beta[64,6]	-0.58	2.8e-3	0.25	-0.97	-0.78	-0.61	-0.42	-0.05	7736	1.0
beta[65,6]	-0.51	3.1e-3	0.27	-0.96	-0.71	-0.53	-0.33	0.06	7494	1.0
beta[66,6]	-0.36	3.5e-3	0.28	-0.9	-0.56	-0.36	-0.17	0.21	6626	1.0
beta[67,6]	-0.29	3.8e-3	0.3	-0.85	-0.5	-0.29	-0.08	0.31	6100	1.0
beta[68,6]	-0.48	3.4e-3	0.27	-0.95	-0.68	-0.49	-0.3	0.1	6682	1.0
beta[69,6]	-0.48	3.4e-3	0.27	-0.94	-0.68	-0.5	-0.3	0.11	6501	1.0
beta[70,6]	-0.28	3.8e-3	0.3	-0.85	-0.48	-0.28	-0.08	0.32	6289	1.0
beta[71,6]	-0.17	3.3e-3	0.29	-0.75	-0.37	-0.17	0.02	0.42	7829	1.0
beta[72,6]	-0.15	3.4e-3	0.3	-0.73	-0.36	-0.14	0.06	0.43	8071	1.0
beta[73,6]	-0.13	4.6e-3	0.31	-0.75	-0.33	-0.13	0.07	0.48	4331	1.0
beta[74,6]	-0.61	3.1e-3	0.24	-0.97	-0.8	-0.63	-0.45	-0.07	6234	1.0
beta[75,6]	-0.33	4.1e-3	0.29	-0.87	-0.53	-0.33	-0.13	0.26	5045	1.0
beta[76,6]	-0.28	3.8e-3	0.29	-0.84	-0.48	-0.28	-0.08	0.3	5781	1.0
beta[77,6]	-0.49	3.4e-3	0.28	-0.95	-0.69	-0.51	-0.3	0.1	6359	1.0
beta[78,6]	-0.36	3.9e-3	0.29	-0.9	-0.57	-0.37	-0.17	0.22	5454	1.0
beta[79,6]	-0.52	3.1e-3	0.26	-0.96	-0.71	-0.53	-0.33	0.05	7221	1.0
beta[80,6]	-0.29	4.1e-3	0.3	-0.86	-0.5	-0.3	-0.1	0.33	5327	1.0
beta[81,6]	-0.53	3.1e-3	0.26	-0.96	-0.73	-0.55	-0.36	0.03	7209	1.0
beta[82,6]	-0.4	3.5e-3	0.29	-0.91	-0.61	-0.42	-0.2	0.19	6926	1.0
beta[83,6]	-0.29	3.4e-3	0.29	-0.83	-0.49	-0.3	-0.1	0.3	6994	1.0
beta[84,6]	-0.28	3.6e-3	0.29	-0.83	-0.48	-0.28	-0.08	0.3	6344	1.0
beta[85,6]	-0.35	3.6e-3	0.27	-0.87	-0.55	-0.36	-0.17	0.2	5614	1.0
beta[86,6]	-0.32	3.6e-3	0.29	-0.86	-0.52	-0.32	-0.12	0.26	6584	1.0
beta[87,6]	-0.02	3.5e-3	0.29	-0.6	-0.22	-0.03	0.17	0.56	6811	1.0
beta[88,6]	-0.57	3.2e-3	0.25	-0.97	-0.76	-0.59	-0.4	-0.03	6122	1.0

beta[89,6]	-0.36	3.3e-3	0.3	-0.89	-0.57	-0.37	-0.16	0.27	7962	1.0
beta[90,6]	-0.3	3.4e-3	0.29	-0.85	-0.5	-0.3	-0.11	0.27	7202	1.0
beta[91,6]	-0.37	3.2e-3	0.28	-0.88	-0.57	-0.38	-0.19	0.21	7526	1.0
beta[92,6]	-0.44	3.8e-3	0.29	-0.94	-0.65	-0.45	-0.25	0.16	5796	1.0
beta[93,6]	-0.5	3.1e-3	0.26	-0.95	-0.7	-0.52	-0.32	0.04	7288	1.0
beta[94,6]	-0.51	3.5e-3	0.29	-0.97	-0.73	-0.53	-0.32	0.09	6490	1.0
beta[95,6]	-0.24	4.2e-3	0.31	-0.85	-0.45	-0.25	-0.03	0.36	5261	1.0
beta[96,6]	-0.43	3.2e-3	0.27	-0.93	-0.63	-0.45	-0.25	0.12	7430	1.0
beta[97,6]	-0.6	3.1e-3	0.25	-0.98	-0.8	-0.63	-0.43	-0.04	6948	1.0
beta[98,6]	-0.39	3.4e-3	0.28	-0.9	-0.6	-0.4	-0.2	0.18	6798	1.0
beta[99,6]	-0.24	4.1e-3	0.29	-0.81	-0.45	-0.25	-0.05	0.35	5183	1.0
beta[100,6]	-0.36	3.4e-3	0.28	-0.9	-0.57	-0.37	-0.17	0.21	6934	1.0
beta[101,6]	-0.43	3.5e-3	0.28	-0.92	-0.63	-0.43	-0.25	0.16	6311	1.0
beta[102,6]	-0.35	3.9e-3	0.28	-0.9	-0.54	-0.35	-0.16	0.22	5432	1.0
beta[103,6]	-0.48	3.8e-3	0.28	-0.96	-0.69	-0.5	-0.29	0.11	5516	1.0
beta[104,6]	-0.42	3.4e-3	0.28	-0.92	-0.63	-0.43	-0.23	0.14	6639	1.0
beta[105,6]	-0.48	3.6e-3	0.28	-0.95	-0.69	-0.5	-0.3	0.1	5879	1.0
beta[106,6]	-0.31	3.4e-3	0.28	-0.85	-0.51	-0.31	-0.12	0.25	6927	1.0
beta[107,6]	-0.49	3.4e-3	0.26	-0.95	-0.69	-0.5	-0.31	0.06	6003	1.0
beta[108,6]	-0.47	3.3e-3	0.27	-0.94	-0.66	-0.49	-0.29	0.07	6515	1.0
beta[109,6]	-0.42	3.8e-3	0.28	-0.93	-0.62	-0.42	-0.23	0.15	5466	1.0
beta[110,6]	0.02	4.0e-3	0.31	-0.58	-0.19	0.03	0.23	0.65	6098	1.0
beta[111,6]	-0.45	3.4e-3	0.28	-0.94	-0.66	-0.46	-0.25	0.14	7111	1.0
beta[112,6]	-0.51	2.9e-3	0.26	-0.95	-0.7	-0.52	-0.33	0.04	8127	1.0
beta[113,6]	0.01	4.4e-3	0.31	-0.61	-0.19	0.01	0.22	0.63	5041	1.0
beta[1,7]	-0.08	3.9e-3	0.3	-0.66	-0.27	-0.07	0.12	0.5	5746	1.0
beta[2,7]	-0.51	3.2e-3	0.25	-0.94	-0.7	-0.52	-0.34	0.03	6443	1.0
beta[3,7]	-0.38	3.6e-3	0.28	-0.89	-0.58	-0.38	-0.18	0.18	5808	1.0
beta[4,7]	-0.19	3.5e-3	0.29	-0.75	-0.39	-0.19	4.2e-3	0.38	6707	1.0
beta[5,7]	-0.2	3.8e-3	0.29	-0.76	-0.4	-0.2	-5.5e-3	0.36	5643	1.0
beta[6,7]	-0.49	3.3e-3	0.26	-0.95	-0.68	-0.5	-0.31	0.06	6267	1.0
beta[7,7]	-0.39	3.6e-3	0.27	-0.89	-0.58	-0.4	-0.2	0.15	5543	1.0
beta[8,7]	-0.1	3.7e-3	0.29	-0.67	-0.3	-0.11	0.09	0.49	6305	1.0
beta[9,7]	-0.28	3.9e-3	0.28	-0.83	-0.47	-0.28	-0.09	0.29	5241	1.0

beta[10,7]	-0.58	2.9e-3	0.25	-0.97	-0.78	-0.61	-0.42	-0.05	7381	1.0
beta[11,7]	-0.08	3.6e-3	0.3	-0.64	-0.28	-0.09	0.12	0.5	6735	1.0
beta[12,7]	-0.29	3.6e-3	0.28	-0.84	-0.48	-0.29	-0.11	0.28	6203	1.0
beta[13,7]	-0.69	2.5e-3	0.21	-0.98	-0.85	-0.72	-0.55	-0.21	7134	1.0
beta[14,7]	-0.73	2.2e-3	0.19	-0.99	-0.88	-0.77	-0.62	-0.32	6991	1.0
beta[15,7]	-0.54	2.9e-3	0.25	-0.96	-0.74	-0.55	-0.37	-0.02	7230	1.0
beta[16,7]	-0.27	3.7e-3	0.27	-0.79	-0.46	-0.28	-0.09	0.26	5412	1.0
beta[17,7]	-0.43	3.4e-3	0.28	-0.93	-0.63	-0.44	-0.24	0.15	6807	1.0
beta[18,7]	-0.69	2.5e-3	0.21	-0.98	-0.85	-0.71	-0.56	-0.21	6721	1.0
beta[19,7]	-0.58	3.0e-3	0.25	-0.97	-0.78	-0.61	-0.42	-0.06	6657	1.0
beta[20,7]	-0.2	4.0e-3	0.29	-0.78	-0.41	-0.2	-5.2e-3	0.38	5442	1.0
beta[21,7]	-0.62	2.7e-3	0.23	-0.98	-0.8	-0.64	-0.47	-0.13	7138	1.0
beta[22,7]	-0.65	2.6e-3	0.22	-0.98	-0.82	-0.67	-0.51	-0.15	6990	1.0
beta[23,7]	-0.5	3.1e-3	0.26	-0.95	-0.69	-0.51	-0.32	0.03	7232	1.0
beta[24,7]	0.12	4.5e-3	0.31	-0.48	-0.09	0.12	0.34	0.74	4797	1.0
beta[25,7]	-0.44	3.1e-3	0.28	-0.92	-0.65	-0.45	-0.26	0.13	7870	1.0
beta[26,7]	-0.65	2.4e-3	0.22	-0.97	-0.82	-0.67	-0.51	-0.17	7986	1.0
beta[27,7]	-0.5	3.1e-3	0.27	-0.95	-0.7	-0.51	-0.32	0.08	7423	1.0
beta[28,7]	-0.68	2.2e-3	0.21	-0.98	-0.85	-0.72	-0.55	-0.19	8876	1.0
beta[29,7]	-0.57	2.7e-3	0.25	-0.97	-0.76	-0.59	-0.41	-0.03	8519	1.0
beta[30,7]	-0.35	3.7e-3	0.28	-0.87	-0.55	-0.36	-0.17	0.21	5457	1.0
beta[31,7]	-0.58	2.7e-3	0.24	-0.97	-0.76	-0.59	-0.42	-0.05	7727	1.0
beta[32,7]	-0.62	2.5e-3	0.22	-0.97	-0.79	-0.64	-0.47	-0.13	7791	1.0
beta[33,7]	-0.54	3.4e-3	0.25	-0.96	-0.72	-0.55	-0.37	-0.04	5243	1.0
beta[34,7]	-0.4	3.8e-3	0.27	-0.91	-0.6	-0.41	-0.21	0.16	5238	1.0
beta[35,7]	-0.59	3.0e-3	0.25	-0.97	-0.78	-0.61	-0.42	-0.05	6586	1.0
beta[36,7]	-0.37	3.3e-3	0.26	-0.85	-0.55	-0.37	-0.19	0.17	6321	1.0
beta[37,7]	-0.64	2.8e-3	0.22	-0.98	-0.81	-0.66	-0.5	-0.17	6165	1.0
beta[38,7]	-0.61	2.8e-3	0.23	-0.97	-0.79	-0.63	-0.45	-0.1	7053	1.0
beta[39,7]	-0.07	3.8e-3	0.3	-0.66	-0.27	-0.07	0.13	0.53	6117	1.0
beta[40,7]	-0.52	2.8e-3	0.25	-0.95	-0.71	-0.54	-0.36	2.0e-3	8230	1.0
beta[41,7]	-0.52	3.0e-3	0.25	-0.94	-0.7	-0.54	-0.36	-9.5e-3	6820	1.0
beta[42,7]	-0.44	3.9e-3	0.27	-0.92	-0.63	-0.44	-0.26	0.11	4644	1.0
beta[43,7]	-0.55	2.9e-3	0.25	-0.97	-0.73	-0.56	-0.38	-0.03	7285	1.0

beta[44,7]	-0.67	2.3e-3	0.21	-0.98	-0.84	-0.7	-0.54	-0.19	8425	1.0
beta[45,7]	-0.65	2.5e-3	0.23	-0.98	-0.83	-0.69	-0.51	-0.13	8110	1.0
beta[46,7]	0.04	4.7e-3	0.3	-0.54	-0.16	0.03	0.25	0.65	4099	1.0
beta[47,7]	-0.64	2.5e-3	0.22	-0.98	-0.82	-0.67	-0.5	-0.15	8198	1.0
beta[48,7]	-0.32	3.5e-3	0.28	-0.86	-0.52	-0.32	-0.13	0.25	6756	1.0
beta[49,7]	-0.42	3.6e-3	0.27	-0.91	-0.61	-0.42	-0.24	0.13	5714	1.0
beta[50,7]	-0.69	2.1e-3	0.21	-0.98	-0.86	-0.72	-0.56	-0.22	9488	1.0
beta[51,7]	-0.48	3.6e-3	0.25	-0.94	-0.66	-0.49	-0.31	0.05	5108	1.0
beta[52,7]	-0.51	3.2e-3	0.26	-0.95	-0.7	-0.52	-0.33	0.04	6604	1.0
beta[53,7]	-0.68	2.3e-3	0.21	-0.98	-0.84	-0.71	-0.55	-0.22	8386	1.0
beta[54,7]	-0.38	3.4e-3	0.27	-0.88	-0.56	-0.38	-0.2	0.16	6303	1.0
beta[55,7]	-0.73	2.1e-3	0.19	-0.99	-0.89	-0.77	-0.61	-0.28	8508	1.0
beta[56,7]	-0.52	3.1e-3	0.26	-0.95	-0.71	-0.53	-0.34	0.05	7117	1.0
beta[57,7]	-0.19	4.3e-3	0.31	-0.79	-0.4	-0.19	0.02	0.45	5390	1.0
beta[58,7]	0.07	5.0e-3	0.32	-0.56	-0.15	0.07	0.29	0.7	4080	1.0
beta[59,7]	-0.49	3.1e-3	0.27	-0.95	-0.68	-0.5	-0.3	0.06	7251	1.0
beta[60,7]	-0.54	3.3e-3	0.25	-0.96	-0.73	-0.55	-0.37	1.9e-3	5818	1.0
beta[61,7]	-0.45	3.2e-3	0.27	-0.93	-0.66	-0.47	-0.27	0.11	7224	1.0
beta[62,7]	-0.63	2.6e-3	0.23	-0.98	-0.82	-0.66	-0.48	-0.12	8083	1.0
beta[63,7]	-0.33	3.8e-3	0.29	-0.87	-0.53	-0.33	-0.13	0.25	5793	1.0
beta[64,7]	-0.44	4.2e-3	0.28	-0.94	-0.63	-0.44	-0.25	0.13	4250	1.0
beta[65,7]	-0.26	4.1e-3	0.29	-0.81	-0.46	-0.26	-0.06	0.33	5252	1.0
beta[66,7]	-0.56	3.1e-3	0.26	-0.97	-0.76	-0.58	-0.38	-5.3e-3	7094	1.0
beta[67,7]	-0.44	3.4e-3	0.27	-0.92	-0.64	-0.45	-0.26	0.13	6429	1.0
beta[68,7]	-0.36	3.9e-3	0.29	-0.91	-0.57	-0.36	-0.17	0.24	5554	1.0
beta[69,7]	-0.5	3.2e-3	0.28	-0.95	-0.71	-0.52	-0.31	0.1	7370	1.0
beta[70,7]	-0.28	3.5e-3	0.29	-0.83	-0.48	-0.28	-0.09	0.29	6643	1.0
beta[71,7]	-0.55	2.9e-3	0.26	-0.97	-0.75	-0.57	-0.37	-2.7e-4	8128	1.0
beta[72,7]	-0.63	2.6e-3	0.23	-0.97	-0.81	-0.66	-0.49	-0.14	7473	1.0
beta[73,7]	-0.23	3.9e-3	0.29	-0.79	-0.43	-0.24	-0.03	0.35	5484	1.0
beta[74,7]	-0.06	4.5e-3	0.3	-0.67	-0.26	-0.06	0.14	0.53	4527	1.0
beta[75,7]	-0.3	3.7e-3	0.28	-0.85	-0.49	-0.3	-0.11	0.24	5770	1.0
beta[76,7]	-0.53	3.1e-3	0.26	-0.96	-0.73	-0.55	-0.35	0.04	7150	1.0
beta[77,7]	-0.52	3.6e-3	0.27	-0.96	-0.73	-0.55	-0.34	0.04	5723	1.0

beta[78,7]	-0.55	3.6e-3	0.26	-0.97	-0.74	-0.57	-0.37	-0.02	5181	1.0
beta[79,7]	-0.32	3.3e-3	0.28	-0.85	-0.52	-0.32	-0.13	0.24	7304	1.0
beta[80,7]	-0.44	3.8e-3	0.28	-0.93	-0.64	-0.45	-0.25	0.15	5484	1.0
beta[81,7]	-0.4	3.3e-3	0.28	-0.92	-0.61	-0.41	-0.22	0.17	7367	1.0
beta[82,7]	-0.26	3.9e-3	0.3	-0.82	-0.46	-0.26	-0.05	0.34	5890	1.0
beta[83,7]	-0.44	3.4e-3	0.28	-0.94	-0.65	-0.45	-0.24	0.14	7007	1.0
beta[84,7]	-0.52	3.2e-3	0.26	-0.96	-0.72	-0.54	-0.35	0.01	6671	1.0
beta[85,7]	-0.61	3.1e-3	0.23	-0.98	-0.79	-0.63	-0.46	-0.11	5678	1.0
beta[86,7]	-0.37	3.9e-3	0.3	-0.92	-0.59	-0.38	-0.17	0.24	5826	1.0
beta[87,7]	-0.61	2.8e-3	0.24	-0.97	-0.8	-0.64	-0.46	-0.1	7331	1.0
beta[88,7]	-0.3	3.4e-3	0.29	-0.84	-0.5	-0.3	-0.11	0.27	7319	1.0
beta[89,7]	-0.31	3.5e-3	0.3	-0.87	-0.52	-0.31	-0.1	0.3	7377	1.0
beta[90,7]	-0.46	3.3e-3	0.27	-0.94	-0.65	-0.48	-0.28	0.1	6433	1.0
beta[91,7]	-0.45	3.8e-3	0.27	-0.93	-0.65	-0.46	-0.26	0.11	5194	1.0
beta[92,7]	-0.51	3.3e-3	0.25	-0.95	-0.69	-0.53	-0.35	0.02	5667	1.0
beta[93,7]	-0.54	3.9e-3	0.26	-0.96	-0.74	-0.56	-0.37	0.01	4562	1.0
beta[94,7]	-0.54	3.1e-3	0.26	-0.96	-0.74	-0.56	-0.37	0.02	7032	1.0
beta[95,7]	-0.54	3.2e-3	0.27	-0.97	-0.74	-0.56	-0.36	0.04	7141	1.0
beta[96,7]	-0.08	3.8e-3	0.29	-0.66	-0.28	-0.08	0.12	0.49	5738	1.0
beta[97,7]	-0.03	3.9e-3	0.31	-0.62	-0.24	-0.03	0.18	0.58	6109	1.0
beta[98,7]	-0.51	3.0e-3	0.26	-0.95	-0.7	-0.52	-0.33	0.04	7606	1.0
beta[99,7]	-0.52	3.2e-3	0.26	-0.96	-0.71	-0.54	-0.34	0.04	6992	1.0
beta[100,7]	-0.51	3.4e-3	0.27	-0.96	-0.71	-0.52	-0.33	0.07	6169	1.0
beta[101,7]	-0.4	3.7e-3	0.28	-0.91	-0.6	-0.41	-0.22	0.16	5638	1.0
beta[102,7]	-0.65	2.5e-3	0.22	-0.98	-0.83	-0.68	-0.51	-0.17	7813	1.0
beta[103,7]	-0.52	3.2e-3	0.26	-0.96	-0.72	-0.54	-0.34	0.03	6598	1.0
beta[104,7]	-0.38	3.8e-3	0.28	-0.91	-0.59	-0.39	-0.19	0.2	5476	1.0
beta[105,7]	-0.53	3.8e-3	0.27	-0.97	-0.74	-0.55	-0.35	0.03	5022	1.0
beta[106,7]	-0.45	3.3e-3	0.27	-0.94	-0.65	-0.46	-0.27	0.12	6789	1.0
beta[107,7]	-0.31	4.0e-3	0.29	-0.88	-0.52	-0.32	-0.12	0.28	5365	1.0
beta[108,7]	-0.32	3.8e-3	0.28	-0.84	-0.51	-0.32	-0.13	0.27	5595	1.0
beta[109,7]	-0.34	4.1e-3	0.29	-0.89	-0.55	-0.34	-0.14	0.25	5230	1.0
beta[110,7]	-0.39	3.3e-3	0.28	-0.9	-0.59	-0.4	-0.2	0.18	7224	1.0
beta[111,7]	-0.48	3.1e-3	0.28	-0.95	-0.7	-0.5	-0.29	0.1	8136	1.0

beta[112,7]	-0.35	3.8e-3	0.28	-0.89	-0.54	-0.35	-0.16	0.21	5532	1.0
beta[113,7]	-0.14	4.0e-3	0.31	-0.74	-0.34	-0.14	0.07	0.46	5810	1.0
beta[1,8]	-0.18	3.7e-3	0.29	-0.75	-0.37	-0.18	0.02	0.38	6159	1.0
beta[2,8]	-0.5	3.2e-3	0.26	-0.95	-0.7	-0.51	-0.32	0.05	6622	1.0
beta[3,8]	-0.56	3.1e-3	0.25	-0.97	-0.74	-0.57	-0.39	-0.02	6314	1.0
beta[4,8]	-0.24	3.4e-3	0.28	-0.78	-0.43	-0.24	-0.06	0.32	6776	1.0
beta[5,8]	-0.4	3.8e-3	0.27	-0.9	-0.59	-0.41	-0.22	0.14	4868	1.0
beta[6,8]	-0.54	2.8e-3	0.25	-0.96	-0.72	-0.55	-0.37	-0.03	7960	1.0
beta[7,8]	-0.25	3.3e-3	0.27	-0.77	-0.44	-0.25	-0.07	0.27	6737	1.0
beta[8,8]	-0.46	3.0e-3	0.26	-0.92	-0.66	-0.47	-0.29	0.08	7664	1.0
beta[9,8]	-0.47	3.1e-3	0.26	-0.93	-0.66	-0.48	-0.3	0.05	6662	1.0
beta[10,8]	-0.43	3.2e-3	0.27	-0.92	-0.63	-0.44	-0.25	0.15	7330	1.0
beta[11,8]	-0.35	3.7e-3	0.28	-0.89	-0.53	-0.35	-0.16	0.21	5593	1.0
beta[12,8]	-0.13	4.0e-3	0.3	-0.74	-0.33	-0.13	0.07	0.46	5688	1.0
beta[13,8]	-0.44	3.0e-3	0.26	-0.93	-0.63	-0.45	-0.27	0.09	7767	1.0
beta[14,8]	-0.17	3.5e-3	0.28	-0.72	-0.36	-0.17	0.02	0.39	6341	1.0
beta[15,8]	-0.51	3.0e-3	0.25	-0.95	-0.71	-0.52	-0.34	0.02	7206	1.0
beta[16,8]	-0.53	3.2e-3	0.25	-0.96	-0.72	-0.54	-0.36	0.01	6159	1.0
beta[17,8]	0.12	4.4e-3	0.3	-0.48	-0.09	0.12	0.32	0.73	4846	1.0
beta[18,8]	-0.44	3.5e-3	0.27	-0.93	-0.63	-0.44	-0.25	0.1	6006	1.0
beta[19,8]	-0.43	3.1e-3	0.28	-0.93	-0.63	-0.44	-0.24	0.14	8077	1.0
beta[20,8]	-0.5	3.1e-3	0.26	-0.94	-0.69	-0.51	-0.32	0.05	6949	1.0
beta[21,8]	-0.46	3.3e-3	0.26	-0.94	-0.64	-0.47	-0.28	0.08	6223	1.0
beta[22,8]	-0.53	3.3e-3	0.26	-0.96	-0.73	-0.54	-0.35	0.01	6129	1.0
beta[23,8]	-0.44	3.7e-3	0.28	-0.93	-0.65	-0.46	-0.26	0.14	5779	1.0
beta[24,8]	-0.14	3.4e-3	0.29	-0.71	-0.34	-0.14	0.05	0.42	6923	1.0
beta[25,8]	-0.53	3.0e-3	0.25	-0.96	-0.72	-0.55	-0.36	-2.8e-3	7221	1.0
beta[26,8]	-0.54	2.8e-3	0.25	-0.95	-0.73	-0.56	-0.37	-0.01	7703	1.0
beta[27,8]	-0.45	3.2e-3	0.27	-0.93	-0.64	-0.46	-0.26	0.1	6892	1.0
beta[28,8]	-0.44	3.3e-3	0.27	-0.92	-0.64	-0.46	-0.26	0.1	6803	1.0
beta[29,8]	-0.47	3.6e-3	0.28	-0.96	-0.67	-0.48	-0.28	0.11	5946	1.0
beta[30,8]	-0.55	3.0e-3	0.25	-0.96	-0.74	-0.57	-0.38	-0.04	6999	1.0
beta[31,8]	-0.51	2.9e-3	0.26	-0.95	-0.7	-0.52	-0.34	0.04	8164	1.0
beta[32,8]	-0.45	3.1e-3	0.26	-0.93	-0.64	-0.46	-0.28	0.08	7217	1.0

beta[33,8]	-0.45	3.0e-3	0.26	-0.92	-0.64	-0.46	-0.27	0.08	7474	1.0
beta[34,8]	-0.31	3.8e-3	0.29	-0.87	-0.5	-0.31	-0.12	0.27	5820	1.0
beta[35,8]	-0.42	3.1e-3	0.28	-0.92	-0.62	-0.42	-0.23	0.17	8113	1.0
beta[36,8]	-0.51	3.2e-3	0.26	-0.96	-0.7	-0.52	-0.34	0.02	6538	1.0
beta[37,8]	-0.36	3.3e-3	0.27	-0.88	-0.55	-0.36	-0.18	0.18	6558	1.0
beta[38,8]	-0.45	3.2e-3	0.26	-0.92	-0.65	-0.46	-0.28	0.08	6781	1.0
beta[39,8]	-0.56	2.7e-3	0.24	-0.96	-0.75	-0.57	-0.4	-0.05	8232	1.0
beta[40,8]	-0.33	3.5e-3	0.27	-0.84	-0.52	-0.33	-0.15	0.21	6169	1.0
beta[41,8]	-0.44	3.1e-3	0.27	-0.94	-0.65	-0.45	-0.25	0.12	7796	1.0
beta[42,8]	-0.45	2.6e-3	0.26	-0.91	-0.64	-0.46	-0.28	0.09	9659	1.0
beta[43,8]	-0.46	3.2e-3	0.27	-0.94	-0.66	-0.48	-0.28	0.09	7175	1.0
beta[44,8]	-0.54	3.1e-3	0.25	-0.96	-0.74	-0.56	-0.37	-0.01	6703	1.0
beta[45,8]	-0.46	3.7e-3	0.28	-0.95	-0.67	-0.48	-0.27	0.1	5647	1.0
beta[46,8]	-0.56	3.1e-3	0.25	-0.97	-0.76	-0.58	-0.4	-8.6e-3	6546	1.0
beta[47,8]	-0.41	3.3e-3	0.28	-0.92	-0.61	-0.42	-0.23	0.14	6990	1.0
beta[48,8]	-0.43	3.4e-3	0.26	-0.91	-0.62	-0.44	-0.25	0.1	6093	1.0
beta[49,8]	-0.47	3.2e-3	0.26	-0.94	-0.66	-0.47	-0.29	0.07	6937	1.0
beta[50,8]	-0.4	3.2e-3	0.28	-0.9	-0.6	-0.4	-0.21	0.16	7418	1.0
beta[51,8]	-0.51	3.2e-3	0.26	-0.95	-0.69	-0.52	-0.33	0.03	6411	1.0
beta[52,8]	-0.48	3.2e-3	0.26	-0.94	-0.67	-0.49	-0.31	0.06	6466	1.0
beta[53,8]	-0.52	3.1e-3	0.25	-0.95	-0.71	-0.54	-0.35	0.02	6614	1.0
beta[54,8]	-0.38	3.4e-3	0.28	-0.89	-0.57	-0.39	-0.2	0.18	6701	1.0
beta[55,8]	-0.52	3.1e-3	0.26	-0.95	-0.72	-0.55	-0.35	8.7e-3	6955	1.0
beta[56,8]	-0.43	3.5e-3	0.29	-0.93	-0.64	-0.44	-0.23	0.18	6955	1.0
beta[57,8]	-0.39	3.9e-3	0.29	-0.91	-0.6	-0.4	-0.2	0.2	5408	1.0
beta[58,8]	-0.33	3.5e-3	0.29	-0.87	-0.54	-0.34	-0.14	0.24	6809	1.0
beta[59,8]	-0.4	3.2e-3	0.27	-0.91	-0.59	-0.41	-0.21	0.16	7105	1.0
beta[60,8]	-0.27	4.1e-3	0.29	-0.84	-0.47	-0.27	-0.08	0.3	5053	1.0
beta[61,8]	-0.39	3.1e-3	0.28	-0.9	-0.59	-0.4	-0.21	0.17	7831	1.0
beta[62,8]	-0.56	3.2e-3	0.25	-0.97	-0.76	-0.58	-0.4	-0.03	5917	1.0
beta[63,8]	-0.29	4.0e-3	0.29	-0.84	-0.5	-0.3	-0.1	0.31	5491	1.0
beta[64,8]	-0.31	3.5e-3	0.29	-0.85	-0.51	-0.31	-0.11	0.27	6857	1.0
beta[65,8]	-0.38	3.6e-3	0.28	-0.9	-0.59	-0.39	-0.19	0.19	6051	1.0
beta[66,8]	-0.34	3.3e-3	0.28	-0.88	-0.52	-0.34	-0.15	0.23	6968	1.0

beta[67,8]	-0.19	3.8e-3	0.29	-0.75	-0.39	-0.19	9.4e-3	0.4	5942	1.0
beta[68,8]	-0.56	2.9e-3	0.25	-0.96	-0.76	-0.59	-0.39	-0.02	7385	1.0
beta[69,8]	-0.44	3.0e-3	0.28	-0.94	-0.65	-0.46	-0.26	0.15	8761	1.0
beta[70,8]	-0.37	3.2e-3	0.28	-0.89	-0.57	-0.37	-0.18	0.2	7726	1.0
beta[71,8]	-0.2	3.9e-3	0.3	-0.78	-0.4	-0.21	-0.01	0.4	5757	1.0
beta[72,8]	-0.19	3.5e-3	0.3	-0.77	-0.39	-0.19	0.02	0.41	7106	1.0
beta[73,8]	-0.11	4.1e-3	0.29	-0.68	-0.31	-0.11	0.08	0.48	5049	1.0
beta[74,8]	-0.25	4.6e-3	0.3	-0.83	-0.46	-0.25	-0.06	0.35	4215	1.0
beta[75,8]	-0.4	3.4e-3	0.27	-0.9	-0.6	-0.41	-0.23	0.15	6442	1.0
beta[76,8]	-0.3	3.5e-3	0.29	-0.85	-0.5	-0.3	-0.1	0.29	6889	1.0
beta[77,8]	-0.43	3.4e-3	0.28	-0.92	-0.64	-0.44	-0.24	0.14	6847	1.0
beta[78,8]	-0.45	3.3e-3	0.28	-0.94	-0.66	-0.46	-0.26	0.1	6933	1.0
beta[79,8]	-0.28	3.2e-3	0.27	-0.81	-0.47	-0.28	-0.1	0.28	7565	1.0
beta[80,8]	-0.19	3.9e-3	0.3	-0.77	-0.39	-0.19	0.01	0.42	5855	1.0
beta[81,8]	-0.19	3.7e-3	0.29	-0.74	-0.38	-0.19	-2.8e-3	0.4	5828	1.0
beta[82,8]	-0.27	4.0e-3	0.29	-0.82	-0.47	-0.27	-0.07	0.3	5229	1.0
beta[83,8]	-0.18	3.8e-3	0.29	-0.75	-0.39	-0.19	0.01	0.41	5900	1.0
beta[84,8]	-0.16	3.4e-3	0.29	-0.74	-0.36	-0.16	0.03	0.41	7054	1.0
beta[85,8]	-0.14	4.7e-3	0.3	-0.72	-0.34	-0.15	0.05	0.45	4080	1.0
beta[86,8]	-0.27	4.1e-3	0.3	-0.86	-0.47	-0.27	-0.07	0.32	5247	1.0
beta[87,8]	-0.52	3.1e-3	0.26	-0.96	-0.72	-0.54	-0.34	0.03	6970	1.0
beta[88,8]	-0.38	3.3e-3	0.28	-0.9	-0.58	-0.39	-0.2	0.21	7054	1.0
beta[89,8]	-0.29	3.6e-3	0.29	-0.85	-0.5	-0.3	-0.1	0.3	6529	1.0
beta[90,8]	-0.39	3.0e-3	0.27	-0.89	-0.58	-0.4	-0.2	0.17	8231	1.0
beta[91,8]	-0.37	3.2e-3	0.28	-0.9	-0.57	-0.37	-0.18	0.21	7512	1.0
beta[92,8]	-0.4	3.2e-3	0.27	-0.9	-0.6	-0.41	-0.22	0.16	7140	1.0
beta[93,8]	-0.18	3.5e-3	0.29	-0.73	-0.38	-0.19	8.5e-3	0.38	6775	1.0
beta[94,8]	-0.46	3.2e-3	0.27	-0.94	-0.66	-0.47	-0.27	0.11	7328	1.0
beta[95,8]	-0.37	3.1e-3	0.29	-0.88	-0.58	-0.37	-0.18	0.22	8574	1.0
beta[96,8]	-0.54	2.8e-3	0.25	-0.96	-0.73	-0.56	-0.38	-0.01	8129	1.0
beta[97,8]	-0.44	3.1e-3	0.27	-0.92	-0.63	-0.44	-0.25	0.11	7836	1.0
beta[98,8]	-0.25	3.9e-3	0.29	-0.85	-0.45	-0.25	-0.06	0.33	5736	1.0
beta[99,8]	-0.45	3.4e-3	0.27	-0.94	-0.65	-0.46	-0.27	0.1	6442	1.0
beta[100,8]	-0.13	3.7e-3	0.28	-0.67	-0.33	-0.13	0.06	0.43	5909	1.0

beta[101,8]	-0.3	3.6e-3	0.28	-0.84	-0.49	-0.3	-0.12	0.27	5909	1.0
beta[102,8]	-0.36	3.9e-3	0.28	-0.9	-0.55	-0.36	-0.17	0.2	5031	1.0
beta[103,8]	-0.42	3.1e-3	0.28	-0.93	-0.64	-0.43	-0.24	0.16	8381	1.0
beta[104,8]	-0.37	3.0e-3	0.27	-0.89	-0.56	-0.38	-0.19	0.18	8561	1.0
beta[105,8]	-0.43	3.5e-3	0.28	-0.94	-0.63	-0.44	-0.25	0.15	6230	1.0
beta[106,8]	-0.32	3.4e-3	0.28	-0.86	-0.52	-0.33	-0.13	0.23	6701	1.0
beta[107,8]	-0.3	3.2e-3	0.28	-0.83	-0.5	-0.3	-0.12	0.27	7826	1.0
beta[108,8]	-0.05	3.5e-3	0.28	-0.62	-0.25	-0.05	0.13	0.52	6713	1.0
beta[109,8]	-0.39	3.2e-3	0.28	-0.9	-0.59	-0.39	-0.2	0.2	7778	1.0
beta[110,8]	-0.27	3.7e-3	0.29	-0.83	-0.48	-0.28	-0.08	0.32	6435	1.0
beta[111,8]	-0.41	3.4e-3	0.29	-0.92	-0.62	-0.42	-0.22	0.18	7094	1.0
beta[112,8]	-0.3	3.2e-3	0.29	-0.85	-0.5	-0.3	-0.1	0.3	8152	1.0
beta[113,8]	-0.22	3.3e-3	0.29	-0.78	-0.41	-0.22	-0.03	0.36	7702	1.0
alpha[1]	0.52	4.1e-3	0.25	-0.02	0.36	0.53	0.7	0.98	3921	1.0
alpha[2]	0.68	3.5e-3	0.22	0.23	0.54	0.69	0.83	1.09	4092	1.0
alpha[3]	0.33	3.3e-3	0.24	-0.19	0.17	0.33	0.5	0.77	5582	1.0
alpha[4]	0.43	3.5e-3	0.25	-0.1	0.26	0.44	0.6	0.88	5248	1.0
alpha[5]	0.6	3.9e-3	0.23	0.12	0.44	0.6	0.76	1.03	3476	1.0
alpha[6]	0.43	3.6e-3	0.24	-0.08	0.28	0.44	0.6	0.87	4493	1.0
alpha[7]	0.7	3.9e-3	0.22	0.26	0.56	0.72	0.86	1.11	3140	1.0
alpha[8]	0.42	4.0e-3	0.26	-0.13	0.26	0.44	0.61	0.89	4302	1.0
alpha[9]	0.46	3.5e-3	0.24	-0.05	0.3	0.47	0.62	0.89	4819	1.0
alpha[10]	0.83	3.6e-3	0.23	0.34	0.69	0.84	0.99	1.25	4207	1.0
alpha[11]	0.46	3.2e-3	0.25	-0.05	0.3	0.47	0.62	0.91	5824	1.0
alpha[12]	0.34	3.3e-3	0.25	-0.17	0.18	0.35	0.52	0.8	5754	1.0
alpha[13]	0.51	3.0e-3	0.22	0.04	0.36	0.52	0.66	0.91	5639	1.0
alpha[14]	0.69	3.1e-3	0.22	0.23	0.55	0.7	0.84	1.09	4873	1.0
alpha[15]	0.83	3.5e-3	0.21	0.37	0.69	0.83	0.97	1.24	3706	1.0
alpha[16]	0.68	3.6e-3	0.22	0.21	0.53	0.69	0.83	1.09	3945	1.0
alpha[17]	0.23	4.2e-3	0.27	-0.34	0.05	0.24	0.42	0.72	4260	1.0
alpha[18]	0.51	3.3e-3	0.23	0.04	0.36	0.52	0.67	0.92	4709	1.0
alpha[19]	0.83	3.9e-3	0.23	0.36	0.68	0.84	0.99	1.27	3567	1.0
alpha[20]	0.62	3.5e-3	0.23	0.14	0.48	0.64	0.78	1.03	4173	1.0
alpha[21]	0.5	2.8e-3	0.23	0.02	0.36	0.51	0.66	0.9	6607	1.0

alpha[22]	0.54	3.2e-3	0.21	0.1	0.41	0.55	0.69	0.93	4389	1.0
alpha[23]	0.84	3.8e-3	0.23	0.36	0.69	0.85	1.0	1.26	3814	1.0
alpha[24]	0.88	4.3e-3	0.25	0.34	0.71	0.89	1.06	1.34	3566	1.0
alpha[25]	0.3	3.2e-3	0.24	-0.21	0.14	0.31	0.47	0.76	5698	1.0
alpha[26]	0.66	3.3e-3	0.21	0.22	0.53	0.67	0.81	1.05	4212	1.0
alpha[27]	0.84	3.5e-3	0.23	0.36	0.69	0.85	1.0	1.26	4330	1.0
alpha[28]	0.51	3.5e-3	0.23	0.03	0.36	0.52	0.67	0.93	4362	1.0
alpha[29]	0.74	3.7e-3	0.23	0.26	0.6	0.75	0.9	1.17	3960	1.0
alpha[30]	0.43	3.3e-3	0.24	-0.06	0.27	0.44	0.59	0.87	5132	1.0
alpha[31]	0.69	3.1e-3	0.22	0.23	0.54	0.7	0.84	1.09	4986	1.0
alpha[32]	0.5	3.2e-3	0.23	0.02	0.35	0.51	0.66	0.91	5062	1.0
alpha[33]	0.48	3.1e-3	0.24	-0.01	0.33	0.49	0.65	0.91	5945	1.0
alpha[34]	0.84	3.5e-3	0.22	0.39	0.7	0.85	0.99	1.24	3949	1.0
alpha[35]	0.91	3.3e-3	0.22	0.44	0.77	0.92	1.06	1.32	4404	1.0
alpha[36]	0.81	3.4e-3	0.22	0.34	0.66	0.82	0.97	1.22	4274	1.0
alpha[37]	0.82	3.5e-3	0.22	0.37	0.68	0.82	0.96	1.22	3696	1.0
alpha[38]	0.45	3.1e-3	0.23	-0.04	0.3	0.46	0.61	0.88	5752	1.0
alpha[39]	0.42	3.7e-3	0.25	-0.12	0.26	0.43	0.6	0.89	4831	1.0
alpha[40]	0.44	3.2e-3	0.24	-0.07	0.28	0.45	0.61	0.88	5519	1.0
alpha[41]	0.5	3.6e-3	0.24	-7.5e-3	0.34	0.51	0.66	0.93	4487	1.0
alpha[42]	0.51	3.4e-3	0.24	0.01	0.36	0.52	0.67	0.94	4937	1.0
alpha[43]	0.48	3.1e-3	0.23	-2.7e-3	0.33	0.49	0.64	0.91	5377	1.0
alpha[44]	0.52	2.9e-3	0.23	0.04	0.38	0.53	0.68	0.94	6327	1.0
alpha[45]	0.71	3.4e-3	0.22	0.25	0.57	0.72	0.87	1.11	4186	1.0
alpha[46]	0.42	3.9e-3	0.25	-0.1	0.26	0.44	0.6	0.89	4307	1.0
alpha[47]	0.7	3.3e-3	0.22	0.25	0.56	0.71	0.85	1.09	4344	1.0
alpha[48]	0.47	3.3e-3	0.24	-0.03	0.31	0.48	0.64	0.92	5593	1.0
alpha[49]	0.84	3.5e-3	0.22	0.38	0.7	0.85	0.99	1.26	4020	1.0
alpha[50]	0.59	3.3e-3	0.22	0.13	0.45	0.6	0.73	0.98	4230	1.0
alpha[51]	0.64	3.2e-3	0.22	0.19	0.5	0.65	0.79	1.05	4592	1.0
alpha[52]	0.76	3.3e-3	0.22	0.29	0.62	0.76	0.91	1.16	4443	1.0
alpha[53]	0.68	3.3e-3	0.21	0.24	0.55	0.69	0.83	1.08	4104	1.0
alpha[54]	0.72	3.6e-3	0.22	0.25	0.57	0.73	0.87	1.12	3887	1.0
alpha[55]	0.63	3.6e-3	0.22	0.16	0.49	0.64	0.78	1.03	3724	1.0

alpha[56]	0.83	3.4e-3	0.24	0.33	0.68	0.84	0.99	1.25	4750	1.0
alpha[57]	0.4	3.8e-3	0.25	-0.12	0.24	0.41	0.57	0.86	4228	1.0
alpha[58]	0.31	4.3e-3	0.28	-0.27	0.13	0.32	0.5	0.81	4200	1.0
alpha[59]	0.49	3.4e-3	0.24	-0.02	0.34	0.49	0.66	0.94	4992	1.0
alpha[60]	0.54	3.0e-3	0.24	0.05	0.39	0.55	0.71	0.96	6088	1.0
alpha[61]	0.65	3.4e-3	0.23	0.16	0.51	0.66	0.81	1.07	4497	1.0
alpha[62]	0.69	3.2e-3	0.22	0.24	0.55	0.7	0.85	1.09	4936	1.0
alpha[63]	0.51	3.3e-3	0.24	5.5e-3	0.36	0.52	0.68	0.96	5379	1.0
alpha[64]	0.47	3.7e-3	0.25	-0.05	0.31	0.48	0.63	0.91	4358	1.0
alpha[65]	0.46	3.2e-3	0.25	-0.06	0.3	0.47	0.64	0.93	6115	1.0
alpha[66]	0.9	3.7e-3	0.23	0.43	0.76	0.92	1.06	1.33	3826	1.0
alpha[67]	0.49	3.1e-3	0.24	-4.8e-3	0.33	0.49	0.65	0.94	5737	1.0
alpha[68]	0.34	3.5e-3	0.25	-0.16	0.18	0.35	0.52	0.8	4864	1.0
alpha[69]	0.82	3.9e-3	0.25	0.29	0.66	0.82	0.99	1.28	4118	1.0
alpha[70]	0.35	3.2e-3	0.25	-0.18	0.19	0.36	0.53	0.82	6155	1.0
alpha[71]	0.42	2.8e-3	0.24	-0.08	0.26	0.42	0.58	0.86	7314	1.0
alpha[72]	0.62	3.3e-3	0.24	0.13	0.46	0.63	0.78	1.05	5196	1.0
alpha[73]	0.43	4.6e-3	0.27	-0.13	0.26	0.44	0.62	0.94	3486	1.0
alpha[74]	0.47	3.8e-3	0.26	-0.07	0.3	0.48	0.65	0.94	4704	1.0
alpha[75]	0.79	3.4e-3	0.22	0.34	0.65	0.79	0.94	1.21	4261	1.0
alpha[76]	0.91	3.5e-3	0.23	0.41	0.76	0.92	1.07	1.34	4471	1.0
alpha[77]	0.84	3.7e-3	0.24	0.34	0.68	0.84	1.0	1.26	3971	1.0
alpha[78]	0.88	3.6e-3	0.23	0.42	0.73	0.89	1.03	1.3	4040	1.0
alpha[79]	0.51	3.5e-3	0.25	-4.0e-3	0.35	0.52	0.68	0.97	5088	1.0
alpha[80]	0.49	3.2e-3	0.25	-0.03	0.33	0.49	0.66	0.95	6165	1.0
alpha[81]	0.9	3.7e-3	0.24	0.39	0.75	0.91	1.06	1.33	4175	1.0
alpha[82]	0.35	3.4e-3	0.25	-0.17	0.19	0.36	0.52	0.82	5261	1.0
alpha[83]	0.49	3.0e-3	0.24	-0.02	0.33	0.49	0.65	0.95	6537	1.0
alpha[84]	0.67	3.7e-3	0.24	0.17	0.52	0.68	0.84	1.12	4194	1.0
alpha[85]	0.8	3.4e-3	0.23	0.32	0.65	0.81	0.96	1.25	4718	1.0
alpha[86]	0.78	4.2e-3	0.24	0.29	0.63	0.79	0.95	1.24	3335	1.0
alpha[87]	0.78	3.6e-3	0.23	0.3	0.63	0.79	0.94	1.19	3840	1.0
alpha[88]	0.34	3.8e-3	0.26	-0.2	0.17	0.35	0.52	0.82	4584	1.0
alpha[89]	0.11	3.8e-3	0.25	-0.41	-0.05	0.12	0.28	0.56	4302	1.0

alpha[90]	0.59	3.4e-3	0.23	0.11	0.44	0.6	0.75	1.01	4624	1.0
alpha[91]	0.71	3.3e-3	0.23	0.25	0.56	0.72	0.87	1.13	4643	1.0
alpha[92]	0.56	3.1e-3	0.23	0.08	0.41	0.57	0.72	0.98	5407	1.0
alpha[93]	0.72	4.0e-3	0.24	0.24	0.56	0.72	0.88	1.18	3525	1.0
alpha[94]	0.74	3.8e-3	0.24	0.23	0.58	0.75	0.91	1.18	3954	1.0
alpha[95]	0.6	3.4e-3	0.24	0.1	0.45	0.61	0.77	1.05	4912	1.0
alpha[96]	0.49	3.7e-3	0.26	-0.07	0.33	0.51	0.67	0.98	4921	1.0
alpha[97]	0.45	3.6e-3	0.26	-0.09	0.28	0.46	0.63	0.92	5105	1.0
alpha[98]	0.81	3.2e-3	0.23	0.36	0.65	0.82	0.97	1.24	5164	1.0
alpha[99]	0.6	3.5e-3	0.23	0.14	0.45	0.61	0.75	1.02	4235	1.0
alpha[100]	0.8	3.4e-3	0.23	0.33	0.65	0.81	0.95	1.22	4523	1.0
alpha[101]	0.55	3.5e-3	0.24	0.05	0.4	0.57	0.72	0.98	4530	1.0
alpha[102]	0.63	3.3e-3	0.22	0.17	0.49	0.65	0.78	1.03	4315	1.0
alpha[103]	0.84	3.9e-3	0.23	0.34	0.69	0.85	0.99	1.27	3598	1.0
alpha[104]	0.39	3.4e-3	0.25	-0.13	0.23	0.4	0.57	0.85	5269	1.0
alpha[105]	0.84	3.4e-3	0.23	0.36	0.7	0.85	0.99	1.25	4324	1.0
alpha[106]	0.82	3.4e-3	0.23	0.34	0.66	0.82	0.97	1.25	4586	1.0
alpha[107]	0.69	4.1e-3	0.23	0.22	0.54	0.7	0.84	1.1	3100	1.0
alpha[108]	0.83	3.8e-3	0.23	0.36	0.67	0.84	0.99	1.26	3723	1.0
alpha[109]	0.49	3.3e-3	0.25	-0.02	0.34	0.5	0.66	0.96	5709	1.0
alpha[110]	0.42	3.8e-3	0.25	-0.09	0.26	0.43	0.6	0.87	4226	1.0
alpha[111]	0.93	4.0e-3	0.24	0.44	0.78	0.95	1.1	1.38	3654	1.0
alpha[112]	0.45	3.6e-3	0.24	-0.05	0.29	0.46	0.62	0.91	4665	1.0
alpha[113]	0.45	4.4e-3	0.27	-0.1	0.28	0.46	0.64	0.95	3703	1.0
theta[1]	-5.41	0.02	1.3	-8.09	-6.24	-5.38	-4.52	-2.99	3817	1.0
theta[2]	-5.47	0.02	1.33	-8.24	-6.31	-5.41	-4.55	-3.08	3745	1.0
theta[3]	-7.51	0.02	1.46	-10.61	-8.48	-7.43	-6.48	-4.82	3558	1.0
theta[4]	-7.74	0.02	1.45	-10.67	-8.73	-7.69	-6.71	-5.08	3399	1.0
theta[5]	-5.79	0.02	1.32	-8.54	-6.61	-5.73	-4.88	-3.42	2984	1.0
theta[6]	-6.63	0.02	1.36	-9.45	-7.53	-6.54	-5.69	-4.16	3912	1.0
theta[7]	-6.35	0.03	1.35	-9.14	-7.23	-6.3	-5.41	-3.87	2880	1.0
theta[8]	-7.76	0.03	1.45	-10.74	-8.74	-7.73	-6.73	-5.04	2777	1.0
theta[9]	-7.9	0.03	1.45	-10.88	-8.84	-7.86	-6.87	-5.17	2984	1.0
theta[10]	-4.83	0.02	1.45	-7.8	-5.79	-4.8	-3.83	-2.11	3737	1.0

theta[11]	-7.71	0.03	1.46	-10.8	-8.69	-7.64	-6.67	-5.03	2846	1.0
theta[12]	-7.44	0.03	1.46	-10.58	-8.4	-7.34	-6.42	-4.81	3011	1.0
theta[13]	-7.95	0.03	1.44	-10.99	-8.9	-7.86	-6.94	-5.33	2635	1.0
theta[14]	-6.04	0.02	1.34	-8.82	-6.91	-6.0	-5.12	-3.53	4204	1.0
theta[15]	-6.55	0.03	1.42	-9.59	-7.43	-6.48	-5.56	-4.0	3095	1.0
theta[16]	-6.22	0.02	1.34	-8.98	-7.09	-6.19	-5.28	-3.74	3692	1.0
theta[17]	-7.18	0.03	1.52	-10.47	-8.16	-7.12	-6.1	-4.47	2974	1.0
theta[18]	-7.96	0.03	1.47	-11.11	-8.95	-7.87	-6.94	-5.31	2050	1.0
theta[19]	-4.84	0.03	1.45	-7.71	-5.79	-4.82	-3.81	-2.07	3270	1.0
theta[20]	-5.16	0.02	1.3	-7.85	-6.02	-5.14	-4.26	-2.74	3680	1.0
theta[21]	-7.93	0.03	1.42	-10.82	-8.89	-7.86	-6.95	-5.31	2999	1.0
theta[22]	-6.21	0.02	1.27	-8.85	-7.02	-6.17	-5.32	-3.9	3404	1.0
theta[23]	-5.13	0.02	1.41	-8.05	-6.06	-5.08	-4.14	-2.45	3369	1.0
theta[24]	-5.22	0.02	1.34	-7.93	-6.08	-5.19	-4.29	-2.73	3818	1.0
theta[25]	-7.39	0.02	1.47	-10.38	-8.37	-7.34	-6.34	-4.69	3857	1.0
theta[26]	-6.71	0.02	1.32	-9.44	-7.58	-6.67	-5.79	-4.29	3698	1.0
theta[27]	-5.13	0.02	1.43	-8.06	-6.06	-5.07	-4.15	-2.46	4261	1.0
theta[28]	-7.98	0.03	1.45	-11.01	-8.94	-7.9	-6.96	-5.27	2629	1.0
theta[29]	-5.06	0.02	1.36	-7.95	-5.92	-5.01	-4.14	-2.56	3820	1.0
theta[30]	-7.75	0.03	1.47	-10.9	-8.7	-7.67	-6.7	-5.1	2559	1.0
theta[31]	-5.81	0.02	1.3	-8.53	-6.66	-5.76	-4.9	-3.47	4523	1.0
theta[32]	-7.93	0.03	1.45	-10.89	-8.9	-7.89	-6.91	-5.27	2875	1.0
theta[33]	-7.9	0.03	1.46	-10.98	-8.89	-7.86	-6.88	-5.19	2808	1.0
theta[34]	-5.63	0.02	1.44	-8.66	-6.53	-5.57	-4.62	-2.99	3751	1.0
theta[35]	-5.27	0.02	1.47	-8.31	-6.22	-5.23	-4.28	-2.45	4005	1.0
theta[36]	-6.28	0.02	1.37	-9.18	-7.19	-6.24	-5.32	-3.7	4125	1.0
theta[37]	-6.58	0.02	1.43	-9.56	-7.5	-6.52	-5.61	-3.95	3502	1.0
theta[38]	-7.86	0.03	1.49	-10.96	-8.85	-7.81	-6.8	-5.13	3298	1.0
theta[39]	-7.65	0.03	1.47	-10.71	-8.62	-7.59	-6.61	-5.02	3257	1.0
theta[40]	-7.73	0.03	1.51	-10.93	-8.73	-7.64	-6.66	-4.98	2919	1.0
theta[41]	-7.94	0.03	1.46	-10.87	-8.94	-7.9	-6.9	-5.25	2143	1.0
theta[42]	-7.94	0.03	1.45	-10.85	-8.95	-7.9	-6.91	-5.17	2726	1.0
theta[43]	-7.95	0.03	1.49	-11.07	-8.94	-7.87	-6.91	-5.22	1910	1.0
theta[44]	-7.91	0.03	1.43	-10.9	-8.87	-7.83	-6.92	-5.23	2939	1.0

theta[45]	-5.13	0.02	1.39	-8.02	-6.03	-5.06	-4.17	-2.5	3549	1.0
theta[46]	-7.64	0.03	1.48	-10.68	-8.62	-7.55	-6.58	-4.92	2895	1.0
theta[47]	-6.92	0.02	1.36	-9.7	-7.81	-6.86	-6.0	-4.37	3243	1.0
theta[48]	-7.64	0.03	1.45	-10.78	-8.56	-7.56	-6.64	-4.96	2747	1.0
theta[49]	-5.48	0.02	1.39	-8.28	-6.4	-5.43	-4.53	-2.88	3556	1.0
theta[50]	-5.86	0.02	1.26	-8.49	-6.67	-5.81	-5.01	-3.53	3684	1.0
theta[51]	-5.74	0.02	1.32	-8.45	-6.63	-5.68	-4.8	-3.34	4189	1.0
theta[52]	-5.45	0.02	1.34	-8.22	-6.32	-5.42	-4.52	-2.9	4360	1.0
theta[53]	-6.4	0.02	1.36	-9.26	-7.27	-6.33	-5.46	-3.9	3085	1.0
theta[54]	-6.0	0.02	1.36	-8.73	-6.9	-5.96	-5.06	-3.49	3686	1.0
theta[55]	-5.8	0.02	1.36	-8.61	-6.69	-5.75	-4.89	-3.33	3238	1.0
theta[56]	-4.64	0.02	1.46	-7.62	-5.61	-4.6	-3.62	-1.94	3774	1.0
theta[57]	-3.91	0.02	1.14	-6.26	-4.67	-3.87	-3.12	-1.82	4105	1.0
theta[58]	-7.32	0.02	1.51	-10.4	-8.33	-7.27	-6.24	-4.52	3744	1.0
theta[59]	-7.54	0.03	1.48	-10.74	-8.5	-7.45	-6.49	-4.89	2631	1.0
theta[60]	-7.84	0.03	1.45	-10.91	-8.79	-7.77	-6.83	-5.16	2653	1.0
theta[61]	-6.89	0.02	1.36	-9.72	-7.76	-6.86	-5.94	-4.38	3394	1.0
theta[62]	-5.88	0.02	1.29	-8.58	-6.71	-5.83	-4.98	-3.51	4313	1.0
theta[63]	-7.75	0.03	1.48	-10.95	-8.72	-7.66	-6.71	-5.08	2113	1.0
theta[64]	-7.65	0.03	1.48	-10.74	-8.64	-7.61	-6.61	-4.97	3106	1.0
theta[65]	-7.62	0.03	1.46	-10.67	-8.58	-7.55	-6.6	-4.93	2697	1.0
theta[66]	-5.49	0.02	1.43	-8.45	-6.43	-5.43	-4.49	-2.87	3634	1.0
theta[67]	-7.31	0.02	1.45	-10.35	-8.23	-7.23	-6.31	-4.65	3945	1.0
theta[68]	-7.39	0.03	1.47	-10.51	-8.37	-7.31	-6.33	-4.73	3060	1.0
theta[69]	-4.24	0.02	1.41	-7.18	-5.16	-4.21	-3.29	-1.61	3702	1.0
theta[70]	-7.4	0.03	1.49	-10.62	-8.36	-7.3	-6.34	-4.72	3117	1.0
theta[71]	-7.23	0.03	1.46	-10.35	-8.15	-7.13	-6.18	-4.58	3069	1.0
theta[72]	-6.44	0.02	1.27	-9.14	-7.27	-6.39	-5.57	-4.07	4381	1.0
theta[73]	-7.55	0.03	1.51	-10.75	-8.56	-7.46	-6.47	-4.8	2128	1.0
theta[74]	-7.61	0.02	1.43	-10.47	-8.58	-7.57	-6.58	-4.95	3470	1.0
theta[75]	-6.08	0.02	1.38	-8.97	-6.97	-6.01	-5.1	-3.54	3721	1.0
theta[76]	-5.22	0.02	1.46	-8.18	-6.2	-5.17	-4.23	-2.41	3858	1.0
theta[77]	-4.68	0.03	1.5	-7.69	-5.66	-4.63	-3.66	-1.92	3556	1.0
theta[78]	-5.25	0.02	1.49	-8.28	-6.24	-5.19	-4.22	-2.51	3594	1.0

theta[79]	-7.73	0.03	1.48	-10.88	-8.69	-7.64	-6.7	-5.01	3061	1.0
theta[80]	-7.28	0.02	1.41	-10.25	-8.21	-7.22	-6.29	-4.7	4287	1.0
theta[81]	-5.35	0.02	1.43	-8.29	-6.27	-5.29	-4.34	-2.68	3663	1.0
theta[82]	-7.34	0.02	1.46	-10.36	-8.28	-7.28	-6.33	-4.64	4211	1.0
theta[83]	-7.32	0.03	1.44	-10.36	-8.25	-7.22	-6.31	-4.71	2882	1.0
theta[84]	-6.58	0.02	1.32	-9.41	-7.43	-6.51	-5.66	-4.16	3344	1.0
theta[85]	-6.44	0.02	1.31	-9.33	-7.25	-6.38	-5.55	-4.11	3365	1.0
theta[86]	-4.62	0.03	1.41	-7.51	-5.56	-4.57	-3.63	-1.99	3086	1.0
theta[87]	-5.63	0.02	1.4	-8.47	-6.54	-5.56	-4.65	-3.11	3209	1.0
theta[88]	-7.47	0.03	1.5	-10.62	-8.44	-7.41	-6.4	-4.76	3038	1.0
theta[89]	-6.95	0.03	1.52	-10.21	-7.94	-6.82	-5.9	-4.2	3188	1.0
theta[90]	-6.57	0.02	1.31	-9.31	-7.43	-6.52	-5.65	-4.17	3578	1.0
theta[91]	-6.55	0.02	1.35	-9.41	-7.43	-6.49	-5.58	-4.08	3909	1.0
theta[92]	-7.79	0.03	1.44	-10.8	-8.75	-7.73	-6.77	-5.11	3146	1.0
theta[93]	-6.93	0.03	1.41	-9.99	-7.8	-6.84	-5.96	-4.46	2189	1.0
theta[94]	-4.45	0.02	1.39	-7.3	-5.35	-4.43	-3.49	-1.83	3410	1.0
theta[95]	-3.7	0.02	1.16	-6.12	-4.45	-3.66	-2.89	-1.57	4302	1.0
theta[96]	-7.76	0.03	1.5	-10.89	-8.76	-7.69	-6.67	-5.06	2354	1.0
theta[97]	-7.68	0.03	1.51	-10.77	-8.68	-7.59	-6.64	-4.84	3152	1.0
theta[98]	-6.6	0.02	1.34	-9.37	-7.48	-6.53	-5.66	-4.08	3671	1.0
theta[99]	-5.24	0.02	1.19	-7.73	-6.01	-5.17	-4.4	-3.07	3558	1.0
theta[100]	-6.51	0.02	1.29	-9.18	-7.34	-6.47	-5.65	-4.13	4411	1.0
theta[101]	-7.76	0.03	1.45	-10.84	-8.71	-7.69	-6.74	-5.08	2518	1.0
theta[102]	-5.8	0.02	1.27	-8.37	-6.63	-5.78	-4.91	-3.45	3738	1.0
theta[103]	-4.68	0.03	1.47	-7.79	-5.63	-4.63	-3.67	-1.9	3144	1.0
theta[104]	-7.52	0.03	1.44	-10.69	-8.46	-7.41	-6.51	-4.93	2848	1.0
theta[105]	-4.72	0.02	1.43	-7.68	-5.67	-4.66	-3.75	-2.03	3935	1.0
theta[106]	-5.52	0.02	1.24	-8.11	-6.31	-5.46	-4.66	-3.25	4716	1.0
theta[107]	-6.01	0.02	1.33	-8.79	-6.89	-5.95	-5.1	-3.57	2935	1.0
theta[108]	-5.79	0.02	1.32	-8.52	-6.66	-5.72	-4.88	-3.4	3728	1.0
theta[109]	-7.7	0.03	1.48	-10.81	-8.66	-7.64	-6.63	-5.05	2403	1.0
theta[110]	-5.39	0.02	1.23	-7.92	-6.2	-5.35	-4.55	-3.1	4168	1.0
theta[111]	-4.57	0.02	1.51	-7.62	-5.59	-4.55	-3.53	-1.67	3756	1.0
theta[112]	-7.63	0.03	1.47	-10.73	-8.59	-7.54	-6.6	-5.01	2685	1.0

theta[113]	-7.55	0.03	1.48	-10.78	-8.52	-7.47	-6.51	-4.85	2379	1.0

Samples were drawn using NUTS at Fri Apr 9 11:34:01 2021.

For each parameter, n_eff is a crude measure of effective sample size,

and Rhat is the potential scale reduction factor on split chains (at

convergence, Rhat=1).

z=pull(fit)