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Visual attention in multi-attributes choices: What can eye-tracking tell us?

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ABSTRACT

Choice experiments (CE), involving multi-attribute choices, are increasingly used in economics to value non-marketed goods. Such choices require individuals to process large amounts of information, shown to trigger partial information strategies in participants. We develop a new framework in which information processing is treated as a latent (unobservable) process. Testing our approach by combining CE and visual attention (VA) data gathered from eye-tracking, we show that treating information processing as a latent process (LIP) outperforms models assuming full information processing (FIP) or binary information processing (BIP). Our modelling of VA results in a number of key findings. We show that the relationship between VA and individuals' preferences depends on the type of product attribute. More specifically, preferences for "easier to process" attributes appear to be less influenced by changes in underlying level of VA than "harder to process" attributes. In turn this impacts on willingness-to-pay estimates, with the LIP model resulting in smaller values than those obtained with the FIP model. Our results have implications for CE designers. More time should be spent getting subjects to understand more complicated attributes of the CE. Our results are likely to extend beyond experimental choices (stated preferences) to actual choices (revealed preferences).

1. Introduction

Choice experiments (CEs) are commonly used in economics to value products or services when markets for them do not exist (de Bekker-Grob et al., 2012; Hoyos, 2010; Lagarde and Blaauw, 2009). Developing from the disciplines of psychology (Luce, 2005; Thurstone, 1927) and economics (Lancaster, 1966; Manski, 1977), CEs present participants with the task of choosing one option from two or more hypothetical products, each described in terms of a set of attributes. Based on the Lancasterian theory of demand, the CE stipulates that the utility of a product comes from its features rather than the product itself, what is known as multi-attributes utility (Lancaster, 1966). Whilst this approach measures the relative contribution of different product features to individuals' choices, as well as trade-offs between attributes, it raises important questions

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regarding how individuals process large amounts of information. Previous studies have investigated information processing (IP) in the context of multi-attributes choices by determining which product attributes do not contribute to individuals' choices, what is known as "attribute non-attendance" (ANA) (Hensher and Greene, 2010; Carlsson et al., 2010; Hole, 2011; Hole et al., 2013). These studies indicate that ANA has important consequences on modelling of discrete choices, computation of willingness-to-pay for product improvement and predictions of market shares. However, due to lack of data about the cognitive processes taking place during individuals' choices, these studies provide no explanation of how ANA occurs. For example, does ANA occur early in the decision making process when individuals start processing or collecting information about the products, or at a later stage when individuals choose their *preferred* product?

We explore the role of visual attention (VA) in processing multi-attribute information, and how this relates to individuals' choices. We use an eye-tracker to explore how individuals visually process the information. An eye-tracker records participants' eyes movements, thus providing data on VA, such as fixation times, while making multi-attributes choices. Using an eye-tracker within a CE offers a unique setting to simultaneously observe both processes and outcomes of individuals' choice behaviour. To the best of our knowledge, this experimental setting has only been used in Balcombe et al. (2015) who analysed the impact of partial information processing (referred to as "visual ANA") on preferences for food labelling. They used a "shrinkage approach" to represent the relationship between visual attention and ANA, allowing for a "*continuum between two extremes from where [visual] non-attendance is non-informative to the case where non-attendance signifies that the non-attender has zero marginal utility for the attribute in question*". This approach showed a weak relationship between changes in VA and marginal utilities. We argue that their result may be due to the procedure they used to identify visual ANA (see Section 3.2). Key to their approach is the use of a cut-off point to convert continuous measures of VA, such as fixation times (in milliseconds) on different attributes, into a binary measure of visual ANA. Whilst this binary approach is conceptually *straightforward* to implement and compatible with previous literature on ANA; it is likely to provide an incomplete account of the role of VA in multi-attribute choices.

Our study contributes to the literature by exploring alternative ways of accounting for VA in the measurement of preferences. Whilst ANA would be associated with one extreme (binary) form of multi-attribute information processing (i.e., *is the piece of information ignored vs. considered?*), our approach is based on the assumptions that (i) attention would be best described as a continuous rather than a binary concept, and (ii) recognising the continuous nature of attention would reveal more information about individuals' preferences. Following Shimojo et al. (2003) and Krajbich and Rangel (2011), VA and preferences cannot be perfectly dissociated as they influence each other in a positive feedback loop i.e., "*The longer I look at something, the more I like it*" and "*The more I like something, the longer I look at it*". This suggests that VA contains useful information about individuals' preferences. We develop a framework in which measures of VA are considered as indicators of an underlying level of "information intake/processing" (i.e., *how much individuals learn about the multi-attribute content of the product*). Our results indicate that measures of VA improve the modelling of choice behaviour. Our study also contributes to the literature by showing that the relationship between VA and individuals' preferences depends on the type of product attribute. More specifically, preferences for "easier to process" attributes appear to be less influenced by changes in underlying level of VA than "harder to process" attributes. In turn this impacts on willingness-to-pay estimates. Our results have important implications for the analysis of choice data (revealed and stated) as well as the design of CEs.

The rest of the article is organised as following. In Section 2, we describe the CE. In the Section 3, we develop the analytical framework for investigating the effect of VA on individuals' multi-attribute choices. In Section 4 we present and discuss the results. Section 5 makes concluding comments.

2. Eye-tracking choice experiment

2.1. Sample of participants

58 psychology students were recruited using online advertisement (See Table 1 for a description of sample characteristics). Recruitment was on a first-come-first-served basis and took part in return for course credit. The study protocol was approved by ethics committee of the School of Psychology at the University of Aberdeen (UK).

2.2. Choice experiment

Participants' choices were recorded for an existing CE concerned with preferences for characteristics of health and lifestyle (H&L) programmes (Ryan et al., 2015). Each H&L programme was described by seven attributes: type of H&L programme [PROG]; objective of the programme [GOAL]; level of weight reduction [WEIGHT]; level of high blood pressure risk reduction [HBP]; level of diabetes (Type 2) risk reduction [DIABETES]; time commitment to the programme [TIME]; and cost of the programme [COST] (Table 2). Twelve choice tasks were derived using experimental designing procedures, allowing main effects of attributes to be estimated. Choices were presented on a computer; participants were asked to select their most preferred alternative in each task (Fig. 1). For each trial, participants looked at the choices until they reached a decision, and then pressed the space-bar on the keyboard to reveal the mouse cursor, indicating that they were ready to indicate their response. With the mouse, they then clicked on their preferred H&L programme. If they did not prefer any of the programmes, participants had the option to click outside the image to indicate they preferred to stick with their current exercise and diet programme. Before the 12 experimental tasks, four practice tasks were presented to familiarise participants