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Visualisations in Choice Experiments: Comparing 3D Film-sequences and Still-images to Analyse Housing Development Alternatives

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ABSTRACT

Participatory planning approaches are said to improve agreement on sustainable housing development objectives among stakeholders. The choice experiment method (CE) offers much potential for an in-depth and rigorous participatory planning approach, e.g. having individuals choose their most preferred option from a range of (planning) alternatives. Here we tested for differences in preferences for housing development alternatives resulting from the different forms of presentation of identical choice set information (treatments) – in particular, digitally generated film sequences presented to respondents as compared with the presentation in the format of a series of still images, as an internet survey among German home buyers. The findings suggest that a more sophisticated form of choice set presentation, 3D film sequences, was outperformed by a more basic form of visualisation technique, the choice set information presented as 3D still-images. Also, we tested for the effect of the degree of 'expertise' of respondents and found that a more sophisticated form of choice set presentation (3D film sequences) led to a better comprehension of the choice set task only among 'expert respondents', i.e. respondents who in the past had made a housing investment decision or were presently making an actual house buying decision.

1. Introduction

Participatory planning approaches are postulated to improve community involvement in planning processes and hence foster broader acceptance of sustainable planning objectives (Ryffel et al., 2014; Kaltenbrunner, 2009). Visual information is believed to facilitate participatory planning approaches, since visual information serves as a 'common language' for all stakeholders involved in planning processes (Kaltenbrunner, 2009; Ryffel et al., 2014). Computer-aided design (CAD) models have been used over the past few decades to present design solutions to professionals and non-professionals alike (Laing et al., 2009). 3D visualisation techniques have been found to lead to a significant increase in the comprehension of planning information compared to two-dimensional illustrations and hence to a more rapid decision making on behalf of the stakeholders (Rohrmann et al., 2000; Al-Kodmany, 2001; Zlatanova et al., 2007; Rid and Profeta, 2011). Patterson et al. (2017) relate this effect to theory in cognitive psychology and the "picture-superiority effect" (for an overview, see Patterson et al., 2017: 65).

Methods developed in fields other than planning sciences offer much potential for an in-depth and rigorous participatory planning approach, such as analysing individual preferences for different variants of (non-marketed) environmental goods. In the past thirty years, two general paradigms for preference elicitation have evolved, termed "conjoint analysis" (CA) and "discrete choice experiment" (CE) (Louviere et al., 2010). Originally introduced in psychology, CA has been increasingly used in academic and applied marketing from the early 1970s on (e.g., Green and Rao, 1971; Cattin and Wittink, 1982). In CA, variants of a good are being rated and ranked by respondents. In contrast, discrete choice experiments are based on random utility theory (RUT), originally proposed by Thurstone (1927) and further developed by McFadden (1974) to take into account inter-linked behaviors with the theory of paired comparisons (pairs of choice alternatives) and multiple comparisons (McFadden, 1986; McFadden and Train, 2000). In choice-based approaches respondents have to actually make a choice between variants of an environmental good presented in

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choice sets. CE methods are commonly used in ecological economics (e.g. Vollmer et al., 2016; Hoyos, 2010; Matthews et al., 2017, 1; Lew and Wallmo, 2017) and often termed stated preference surveys, stated choice surveys, or discrete choice experiments.

This paper makes use of the discrete choice experiment (CE) that allows the collecting of stated preference data, where individuals choose their most preferred option from a range of planning alternatives (Louviere et al., 2010; Laing et al., 2009; Hensher et al., 2007). Enneking (2004) stresses that eliciting individual preference might be superior to other participatory planning methods, as stated-preferences research accounts equally for every individual's preferences and data is not biased by votes from opinion leaders or well-organised groups of stakeholders.

The CE method, however, has raised some concern with regard to the comprehension of choice tasks. Preference elicitation in CE is dependent on the degree of respondents' comprehension of the information provided in the choice sets, as information is central to the formation of preferences and a failure to adequately explain the information leads to bias (Bateman et al., 2009). Attributes in CE experiments have often been presented to the respondents as numerical or textual expressions of different levels of the attributes, a procedure increasingly criticised in literature. For example, Dijkstra et al. (1999, 2003) stated that a verbal presentation format might have a potential lack of realism and recommends using visualisation techniques to improve comprehension and thus for the evaluation of complex information provided in choice experiments, as well as for helping alleviate fatigue effects. In consequence, some CE experiments have been using various forms of visualisations to overcome data bias.

Among the first such applications, Haider (1998) used digitally calibrated images presenting multiple attributes in recreation research CE applications to evaluate utilities for scenic beauty or forest aesthetics (Haider, 1994; Haider and Hunt, 2002). Likewise, Macmillan et al. (1996) analysed preferences for variants of Environmentally Sensitive Areas (ESA) in Scotland using computer manipulation of photographic images showing visual changes to landscapes with or without the effect of ESA policy programmes (see also Simpson et al., 1997 for the design of images of landscape variants). Also similar, Johnston and Swallow (2002) use sketchy layouts of digitally generated images in a CE study to analyse housing choice, for example.

The use of more precise digitised images, however, is more recent: For example, Manyoky et al. (2016) report on an approach to evaluate annoyance from noise and visual impact on landscape aesthetics from wind parks in Switzerland using spatially explicit and exactly calibrated visual-acoustic simulations. Regarding the use of visualisations in CE surveys, Ryffel et al. (2014) analysed WTP for different scenarios of long-term land use changes that impact water retention in a Swiss Alpine catchment area. In that study, GIS-based 3D visualisations were created to compute spatially explicit variants of landscapes visualizing forest- and settlement attributes using ArcGIS10 (ESRI)- and Visual Nature Studio (3D Nature)- software to precisely control for effects of landscape changes. Bateman et al. (2009) carried out a split-sample experiment to compare standard text presentations of choice set information with virtual reality (VR) presentations of objectively identical information and found that virtual reality presentations significantly reduced variability and gain/loss asymmetry in CE data. Patterson et al. (2017) compared text-only and virtual reality attributes presented in a CE to elicit preferences for neighbourhood choice, and found that the virtual reality model outperformed the text-only model. These studies, however, fall short of explaining the varying results from different formats of choice task presentation from the perspective of socio-demographics of respondents, e.g. whether respondents are familiar with the choice task subject or not.

In the past decades, methods of stated preferences elicitation (CE and CA) were intensively applied to various research problems focusing on (sustainable) housing preferences and neighbourhood choice. According to the character of the generic attributes used to describe the choice alternatives, literature pertains to different scales of planning, such as studies analysing preferences on the building-, neighbourhood- or urban scale of planning and location choice. For instance, Dijkstra et al. (2003) aimed to evaluate different designs for new workspaces in a new building at the Eindhoven University of Technology. The authors presented three design variables as generic choice attributes to a sample of University employees, i.e. dividing walls between workplaces and public spaces, dividing walls between workplaces and dividing walls between workplaces and the open area.

Other studies focus on the neighbourhood scale of planning and neighbourhood choice, including attributes such as 'neighbourhood layout' (grid or cul-de-sac), building density, quality of public spaces and green spaces, safety, travel time or other transport related attributes (Balbontín et al., 2015; Iglesias et al., 2013; Rid and Profeta, 2011; Morrow-Jones et al., 2004).

The selection of attributes in these studies are mostly based on considerations about theoretical concepts such as 'Neotraditonal' and 'New Urbanist' concepts or concepts of 'Sustainable Housing Development' as – for example – opposed to "conventional postwar suburban developments" (Morrow-Jones et al., 2004: 183). Other studies conduct extensive pre studies to find out about relevant attributes, such as employing a Delphi survey for the identification of attributes or focus group interviews (Greene and Ortúzar, 2002).

On the urban scale, Iragüen and Ortúzar (2004) reported on a stated preference experiment to estimate willingness-to-pay (WTP) for reducing fatal accident risk in urban areas and selected travel time, travel cost and different indications for the level of risk as generic attributes for the experiment. Also, on the urban scale, various studies analysed residential location choice (Jiao et al., 2015; Timmermans et al., 1992; Ortúzar et al., 2000), or housing and neighbourhood choice in the context of urban attributes such as the aesthetic quality of environmental amenities in an urban or suburban setting (Earnhart, 2001). Garcia and Hernandez (2007) analysed housing and urban location decisions in Spain and used different housing types as generic variables, such as high level urban property, medium-inferior level urban property, rural property and renting. Another study by Bullock et al. (2011) analysed housing choices in rural areas and used attributes such as house design, house location and journey times. Similar, Rouwendal and Meijer (2001) analysed housing choice in the context of commuting and employment and included attributes such as type of dwelling, commuting time or location of houses. Greene and Ortúzar (2002) report on a study to elicit WTP for social housing attributes and included both building related attributes such as sanitation and comfort and 'urban facilities' attributes (schools, health centres etc.).

In this paper, we report on an approach to measure stated preferences for sustainable housing development options on the neighbourhood scale by comparing the presentation of objectively identical information in a CE experiment using different CAD visualisation techniques. More specifically, we investigate the influence of digitally generated film sequences on CE results compared with the presentation of still images ('treatment effects') in an internet survey on preferences concerning various attributes of sustainable housing alternatives among German house buyers. Furthermore, we test the impact of the situation or stage of the house-buying decision on treatment effects, specifically whether or not a respondent has already made or is about to make an actual house-buying decision ('situational treatment effects'). Compared to other studies that tested for differences of choice set presentation formats, we included a relatively large number of attributes of neighbourhood choice (eight attributes).

2. Study Design

2.1. Attributes

The selection of criteria for describing sustainable housing development was based on a thorough literature review (Bramley and Power,