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Article

Information sharing preferences within buildings: Benefits of cognitive interviewing for enhancing a discrete choice experiment

Paul Haggar ^{1,*}, Eleni Ampatzi ², Dimitris Potoglou ³, Marcel Schweiker ⁴

¹ Department of Psychology, University of Bath, UK; ph640@bath.ac.uk

² Welsh School of Architecture, Cardiff University, UK; AmpatziE@cardiff.ac.uk

³ School of Geography and Planning, Cardiff University, UK; PotoglouD@cardiff.ac.uk

⁴ Institute for Occupational, Social and Environmental Medicine, Medical Faculty, RWTH Aachen University, Germany; mschweiker@ukaachen.de

* Correspondence: ph640@bath.ac.uk;

Abstract: To design and operate energy efficient and comfortable buildings it is important to know what the occupants' preferences for indoor environmental quality would be. These preferences are related to a range of personal characteristics that occupants may or may not be willing to share. Preparing materials for a forthcoming stated preference discrete choice experiment (SPDCE) investigating willingness of building occupants to share information, we conducted cognitive-interview pretesting with 12 participants to find out whether these materials were interpretable and meaningful. Qualitative analysis identified seven important limitations, including misinterpretations and uncertainties arising from language and difficulties imagining the situation and options being described. Most participants expressed some desire for a deeper understanding and were not satisfied with the choices they were asked to make. We discuss how identifying these limitations assisted in refining these SPDCE materials, the potential cognitive interviewing has for enhancing the validity of study materials and the importance of better understanding when researching occupant behaviours.

Keywords: cognitive interviewing; discrete choice experiment; indoor environmental quality; pretesting; validity

1. Introduction

It is important to understand human action indoors. The need for establishing a better understanding of the effects of multi-domain (thermal, visual, aural, and olfactory) environmental and personal stimuli on occupants' perception and behaviour is now recognized as critical for the creation of energy efficient buildings that satisfy the current and future requirements for comfort [1]. In recent years, the advancement of sensing devices [2] and the opportunities provided by information and computing technologies [3], the social media and the Internet of Things more broadly [4], have vastly increased the accessibility to data that can potentially lead to such enhanced understanding of human actions, perceptions, and experiences. These can include data perceived to be both personal and private [5-7], such as physiological information (e.g., heart rate, skin temperature) and psychological or social information (through self-report – e.g., private life activities, preferences). So, acknowledging that collecting this data is beneficial in achieving important applied research objectives, such as designing comfortable, healthy, and carbon-neutral indoor environments, it is important to know about what information occupants are willing to share with researchers and under what circumstances [8-10]. With this knowledge, studies can be designed that have a real potential to collect useful data with sensitivity to the concerns of participants; studies that are ethical and responsible by design [11]. Such knowledge is also potentially relevant when applying theory in practice, because even a

beneficial product – a ‘smart’ system for thermal efficiency through human behaviour prediction, for instance – is of little commercial value if the customer finds the product invasive.

The objective of this article is to report the findings from cognitive interview pretesting conducted in preparation for a stated preference discrete choice experiment (SPDCE) investigating willingness to share personal information relevant to indoor environmental quality in the workplace [12]. In doing so, we show the utility of this approach in pretesting choice experiments, questionnaires, and surveys for their internal and content validity.

Choice experiments [13], also known as stated preference discrete choice experiments or SPDCE, ask participants to choose between different (hypothetical though realistic) options where each option is similar but presented as a combination of different attributes (features, characteristics) with varying levels (numerical values or qualitative categories). The choices made indicate respondents’ relative importance on the attribute levels that characterise each option. Choice experiments are particularly useful when real choices cannot be studied directly, such as when attributes of options are less manifest (e.g., privacy, sustainability). Several previous studies have successfully employed choice experiments to identify preferences for alternative options with different levels of privacy and security: preferences for security over privacy on UK rail services [14]; preferences for consumer-privacy over e-commerce [15]; and preferences for privacy over surveillance when choosing an Internet Service Provider [8].

Pretesting materials for internal and content validity is an important preliminary step to survey or questionnaire research [16] and SPDCE [13], in particular [81]. If participants consistently misunderstand or reinterpret questions and choice options, then this may impact upon the internal validity of the experiment, the response rates of the survey, prompt respondents to use simplifying strategies, select the ‘opt-out’ option (if available), lead to non-trading behaviours and missing responses (see, [17]). Choice experiments, like surveys, depend upon the validity of their materials for meaningful estimates, however, the use of pretesting for validity is, to our knowledge, more established in certain fields – for example, health and healthcare, e.g. [17,18]. It may be the case that researchers using stated preference methods, or conducting indoor environmental quality research, may be less aware of the benefits of cognitive interview pretesting for improving the validity of a study’s materials. In the present study, in addition to prosaic issues relating to clarity of presentation, we identified more challenging issues concerning the comprehension and interpretation of materials that provide valuable insights into how participants might understand the collection of sensitive personal information for research and how they approach the choice task itself. The results highlight the importance of rigorous testing of questionnaire material and in particular of the advantages of using cognitive interviews in social science - built environment and occupant behaviour research.

2. Theoretical Background

2.1. Human Participation in Research on Indoor Environmental Quality

As with any research activity involving human participation, studies on indoor environmental quality and comfort are subject to research ethics checks and approval. Typical in this subject of research [19-20] are field or laboratory studies in which the environmental conditions are monitored, the participants’ subjective votes or opinions are captured using questionnaire surveys, and objective reactions are recorded through sensory equipment (physiological reactions such as skin temperature, heart rate) as well as behavioural reactions (interactions with windows, thermostats, etc.) [21]. Fundamental to our current understanding of thermal comfort is the appreciation that the human physiology, behaviour, and psychology all have an impact on thermal perceptions [22]. The growing evidence of the direct impact of perceived control, expectation, habituation, and adaptive actions to the notion of comfort [23] calls for a more holistic exploration of environmental

and personal conditions co-present, so that overlapping or masking effects between these can be accounted for (see, [20] for a review).

The interest in potential physiological markers of environmental experience has led into examination of a range of possible bio-indicators of environmental perception, that express functions of the human body: the immune, the thermal metabolism, the respiratory and the cardiovascular systems [24]. These research directions involve the collection of personal data, in ways that are — if not invasive — then greatly dependent on close monitoring regimes, that often include also wearable sensors. Increased attention is now demanded when handling data — of any kind — that can identify individuals and thus compliance with the current protocols needs to be upheld, such as the Findable, Accessible, Interoperable and Reusable (FAIR) principles [25] and the EU General Data Protection Regulation (GDPR: [26]). Aside from the ethical issues arising that concern confidentiality and data protection, there is a current need to understand the level of willingness that different groups of building users share with regards to making personal data available for research purposes or for the improvement of real indoor environments [1].

2.2. Questionnaire Materials, Stated-Choice Experiments and Comprehension

Questionnaire materials are used across a variety of study designs [27]. In the context of information privacy and personal data, survey questionnaires have been the standard approach in capturing respondents' privacy concerns, level of trust (e.g., to organisations, academic research), and perceptions about control of information using Likert-scale questions [28]. These sets of questions have been usually linked with a stated intention to disclose information and/or antecedents such as age, gender, education qualifications and other observed individual characteristics [29]. Structural equation modelling has been the workhorse analytical framework, which has been employed to establish associations across Likert-scale questions (e.g., trust, concerns), antecedents and stated behavioural intentions to disclose information (e.g., [30, 31]). The key shortcoming of this approach is that the *stated intention to disclose* remains a single question with very limited information about the context under which information is disclosed and limited variation regarding the circumstances (conditions) under which individuals are asked to disclose information. In other words, within a Privacy Calculus model [32] under which individuals weigh the risks and benefits from disclosing their personal data, there is only a limited set of risks and benefits to be assessed. It is therefore necessary to capture how respondents effectively 'trade-off' between the data requirements and the terms under which they disclose their data and the potential benefits that doing this may bring (e.g., improving indoor environmental qualities).

Stated choice experiments are based on Random Utility Theory [13,33] and can be employed to present variations of personal data requirements to improve real indoor environments. Aimed at maximizing the benefits of a *comfortable indoor environment*, our hypothesis is that respondents would place different levels of sensitivity against *the type* and *the terms* under which their personal data will be monitored/disclosed. For example, data requirements to improve indoor environments may range from socio-demographic information to activity monitoring (e.g., presence), and physiological data at different levels of detail. Also, different organizations may be responsible for the data collection and analysis as well as the terms of collection and use of those data may involve third parties (or not) and different levels of *control* over individuals' personal data. SPDCE provide the theoretical and empirical foundations to construct different scenarios and capture respondents' sensitivity against data requirements and terms of use of those data by allowing those combinations to be presented in the form of different choice options within a hypothetical scenario.

Stated choice experiments are primarily administered within computer-based, face-to-face, or online survey questionnaires. Beyond basic guidance [34], response to survey questions is a cognitive process that can be inaccurate or biased if a question is unclear or being asked in the wrong way, requiring additional cognitive effort [35]. For instance,

respondents may judge a question's importance by its length or give undue attention to the most recent item of information presented [36,37]. While these and other effects have been studied within the conventions of questionnaire surveys (e.g., opinion questions, multiple choice Likert scales), less is known about such cognition effects within choice-experiments, mainly because qualitative pretesting and cognitive interviews are frequently overlooked. The only exceptions, in which extensive testing of choice experiments is taking place, is the subject areas of Health and Healthcare in which there is ample evidence on pretesting and cognitive testing of SPDCE [17].

Behavioural Decision Theory [38] identifies a tendency for decision-makers to use choice strategies (or heuristics) to trade-off accuracy against cognitive resources. Some evidence is available that these trade-offs occur in choice experiments: (a) with attributes being neglected or others 'added up' to make decisions easier [39] and (b) with greater error variance attributable to cognitive load in more complex choice experiments [40]. Beyond this trade-off, language – wording of scenarios, attributes, and levels – is a further source of potential error. These errors may be due to structural issues (syntax) or social norms of questions and answers (pragmatics), but issues of meaning (semantics) are also important: the language used in the materials may be vague/ambiguous, include unwarranted presuppositions that bias responses, or include concepts or words unfamiliar to the respondent [35], above all technical language that becomes jargon. There may be a lack of consensus on the best practices for designing meaningful choice experiments [17,41]; qualitative methods can be effective in addressing the problem [42], but cognitive interview pretesting was developed, and is ultimately required, for the purpose of detecting these cognitive issues [43].

2.3. Cognitive Interview Pre-testing

Cognitive interviewing is a method for identifying and correcting problems with survey questions [43]. The method originates in the work done by Lessler and colleagues at the Questionnaire Design Research Laboratory (QDRL) of the US National Centre for Health Statistics [44] following the NCHS Cognitive Aspects of Survey Methodology project [45,46]. Cognitive laboratories like QDRL were subsequently established within other statistical organisations in the United States, such as the Census Bureau [47]. Researchers within these laboratories codified their cognitive interview methods in protocols and training manuals (e.g. [48,49]) that became the basis for current paradigms [43,50]; recent scholarship puts emphasis on qualitative aspects of the method [51,52].

A cognitive interview is a person-to-person interview during which the interviewee completes the questionnaire materials being tested. The interviewee may be instructed to 'think aloud' – to speak their thoughts aloud – as they complete the survey, and the interviewer may then use 'verbal probes' (often questions) to encourage them talk about their understanding of the question and how they answered it. In this way, interviewees can provide useful information about how they are answering a question that can indicate when and how questions are problematic. While cognitive interview pretesting is often used in survey research, and some health researchers have made use of the technique to develop their choice experiment materials (e.g. [53-56]), we found no instances of occupant behaviour, indoor environmental quality or thermal comfort research reporting cognitive interviewing as a pre-test for choice experiments, and relatively few such studies from other fields, such as transport research (e.g., [57]) or environmental economics (e.g., [58,59]).

3. Materials and Methods

3.1. Materials

A slide presentation was used to show materials to the participant. The first slide showed the instructions for the choice tasks and is shown in Figure 1.

Imagine that you are at your typical workplace. The following screen will present you a scenario with two options under which sensors and/or computer-based surveys are used to record personal (e.g. age, gender, presence, heart rate) and space-related information. This information would help to improve the indoor environmental quality in terms of temperature, air quality, light, and sound; and reduce the energy consumption of your workplace.

We will show you five scenarios in total – each time different levels of personal and space-related data may be required to adjust the indoor environment. Please, take your time to familiarise and review the scenarios, and choose the one you would most likely agree with.

Figure 1. Instructions Slide.

As shown in Table 1, the SPDCE included two groups of attributes: (a) key dimensions related to *'what type of information'* or personal data may be collected to improve indoor environmental qualities using sensors and follow up survey questionnaires, and (b) aspects related to *'who collects and controls the data'* including potential secondary use of the data by third parties. The selection of attributes and levels was based on a literature review regarding key influencing factors in related choices and several discussion-rounds among the researchers involved in the main project establishing the choice experiment [12].

Table 1. Attributes and levels in the choice experiment.

Attribute	Levels			
	1	2	3	4
<i>What information is collected</i>				
Demographics (e.g. age, gender)	No	Yes		
Psychological parameters through follow up survey questionnaires	No	Yes		
Physical parameters (e.g. room temperature, noise level, illuminance)	No	Yes		
Activity monitoring (e.g. presence, interaction with windows)	No	Yes		
Physiological data (e.g. heart rate)	No	Yes		
<i>Collection, anonymity and control of data</i>				
Responsible organisation for data collection and use	Government	Research Institution	Not-for-profit organisation	For profit organisation
Level of anonymity	You can be personally identified by those having access to the data	You can be personally identified by the data collector only	You cannot be personally identified	
Level of autonomy	No control over your own data	View your own data	View and delete your own data	View, delete, and choose what and how often your own data can be collected
Other uses of the data	None	Market research	University research	Governance and policy making (e.g. tax savings)

Using the Ngene software [60], a D-efficient experimental design with zero priors was employed to generate 60 choices divided into 12 blocks so that each respondent saw five (5) choice cards; an example choice task (card) is shown in Figure 2. Each choice card included two unlabelled alternatives and an 'opt-out' option.

Please, take your time to familiarise and review the scenarios, and choose the one you would most likely agree with.

Description	Option A	Option B	Option C
What information is collected			
Demographics (e.g. age, gender)	Yes	No	
Psychological parameters through follow up survey questionnaires	Yes	No	
Physical parameters (e.g. room temperature, noise level, illuminance)	No	Yes	
Activity monitoring (e.g. presence, interaction with windows)	Yes	No	
Physiological data (e.g. heart rate)	No	Yes	
Collection, anonymity and control of data			
Responsible organisation for data collection and use	Government	For Profit organisation	I would not choose any of the options in this card
Level of anonymity	You can be personally identified by those having access to the data	You can be personally identified by the data collector only	
Level of autonomy	No control over your own data	View, delete, and choose what and how often your own data can be collected	
Other uses of the data	Market research	None	
I would choose option:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Figure 2. Choice Task Slide Example.

3.2. Participants and procedure

This study was ethically approved by the Research Ethics committee of the Welsh School of Architecture in summer 2020. Commensurate to a small pre-test, a minimum of ten volunteers were sought through a convenience sample. Of 32 University colleagues contacted, 12 volunteered and participated. This sample was selected with a view to recruiting both men and women and both researchers and professional services staff (Table 2). Most were native English speakers, though a few spoke English fluently as a second language (#3, #8 and #9). Three, recruited from within the School, had some subject expertise. All were aged between 30 and 49, except for participant #6 who was aged between 50 and 64.

Table 2. Participants Information.

Participant	Gender	Role	Education
1	Female	Academic	PhD
2	Female	Professional	Masters'
3	Female	Academic	PhD
4	Female	Professional	Masters'
5*	Male	Academic	Masters'
6	Male	Academic	PhD
7*	Female	Academic	PhD
8	Female	Academic	PhD
9	Male	Academic	PhD
10*	Male	Academic	PhD
11	Male	Professional	Bachelor's
12	Female	Academic	PhD

*These participants have some subject expertise.

Interviews took place between June 30th and July 31st, 2020. Due to the COVID-19 pandemic, interviews were conducted remotely using videocall software and were audio

recorded by the interviewer with the participant's consent. Semi-structured cognitive interviews were conducted, employing a mixture of think-aloud and verbal-probe paradigms [43]. After obtaining informed consent, the interviewer used the 'share screen' function in the videocall software to display the materials to the participant.

The participant was asked to read the content of the first slide (see, Figure 1 – instructions) and then they were asked questions by the interviewer about the instructions. The participant was then asked to complete the five choice tasks (on the choice card slides) and was told they would be asked questions after completing each task. Participants were not explicitly asked to think aloud whilst answering, but most chose to do so. The questions asked after each slide were a mixture of pre-prepared and improvised verbal probes, first to encourage the interviewee to offer their own feedback (e.g. "how did you find that?"), then to encourage elaboration on specific aspects (e.g., "was there anything you found particularly easy or difficult?") or following up on comments (e.g., "why do you say that?"), and finally probe specific features of the materials (e.g. "what comes to your mind when you read the phrase 'activity monitoring'?"). Each interview concluded with a series of prepared questions concerning all the materials together, after which interviewees were thanked for their participation. The interview guide is provided in Appendix A.

3.3. Analysis

After each interview, the interviewer wrote notes. In these notes, the interview events were recorded in sequence, including verbatim (word-for-word) transcription of important speech only, as recommended [50]. The interviewer's own interpretations, impressions and ideas arising from the interview were also recorded, so that these were explicit during analysis. These notes were used as data which was analysed thematically [61]. The interviewer constructed a thematic table with participant-rows, theme-columns, and populated with extracts from the notes, thereby coding the data. At this stage, columns were considered as both codes and themes. The materials, including parts of the choice tasks, were used as a coding-frame (e.g., "introductory text", "activity monitoring", etc.) to which was added a small number of codes/themes relevant to elements identified as potentially problematic before the study (e.g., how participants would interpret the word 'government'). The coding process (comparisons between data and codes/themes) made issues with questions more salient. As issues became salient, new codes/themes were identified (e.g., "introduction is difficult to follow", "activity monitoring not always pictured clearly"). This process of analysis was also informed by Beatty and Willis [43] (pp. 301-302), particularly to identify "whether apparent problems can be logically attributed to question characteristics" and whether "a reasonable case could be made that respondents in similar circumstances would have similar difficulties responding" while acknowledging that "a claim that this process found "proof" of the problem would overstate the evidence." Analysis was recursive, rather than linear [61] with the process of reviewing, defining, and naming themes undertaken concurrently alongside writing a report document for the information of the whole research team. The results section of this article summarizes the key findings from this report, with sub-headings reflecting key themes. Prosaic themes (e.g., those concerning only clarity of language or visual presentation) are not reported in this article.

4. Results

4.1. Instructions Text

4.1.1. Imagining a typical workplace

The introductory text began with the instruction "Imagine that you are at your typical workplace" (see also Figure 1). Most participants did not mention difficulties, however some participants had different problems with this instruction. Some found the specific

instruction – to ‘imagine’ – suggesting invention and, therefore, found it confusing (#6, #7 and #8).¹ Others had difficulty imagining the sort of situation being described in the introduction as whole. There was a tendency to describe a ‘typical workplace’ in terms of an office environment; some participants noted that the phrase “computer-based survey” implicitly assumes a desktop computer, rather than the multiple devices and hot-desking sometimes more common in modern workplaces. One participant (#12) denied having any one workplace environment, instead they worked in “eight different places on a day” and “didn’t ever sit in ‘an office’” Indeed, some of the difficulties in imagining a typical workplace could have been due to many participants not using their workplaces during the national COVID-19 lockdowns, as well as individuals for whom home-working was a normal practice or for whom work takes place across a range of locations (meeting rooms, workshops, event spaces, etc.). Indeed, uncertainties arise when a participant’s circumstances do not correspond to the prototypical situation depicted [62].

4.1.2. Confusion with ‘scenario’ and expectations for the task

The introductory text stated that the participant would be presented with “a scenario with two options...” and that “we will show you five scenarios in total [...] choose the one you would most likely agree with.” Several participants expressed no issues with this language, but it is significant both that two participants (#2 and #8) neglected this information, preferring to learn by “seeing what pops up” (as Participant #8 put it), and that others required additional guidance with the task upon seeing it for the first time (#2, #5 and #7). Two of these three participants (#5 and #7) identified this text as confusing: confusing in terms of the language itself, the differences between ‘scenarios’ and ‘options’, and in judging how many tasks there would be. Judging the number of tasks could be of significance because, as Participant #7 reported, they and others might be inclined to rush their responses if they anticipated many complex tasks to follow. After seeing the task, these participants also remarked that the scenario actually had three options, not two (because, in addition to options A and B was option C, which was to choose none of the options on the card). For instance, Participant #5 observed that “if you say ‘two options’ this is like you really want [...] to get one of the two options and you think that the third option is not a very good one.” Asking participants about their expectations for the forthcoming task, some gave fairly accurate descriptions (e.g., #3, #10), but two (#2 and #8) expressed uncertainty and others described more typical questionnaire materials: vignettes (#6) and scale responses (#1, #7). This indicates that these participants formed expectations about the questions using their past experiences with questionnaires rather than what they had just read. It is also worth noting that some of the participants, being academic researchers, were likely informed by their relevant experience with questionnaire design and evaluation. However, altogether, the ‘scenario’ and ‘options’ language was shown to be confusing and not sufficient for introducing the context in the choice experiment. Choice experiments, or survey questions that similarly reference a context (a ‘scenario’), require clear explanation of this, differentiable from the task itself. This is especially true where choice tasks are complex or unfamiliar, or the context is beyond normal daily experience [e.g., 53, 54, 55].

4.2. Choice Tasks

4.2.1. Uncertainties about information collection can become worrying

The first five choice variables in the task were titled “what information is collected” and included “psychological parameters through follow up survey questionnaires”, “activity monitoring (e.g., presence, interaction with windows)” and “physiological data (e.g., heart rate)”; each could take the value ‘Yes’ or ‘No’ (see Figure 2, above). Overall,

¹ “Imagine: (1) to form a mental image of (something not present); (2) suppose, guess; (3) to form a notion of without sufficient basis : FANCY” [62].

participants were uncertain about these variable-concepts, leading some participants towards misinterpretation and doubt.

The absence of examples for ‘psychological parameters’ left participants free to speculate on what they might be, and answers were usually plausible (e.g., mood, attitudes, comfort, stress, working practices). However, three participants expressed concern over more worrying possibilities. Participant #3 was very comfortable about the collection of physiological data (“I wear a [smart device]; I give a corporation my physiological data every day”) but said it was a “big question mark” for them as to “how personal” the psychological parameters would be, citing sexual activity as an example: “I would feel quite uncomfortable sharing that.” Participant #8 described the psychological parameters as one of their key concerns, citing menstrual cycles and depression history as worrying potential examples. Participant #6 offered grief and anxiety (alongside attitudes) as examples of psychological parameters. Participant #8 was concerned that, in such a scenario, their employer might have access to this sensitive information as part of the study. Both participants 8 and 10 identified these uncertainties as a reason for not consenting to these options or “opting out” by choosing option C.

This contrasts with physiological measures, where the single example (‘heart rate’) tended to define the variable narrowly. Six participants (#4, #6, #8, #9, #10, #11) could give other plausible examples, but had difficulty doing so and may not have considered other possibilities had they not been asked to do so. At least two participants (#3 and #5) slipped into talking about ‘heart rate’ rather than ‘physiological measures’ when talking about their choices later in the interview. However, like psychological measures, some participants found the idea of physiological measures “quite intrusive” (#2).

Eight participants seemed clear on what activity monitoring was and what sorts of activities would be monitored in the scenarios, but four were uncertain about *how* activity would be monitored (“you know what’s being collected but you don’t know how”, said Participant #4). Two participants (#6 and #12) pictured activity monitoring through self-reports (e.g., diaries) whereas others mentioned electrical sensors monitoring physical actions. Three participants (#4, #9 and #11) thought of activity monitoring as possibly being observation using cameras and so considered this ‘monitoring’ potentially invasive; one participant (#8), while they did not mention cameras, did interpret this variable in terms of managerial control, including time spent working, on lunchbreak and counting trips to the bathroom.

Two participants (#5 and #7) expressed similar worries about means of measurement, but across all information variables. For instance, Participant #7 reflected that the participants are “not likely to have an understanding of what [the measures] would be unless [they’d] been involved in this kind of investigation and with [this] kind of equipment [...] you’re probably not clear on what that would actually mean to you [...] things like that, I think, would have to be clear.”

Across these instances, uncertainty ultimately stemmed from lack of knowledge about the concepts behind the terms used: difficulties thinking of other examples, reliance upon a single given example, concerns about the worst potential examples, and concerns about what these concepts represent in practice. Knowledge problems such as these are commonly found in cognitive pre-testing of survey materials where specialist terminology is used or where levels of existing knowledge differ [e.g., 64, 65, 66].

4.2.2. Inferring legitimacy from data collected

Four participants (#3, #6, #10 and #12) judged the legitimacy of the hypothetical research by the types, and combination, of information collected in the scenarios. Participant #6 said they were “not really worried about what information you take [but] just take the right information for the right research.” Likewise, Participant #10 said that the information being collected reflected the “quality” of the research and that they were reluctant to select options where basic information was not being collected. Participant #12 asked

(rhetorically): “would you want to take part in a piece of research where it wasn’t collecting all the information it needed to?” Participant #3 had similar concerns, but also felt that a study that did not collect basic information (e.g., demographic data) would not only be limited but would also present an inaccurate picture of them as an individual, thus misrepresenting them in the research. In presenting this theme, it is important to acknowledge that these four participants were academics with PhDs, and it was not clear whether lay participants would evaluate the options in this way.

4.2.3. Anonymity and autonomy were not very realistic

The last four choice variables in the task were titled “collection, anonymity and control of data” and included “level of anonymity” and “level of autonomy” as variables. These variables and their levels were accurately interpreted by participants; however, five participants found the levels of these variables unrealistic. Participant #5 and Participant #10 both considered the level of non-anonymous studies (‘you can be personally identified by those who have access to the data’) as unusual; Participant #5 questioned the need for any non-anonymous studies in these scenarios. For autonomy, Participant #6 reasoned that having ‘no control over your own data’ would be illegal: “inherently you have control over your data [...] in any instance where you’re doing research – you have control over your data, and anybody who says [otherwise] would not be telling the truth.” Applying this logic, Participant #6 neglected the autonomy variable when making choices, saying when asked about it that “maybe I didn’t read [about autonomy] and maybe I kind of just glossed over it assuming that as soon as I give my data away I can have it back – I can get it deleted.” Participant #11, identifying both anonymity and autonomy as unrealistic, said that if legislation was taken into account, there would be “massive issues” with the lower levels of autonomy/anonymity given. In consequence, Participant #11 approached the tasks as hypotheticals (which they termed ‘trolley problems’ or ‘thought experiments’). By contrast, Participant #7 found *high* level autonomy strange, saying that they had never been given control over their own data as a research participant in the past and so did not have any expectations that this would be possible in the scenario options. This is important, because it shows that while researchers might be acutely aware of the issues around participant autonomy, participants may not always be made aware of their own autonomy. More generally, the issue we identified was not that these concepts were difficult but that our descriptions of them were difficult to take seriously, leading to the potential for some respondents to under-emphasise them as a factor in their decision-making. This can also arise as the scenario becomes more hypothetical [e.g., 53; see also 67].

4.2.4. Over-interpretation of the ‘responsible organisation’ and ‘other-use’ information

The last four choice variables in the task also included a ‘responsible organisation for data collection and use’ variable – levels: government, for profit organisation, not-for-profit organisation, research institution – and an ‘other uses of the data’ variable – levels: none, market research, university research, governance-and-policymaking (e.g., tax savings). Participant interpretations of these variables and levels were broadly accurate, but they often desired more precise descriptions or over-interpreted this information to facilitate decision-making.

Five participants (#3, #5, #8, #10 and #12) found ‘research institute’ to overlap with both ‘for profit organisation’ and ‘not-for-profit organisation’, either because they assumed that these organisations were research institutes before seeing the separate ‘research institute’ level in subsequent tasks, or because the concepts were not distinct for them (some framing ‘research institutes’ as for-profit or not-for-profit organisations). Likewise, ‘government’ was considered vague by four participants (#5, #8, #9 and #11) both because it “can be anything, at any level” (#9) and because they found it difficult to imagine government being interested in improving their indoor work environments through research (#3, #5 and #9). Two participants (#3 and #8) expressed preferences for

knowing the specific commercial organisations involved, because otherwise, as Participant #8 said, "I don't know what they're covering! I don't know what a for profit organisation is [...] that's simply too vague!"

Many participants seemed to use a combination of their prior expectations, the 'responsible organisation' and the 'other uses of the data' to infer the existence of third-party organisations or to divine the nature of the 'responsible organisation' in the research. From prior expectations, some participants reasonably assumed that their employer would be involved in any workplace research (#3 and #5) and one participant assumed that the 'responsible organisation' would be commissioning a university to conduct the research (#7). Participant #10 interpreted 'research institute' as a private-sector firm when the 'other use' was market research, and so inferred that they would be "more driven by providing information which can help people sell more things rather than necessarily [...] making things better." Similarly, Participant #11 interpreted 'not-for-profit organisation' and 'policy and governance' as an indicator that the government was driving the research because "the not-for-profit would be set up possibly just for the purposes of investigating these spaces or with a broader remit but for them to be feeding into [the] government level [...] I'd presume it was some kind of spinoff." Participant #8 reasoned that if both parties "have equal access to use the data, [then] it's basically the same" as ownership of the data, and that if a commercial organisation had access to the data "then it's out on an open market, isn't it, being traded; and if it is freely tradeable, I'd want to know." Using similar logic, Participant #9 linked market research purposes to receiving 'scam' telephone calls because such a call is evidence that "someone has shared that phone number with someone else." Likewise, Participant #10 worried about the wider distribution of the data for the combination of 'government' as responsible organisation and 'university research' as the other data-use, because (he reasoned) governments usually make their data freely available, so universities might not be the only organisations able to use the data.

As expressions of attitudes, these interpretations show unfavourable attitudes towards for-profit organisations, and particularly market research, affecting judgements about their ulterior motives and data-security practices. More broadly, however, participants showed a need for more detailed information on these variables to make their choices, using their attitudes and inferences to fill this gap.

4.2.5. Why is the information being collected?

Eight participants (#1, #2, #3, #4, #6, #7, #10 and #12), at some point in the interview, asked why the information was being collected. This showed that this was an important question in guiding their choices and one for which they did not have an answer. This was strange because the research-purposes were stated clearly in the introductory text:

"This information would help to improve the indoor environmental quality in terms of temperature, air quality, light, and sound; and reduce the energy consumption of your workplace."

Three participants (#5, #8 and #9) recalled this information and were satisfied with it. At least two participants (#2 and #4) did not recall this information from the introduction, leading to difficulties when making their choices. These participants tended to report neglecting this information when reading the introduction, either because of the way it was phrased (#2) or because the long, dense sentences in the other parts of the introduction distracted them (#4). Two participants, asking 'why is this information being collected' and, on being shown the introduction a second time, claimed to remember this information but added either that they had not made a mental 'link' to the current task (#3) or that it was insufficient for the current task (#12). Three participants (#6, #7 and #10) claimed to recall the information during the task, but with manifest difficulty. Participant #6 had only a vague recollection of the purposes given in the introduction, whereas Participant 7 and Participant 10 both recalled the purposes from the introduction in broad terms, but had difficulty recalling them during the tasks themselves, especially with 'other

uses of the data' present (see 3.2.4., above). So, the broad purposes given in the introduction may have been insufficient for making sense of the options as they were presented. As Participant #12 said when shown the introduction for a second time:

"I knew that's what you were collecting, it still doesn't necessarily say why they're doing it – who are they doing that for? [...] I mean I understand the purpose is to lower energy consumption – I don't know why they are doing it in this context – I don't know what the ultimate purpose is [...] and that's what was in my head [during the task]."

5. Discussion

Building operation leads to greenhouse gases emissions, contributing to global warming and climate change [68]. Emissions due to buildings are partly attributable to indoor comfort: maintaining optimum environmental conditions for human occupants [69]. Therefore, it is vital to fully understand occupant needs in order to optimally balance sustainability and comfort: in how buildings are designed and operate and how they incorporate information technologies. However, the advancement of information technologies brings this goal closer at the risk of violating personal privacy, because the access to information required to study and control indoor environments is also access to information about what people experience in private spaces. The purpose of this research is to understand the influences on willingness to share this information, specifically the influences of either the types of information collected (physical, behavioural, psychological) or the conditions of information collection (anonymity and autonomy). At the same time, it is crucial to evaluate the validity of materials provided to participants. Therefore, in the part of this project presented here, we used cognitive interview pretesting [43] to find out whether our materials for a choice experiment would be meaningful and interpreted correctly by participants. We interviewed 12 participants and analysed this qualitative data thematically, identifying seven important ways in which our materials appeared to be limited. These included potential problems communicating the research scenarios to the participants and unanticipated ways in which scenarios were interpreted. Overall, most participants expressed a desire for a deeper understanding of the research being described in the scenarios and, finding the information provided to be unclear or limited, were not satisfied with the choices they were asked to make.

At a basic level, this study identified several practical issues with the clarity and interpretability of our materials, which we then addressed by revising them (revised materials are presented in Appendix B). Useful feedback concerning essential clarity of the materials (e.g., language quality, presentation on the page) we addressed with re-wording and basic format changes. Those more serious issues, those reported in this article, were addressed through careful re-wording. The psychology of questionnaire response identifies the importance of clear wording [35] and, through cognitive interviewing, we identified several ways in which we could make our labelling of attributes and levels less ambiguous so avoid misinterpretation. As a result of this process, the levels of the attribute 'organisations responsible for data collection' were further specified: 'research institute' became 'university/research institute', to emphasise the pure-research aspect of this category, and 'government' became 'government department' to differentiate this from political or local government.² To avoid worry that a scenario option might involve sensitive psychological information collection, 'attitudes' and 'personal preferences' were given as examples, and multiple examples were provided to guide interpretation of all those information types that this study considered as important to collect and analyse. To clarify what was meant in terms of imagining a 'typical workplace', which was problematic because some participants were currently working in an atypical workplace (from their

² Currently, according to the website for the UK government, there are 43 government departments of the national government, each of which differ from parliament, local government and regional devolved government [70].

homes during the COVID 19 pandemic) or did not have any one typical workplace, we specified this as their 'typical office-based workplace.' Although these changes are particular to the present study, application of cognitive interview pre-testing can help to identify likewise the particular issues of interpretability for other choice experiments and survey questionnaires.

Previous studies of cognitive aspects of choice experiments indicated heuristic decision-making [39] and this is one interpretation of the way in which some participants re-interpreted the materials in order to make sense of them. The first of these issues identified here was the way in which participants had difficulties understanding what the 'scenario' in the instructions was and, therefore, the difficulty they had in contextualising the choices. To address this, we simplified the instructions and presented them alongside an example of a choice card, so that participants could easily see the correspondence between the scenario described and the choices they were being asked to make. We also simplified the term by using 'scenario' as synonymous with 'option' and, therefore, to refer to the three options on each choice card. We also revised the instructions to emphasise the purpose of the scenario research and link it to the choice cards by presenting an example choice card between the two paragraphs. Two of the themes from this study were not recognised as problems but, instead, as clues concerning how participants made their decisions. That the legitimacy of the scenario could be inferred from the data collected was recognised as a legitimate choice strategy and not something to be 'fixed'. Similarly, that participants used the 'other use' of the data to infer the existence of secondary organisation in the research was recognised and incorporated into the materials explicitly, by rephrasing this attribute as "secondary use of the data by a third-party organisation", in contrast to the 'responsible organisation', which was rephrased as "responsible organisation for data collection and primary use." This has the added benefit of reemphasising the primary use, to explicitly identify the primary actor in the scenario with the rationale in the instructions (now phrased as "to adjust the indoor environment to improve your comfort level and reduce the energy consumption in your workplace"). While our focus was on choice experiment materials, cognitive interview pretesting can facilitate identification of similar problems of interpretation and answering that arise when respondents complete a survey: whether they are engaging, and in the right ways, with the intended questions. In this way, the present study has been particularly useful in uncovering these problems in the context of building occupant privacy and energy behaviours, providing an evidence-informed 'starting point' for future work in this area.

The primary purpose of this research was to refine our choice experiment materials. However, some qualitative insights were also present in our results, at least as initial indications of the face validity of our materials with respect to our research questions. For instance, the types of information collected were important both in so far as they were not too invasive (or were not collected in an invasive manner, such as direct observation) and in so far as they represented a sound basis for collecting a full, representative set of research data. Also, it was important that participants trusted the responsible organisations and attributed to them acceptable motives, and that there was no diminution in this when they inferred the existence of any secondary organisation whose trustworthiness or motives might differ. Had participants not identified these issues spontaneously, we might question whether our materials were assessing variables/attributes relevant to topics of research. In this way, cognitive interviewing, as a qualitative method, is useful in providing empirical evidence on the applicability of instruments in specific contexts. In the present study, we have provided a foundation for pursuit of studies relevant to privacy and buildings by providing empirical evidence of what language 'works' in the context of privacy, buildings and occupant behaviours more generally.

With respect to the design of effective research, our findings are a demonstration of the benefits of cognitive interviewing as a form of pretesting. While most often used in

questionnaire research, we have shown them applicable to refining materials for SPDCEs, particularly in so far as our revisions make attributes and levels more conceptually discrete. Our pretesting complemented further pilot testing that took place independently, offering unique insights on the effectiveness of the experiment design. As our choice experiment was intended for both lay and expert participants, our choice to interview academics and university-based professionals was not only convenient but also provided information indicative of lay and expert samples. It also had the added benefit of providing feedback from our peers, in addition to their responses as participants. However, it is important to acknowledge that while our sample may have been suitable in these respects, it was a sample of convenience and, ideally, purposive, or representative sampling should be made to sample according to the research question or to represent diversity in a group [27]. Our research was limited in some other respects. Cognitive interviews are necessarily qualitative and so include the same advantages and limitations [71]. Most salient is the extent to which our findings are necessarily interpretations and so should not be taken to be generalisable propositions, and this was not the object of this study. The principal aim of the study was to conduct a qualitative investigation towards the design of a choice experiment aimed to examine occupant behaviours under which achieving thermal comfort may involve different levels of threats to privacy and personal information. The qualitative work presented in this study helped to improve the framing of the experiment, the wording of the attributes and levels and the overall presentation of the decision-making context.

One individual conducted interviews and analysed the data; with respect to analysis, this has the advantage of interpretative clarity but at the cost of the credibility provided by tempering interpretations through consensus across analysts [72]. Finally, cognitive interview findings can be verified and enhanced by conducting further interviews ('rounds') using the revised materials [43]; this was not possible in the present research for practical reasons.

There is emerging evidence that in research topics concerned with human perceptions of the environmental experience the risk of misinterpretation of questionnaire wording is significant. This is particularly a concern in cross-national research when translated versions of the 'same' questionnaire are used to offer participants research material in their native language, as research has shown these translations may deviate in meaning from the original [73-76]. Findings also point out to more systemic both semantic and symbolic issues with questionnaire or survey research, as contextual factors seem to influence participants' interpretation of words or rating scales, in ways that are not always predictable or manageable with common translating protocols [20]. Such patterns or risks of ambiguity must be addressed prior to conducting the surveys so that research findings are not skewed by influences that are embedded in the data collection processes used.

Another key issue is the use of technical terms; these are useful to specialists but are jargon when they are abstruse [77]. Where jargon is not obvious, it may be interpreted through the vernacular or dictionary-definition of the words used [78], leading to answers at crossed purposes with the researcher's intent. Even when technical terms are generally understood, their use can often discourage the reader [79]. The terminology of energy research raises these difficulties [80], particularly to the extent that commonplace words are given more particular definitions. While one may be advised against the use of jargon [e.g., 35], its presence is not always obvious to researchers fluent in the terminology, and cognitive pre-testing can help identify the presence or absence of jargon in materials.

Our study highlights the importance of establishing and confirming the decision context, wording of attributes and levels, and overall framing of the experiment through a qualitative investigation [42, 81], namely cognitive interviews [43]. The research findings presented herein support the idea that cognitive testing has the potential to identify and

address areas of uncertainty or ambiguity that would otherwise only be detected after data collection. The techniques discussed above have also the potential to help disentangle some of the confusion identified in past studies that may be attributed to linguistic issues, if done retrospectively and when sufficient demographic information is available for the participants' population. Such approaches have the potential to provide further human insights on such bias, by targeting specific groups of participants that share specific characteristics of interest e.g., thermal history and level of acclimatization. There is inarguably a limit on the potential that such approaches can hold on understanding other types of 'outliers', for which other strategies would be needed such as those discussed in [82]. The opportunity to review and verify observed effects via cognitive testing after data collection has been completed may be vastly beneficial, but implications related to anonymity and the associated ethical practicalities of returning to particular subgroups of a study's sample would have to be considered and addressed.

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Appendix A: Interview Guide

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	453
1. Introductions and thank participant.	454
2. Briefing on study.	455
3. Confirm consent to participate and to be audio recorded.	456
4. Present instructions slide.	457
[Wait for them to read the text; listen to their speak-aloud.]	458
> "How did you find that?"	459
> "Was there any part you had to go back and re-read"	460
> "Was that easy or difficult to follow?"	461
> "How sure are you that you understood the text"	462
> "Could you describe to me what the 'scenario' is, in your own words?"	463
> "What will you be doing next [for this task]?"	464
5. Are you happy to move on to the next task?	465
6. Present first choice card.	466
[Wait for them to make choice; listen to their speak-aloud.]	467
> "What was your choice?"	468
> "How did you find that?"	469
> "How did you make your choice?"	470
> "Was there anything you found particularly easy or difficult?"	471
> "What comes to mind for [word/phrase from the card]?"	472
> "What does [word/phrase from the card] mean here?"	473
> "Can you give me some other examples of [word/phrase from the card]?"	474
> "Would you be able to suggest anything we could change or add to make this task easier?"	475 476
7. Repeat step '6' for all choice cards.	477
8. Tell participant these are questions, about the tasks in general.	478
> "How did you find making the comparisons between options?"	479
> "Why do you think that was?"	480
> "Did you feel the characteristics were realistic?"	481
> "Did you understand each of the characteristics and the text?"	482
> "Which parts were not clear?"	483
> "When you made your choices, which information was most (least) important to you?"	484 485
9. Obtain participant information (as final questions).	486
> "What is your age" [18-29, 30-49, 50-64, 65+]?	487
> "What is your highest level of education?"	488
10. Thank participant for their help, ask if they have any final thoughts or questions, and end call.	489 490 491

Appendix B: Original and Revised Materials

Imagine that you are at your typical workplace. The following screen will present you a scenario with two options under which sensors and/or computer-based surveys are used to record personal (e.g. age, gender, presence, heart rate) and space-related information. This information would help to improve the indoor environmental quality in terms of temperature, air quality, light, and sound; and reduce the energy consumption of your workplace.

We will show you five scenarios in total – each time different levels of personal and space-related data may be required to adjust the indoor environment. Please, take your time to familiarise and review the scenarios, and choose the one you would most likely agree with.

Figure B1. Original instructions text

Description	Option A	Option B	Option C
What information is collected			
Demographics (e.g. age, gender)	Yes	No	
Psychological parameters through follow up survey questionnaires	Yes	No	
Physical parameters (e.g. room temperature, noise level, illuminance)	No	Yes	
Activity monitoring (e.g. presence, interaction with windows)	Yes	No	
Physiological data (e.g. heart rate)	No	Yes	
Collection, anonymity and control of data			
Responsible organisation for data collection and use	Government	For Profit organisation	I would not choose any of the options in this card
Level of anonymity	You can be personally identified by those having access to the data	You can be personally identified by the data collector only	
Level of autonomy	No control over your own data	View, delete, and choose what and how often your own data can be collected	
Other uses of the data	Market research	None	
I would choose option:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Figure B2. Original choice card (example)

Imagine that you are at your typical office-based workplace. The following screens will show you a total of five choice cards like the one shown below. Each choice card will present you with two scenarios (Scenario A and Scenario B) for collecting different levels of **personal data** and **space-related information**. The information collected by **devices** and/or computer-based surveys in each scenario would be used to adjust the indoor environment to improve your comfort level and reduce the energy consumption in your workplace.

Description	Scenario A	Scenario B
What information is collected		
Demographics (e.g. age, gender)	✘	✔
Psychological parameters through follow up survey questionnaires (e.g. personal preferences and attitudes)	✔	✔
Physical parameters (e.g. room temperature, noise level, illuminance)	✔	✔
Activity monitoring (e.g. presence, interaction with windows)	✘	✔
Physiological data (e.g. heart rate, body temperature)	✔	✔
Who collects and controls the data		
Responsible organisation for data collection and primary use	Not-for-profit organisation	Not-for-profit organisation
Level of anonymity	You can be personally identified by those having access to the data	You can be personally identified by those having access to the data
Level of autonomy	No control over your own data	View, delete, and choose what and how often your own data can be collected
Secondary use of the data by third party organisations	None	Market research

Scenario A

Scenario B

Neither scenario

Please take your time to familiarise yourself with the choice cards, and carefully review the scenarios. In each choice card choose the scenario you would most likely agree with or 'neither scenario' if you would not likely agree to either of the two options.

Figure B3: Revised instructions text

Choice card 1 of 5 – Please, review the scenarios and choose the one you would most likely agree with.

Description	Scenario A	Scenario B
What information is collected		
Demographics (e.g. age, gender)	✘	✔
Psychological parameters through follow up survey questionnaires (e.g. personal preferences and attitudes)	✔	✘
Physical parameters (e.g. room temperature, noise level, illuminance)	✘	✘
Activity monitoring (e.g. presence, interaction with windows)	✔	✘
Physiological data (e.g. heart rate, body temperature)	✔	✔
Who collects and controls the data		
Responsible organisation for data collection and primary use	Government Department	Not-for-profit organisation
Level of anonymity	You cannot be personally identified	You can be personally identified by those having access to the data
Level of autonomy	No control over your own data	View, delete, and choose what and how often your own data can be collected
Secondary use of the data by third party organisations	Governance and policy making (e.g. tax savings)	Market research

Scenario A

Scenario B

Neither scenario

Figure B4: Revised choice card

Table B1. Revised attributes and levels in the choice experiment.

Attribute	Levels			
	1	2	3	4
<i>What information is collected</i>				
Demographics (e.g. age, gender)	No	Yes		
Psychological parameters through follow up survey questionnaires (e.g. personal preferences and attitudes)	No	Yes		
Physical parameters (e.g. room temperature, noise level, illuminance)	No	Yes		
Activity monitoring (e.g. presence, interaction with windows)	No	Yes		
Physiological data (e.g. heart rate, body temperature)	No	Yes		
<i>Who collects and controls the data</i>				
Responsible organisation for data collection and primary use	Government Department	University/Research Institution	Not-for-profit organisation	For profit organisation
Level of anonymity	You can be personally identified by those having access to the data	You can be personally identified by the data collector only	You cannot be personally identified	
Level of autonomy	No control over your own data	View your own data	View and delete your own data	View, delete, and choose what and how often your own data can be collected
Secondary use of the data by third party organisations	None	Market research	University research	Governance and policy making (e.g. tax savings)

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