Respondent Understanding in Discrete Choice Experiments: A Scoping Review

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Abstract

Introduction Despite the recognised importance of participant understanding for valid and reliable discrete choice experiment (DCE) results, there has been limited assessment of whether, and how, people understand DCEs, and how ‘understanding’ is conceptualised in DCEs applied to a health context.

Objectives Our aim was to identify how participant understanding is conceptualised in the DCE literature in a health context. Our research questions addressed how participant understanding is defined, measured, and used.

Methods Searches were conducted (June 2019) in the MEDLINE, EMBASE, PsychINFO and Econlit databases, as well as hand searching. Search terms were based on previous DCE systematic reviews, with additional understanding keywords used in a proximity-based search strategy. Eligible studies were peer-reviewed journal articles in the field of health, related to DCE or best-worst scaling type 3 (BWS3) studies, and reporting some consideration or assessment of participant understanding. A descriptive analytical approach was used to chart relevant data from each study, including publication year, country, clinical area, subject group, sample size, study design, numbers of attributes, levels and choice sets, definition of understanding, how understanding was tested, results of the understanding tests, and how the information about understanding was used. Each study was categorised based on how understanding was conceptualised and used within the study.

Results Of 306 potentially eligible articles identified, 31 were excluded based on titles and abstracts, and 200 were excluded on full-text review, resulting in 75 included studies. Three categories of study were identified: applied DCEs (n = 52), pre-testing studies (n = 7) and studies of understanding (n = 16). Typically, understanding was defined in relation to either the choice context, such as attribute terminology, or the concept of choosing. Very few studies considered respondents’ engagement as a component of understanding. Understanding was measured primarily through qualitative pretesting, rationality or validity tests included in the survey, and participant self-report, however reporting and use of the results of these methods was inconsistent.

Conclusions Those conducting or using health DCEs should carefully select, justify, and report the measurement and potential impact of participant understanding in their specific choice context. There remains scope for research into the different components of participant understanding, particularly related to engagement, the impact of participant understanding on DCE validity and reliability, the best measures of understanding, and methods to maximise participant understanding.

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Key Points for Decision Makers

- We consider understanding in the context of discrete choice experiments (DCEs) as an overarching concept that can be defined as participants choosing rationally based on comprehending both the choice context and choice task, and being willing to participate.
- We identify a broad range of definitions, measurement approaches and proposed implications of participant understanding in the DCE literature.
- While some common approaches emerge, there is little consensus around how to maximise participant understanding of DCEs in the health context.
- There remains significant scope for further work on measuring and improving DCE participant understanding in health, which may draw on the use of DCEs in other fields, behavioural and experimental economics, and psychology.

1 Introduction

Discrete choice experiments (DCEs) are a quantitative method used to measure preferences for goods and services. The application of DCEs to measure preferences for health and health care is increasing in geographic scope, areas of application, and sophistication of the design and analysis [1].

The health context can present unique challenges that make DCEs complex to complete. They often include attributes related to risks or probability, and these concepts can be difficult for people to understand and accurately interpret [2–4]. Many health DCEs include unfamiliar medical terminology and some people, particularly those with lower health literacy, may have difficulty understanding the context of the choice they are asked to make [5]. The emotional intensity associated with making decisions about health and healthcare may result in heuristics that change people’s choice behaviour [6] and many health scenarios may be difficult to imagine, such as being in a wheelchair or having to pay for health care in a universal healthcare system [7, 8]. Features of the DCE design such as the number of attributes, levels, alternatives and choice tasks [9–11], and the use of choices with utility balance or in the ‘magic-p’ range [12, 13], can also lead to increased choice difficulty.

If people have difficulty understanding a DCE this may impact the validity of their responses. Difficult questions in surveys can reduce response rates [14] and increase the use of simplifying strategies [15], opt out selection [16], non-transitivity of choices [17], non-trading [18] and missing responses [19], and result in added variance and measurement error [20]. Each has the potential to reduce the quality or validity of the resulting preference data and therefore compromise results and interpretation of a DCE. An expert stakeholder panel of people doing and using DCEs suggested ensuring participant understanding was both the most desirable and most actionable characteristic of high-scientific-quality preference studies [21].

The concept of understanding relates to participants responding (choosing) rationally within a DCE based on comprehending both the choice context and choice task and being willing to participate. We conceptualise understanding as an overarching concept that is impacted by the task design and instructions, the attributes and levels and the choice context, as well as the personal characteristics of the respondents and the familiarity or relevance of the topic. There is no consistent or recommended approach to assess participant understanding of DCEs. Options include pretesting and piloting of the attributes and levels during the design phases [22, 23], including rationality or validity checks such as duplicate or dominated choice sets within the design [1, 24–27], using econometric approaches to assess rationality [28], or collecting self-reported participant understanding of the DCE [25]. However, most of these assessments are designed to assess a single component or indicator of understanding (such as consistent choices) rather than overall understanding in terms of choice context, choice task and/or task engagement.

There is limited previous research about whether and how people understand health DCEs and, more broadly, how ‘understanding’ is conceptualised. Ryan and Gerard [29] found “there did appear to be a significant minority who felt they had some difficulty, but given the nature of the question it was not clear whether this arose from the choosing per se or because the instructions were unclear”, recommending further research around how comprehension is impacted by the number of attributes, number of levels, and presentation format. Others describe respondent understanding in terms of participant comprehension and minimising choice task ambiguity, with rigorous development processes and effective communication as strategies to achieve understanding [21]. A recent review considered pre-choice processes of decision making rather than broader understanding [30], describing methods such as eye-tracking, brain imaging, time to complete and think-aloud interviews to investigate the processes individuals follow in completing a choice task. The aim of this review was therefore to identify how participant understanding is conceptualised in the health DCE literature, including how understanding is defined, measured, and used. This can inform future research to improve ease of understanding of DCE choice tasks, approaches to maximise...
validity of DCE findings, and how to appropriately interpret DCE results for use in changing practice and policy.

2 Methods

A scoping review was conducted following the methods of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) guidelines [31, 32] to capture the scope of the literature and conceptualisation of understanding in health DCEs [33]. As a scoping review, registration in PROSPERO was not applicable.

2.1 Review Questions

How is participant ‘understanding’ (1) defined, (2) measured, and (3) used within the health DCE literature?

2.2 Eligibility Criteria

Eligible papers included peer-reviewed journal articles in the field of health, related to a DCE or BWS3 (best–worst scaling case 3 studies, an extension of DCE where respondents are presented with three or more profiles and instead of choosing the single profile they most prefer, they choose both the best and the worst profiles [34]), and including some consideration or assessment of participant understanding. The concept of understanding was deliberately kept broad using words such as comprehension and misunderstanding to allow the full scope of how understanding is conceptualised in the health DCE literature to be captured.

Conference abstracts, review articles or non-English papers were excluded. Additionally, papers describing how preferences or choice responses differed by subgroups such as sex or age were excluded unless they assessed differences by level of understanding.

2.3 Information Sources, Search Strategy and Selection of Sources of Evidence

Searches were conducted in June 2019 in the MEDLINE, EMBASE, PsychInfo and Econlit databases, consistent with other recent systematic reviews of DCEs [35, 36]. Search terms were based on previous systematic reviews of DCEs [1, 35–37]. Keywords for the concept of understanding were used in a proximity-based search with keywords for patient, participant and respondent. The full search strategy for each database is presented in ‘Supplementary Material A: Database-Specific Search Terms’. Hand-searching reference lists of identified papers, a recent systematic review of DCEs in healthcare [1], and personal collections of authors was also conducted.

A single reviewer reviewed the title and abstract for each paper identified. All authors participated in the full-text review of any studies that appeared eligible, or which could not be identified as ineligible from the title and abstract, with each paper reviewed by two reviewers and uncertainty discussed with an additional reviewer to achieve consensus.

2.4 Data Extraction and Synthesis

A descriptive analytical approach was used to summarise the relevant data from each eligible paper (and online appendices). Data extraction was initially developed and trialled on six studies and circulated to all authors to ensure all relevant information was captured. Final data extraction included publication year, country, clinical area, subject group (e.g. general public, patients, or health professionals), sample size, study design (e.g. online survey, qualitative interviews), DCE or BWS3, number of attributes, the range of number of levels, number of choice sets, definition of understanding, how understanding was tested, results of the understanding tests, and how the understanding information was used. Each study was also categorised based on how understanding was conceptualised and used within the study. Consistent with the best practice guidelines for scoping reviews [32], methodological quality and risk of bias assessment were not undertaken for this study.

3 Results

The search strategy identified 306 unique articles for potential inclusion. Review of titles and abstracts excluded 31 papers and full-text review excluded a further 200 papers, resulting in 75 eligible studies (Fig. 1).

Tables 1, 2 and 3 show the characteristics of the eligible studies, while Tables 4, 5 and 6 show how understanding was defined, measured, and used within each eligible study. The majority of studies were DCEs (or studies about DCEs), with two BWS3 studies [38, 39] and three studies including both a DCE and a BWS3 design [40–42]. Most were conducted in Europe (n = 24) and the UK (n = 17), followed by the US (n = 15) and Australia (n = 10). Over half of the studies (n = 42) had a population of patients or carers, and 31 studies included the general population or target population (e.g. for prevention studies, the general population is the target population). Two studies examined clinician preferences [39, 43]. The mean sample size was 421 (range 18–4287, median 231). In the DCE studies, the number of attributes ranged from 3 to 12 (mean = 6) and the number of levels ranged from 2 to 6. On average, participants faced 11 choice sets (range 5–27).

Studies were categorised as (1) applied DCEs (n = 52), which included an assessment of understanding in the
pretesting, analysis, or discussion; (2) pretesting studies \((n = 7)\), which were stand-alone studies conducted prior to a DCE, designed to identify relevant attributes and levels of pilot DCE instruments; and (3) studies of understanding \((n = 16)\), which were a mixture of qualitative studies and survey methods papers. Often these studies of understanding were a substudy to an applied DCE and aimed to assess the concept of understanding within the context of a choice discrete choice experiment. *PRISMA* Preferred Reporting Items for Systematic Reviews and Meta-Analyses.
| First author, year | Country | DCE/BWS3 | Clinical area | Subject group | Sample size | Main study design | Number of attributes | Number of levels | Number of choice sets |
|--------------------|---------|----------|---------------|---------------|-------------|-------------------|--------------------|-----------------|----------------------|
| Adam, 2019 [82]   | Europe  | DCE      | Complementary medicine | General (or target) population | 263         | Online survey     | 6                  | 3               | 6                    |
| Becker, 2018 [79] | UK      | DCE      | Breastfeeding  | General (or target) population | 564         | Paper-based survey | 4                  | 3–6             | 8                    |
| Bottomley, 2017 [57] | UK      | DCE      | Multiple sclerosis | Patients | 350         | Online survey     | 7                  | 3–5             | 12                  |
| Bridges, 2012 [53] | UK      | DCE      | Non-small cell lung cancer | Patients | 89 DCE, 6 pretesting interviews | Online survey | 8                  | 3               | 12                  |
| Brown, 2011 [38]  | USA     | BWS3     | Haemophilia    | Patients | 53          | Paper-based survey | 12                 | 2–4             | 12                  |
| Buchanan, 2016 [80] | UK      | DCE      | Genetic testing | Patients | 219         | Paper-based survey | 6                  | 4               | 16                  |
| Byun, 2016 [70]   | Asia    | DCE      | Arthritis      | Patients | 100 patients, 60 doctors | Face-to-face survey | 4                  | 3               | 18                  |
| Cernauskas, 2018 [88] | India   | DCE      | Health care provider | General (or target) population | 100         | Face-to-face survey | 5                  | 2–3             | 8                    |
| Damen, 2011 [69]  | Europe  | DCE      | Breast reconstruction | Patients | 272         | Paper-based survey | 6                  | 3               | 10                  |
| de Bekker Grob, 2013 [81] | Europe | DCE      | Prostate-specific antigen testing | General (or target) population | 459         | Paper-based survey | 5                  | 4               | 16                  |
| de Freitas, 2019 [52] | Europe | DCE      | Prostate cancer | Patients | 152 DCE, 18 pretesting interviews | Online survey | 6                  | 2–4             | 16                  |
| de Vries, 2015 [73] | Europe  | DCE      | Blood pressure | Patients | 161         | Paper-based survey | 6                  | 3–4             | 10                  |
| Fifer, 2018 [89]  | Australia | DCE   | Type II diabetes | Patients | 171         | Online survey     | 10                 | 2–4             | NS                  |
| Gregor, 2018 [62] | Canada  | DCE      | Inflammatory bowel disease | Patients | 586         | Online survey     | 12                 | 2–4             | NS                  |
| Hauber, 2016 [44] | USA     | DCE      | Diabetes       | Patients | 1791        | Online survey     | 5                  | 2–3             | 10                  |
| Hauber, 2017 [48] | USA     | DCE      | End-stage renal disease | Patients | 200         | Online survey     | 7                  | NS              | 8                    |
| Heringa, 2018 [59] | Europe  | DCE      | Pharmacy       | Patients | 476         | Online survey     | 5                  | 2               | 12                  |
| Hofman, 2014 [75] | Europe  | DCE      | HPV vaccination | General (or target) population | 302         | Paper-based survey | 4                  | 3               | 9                    |
| Hofman, 2014 [76] | Europe  | DCE      | HPV vaccination | General (or target) population | 500         | Paper-based survey | 4                  | 3               | 16                  |
| Hol, 2010 [78]    | Europe  | DCE      | Colorectal cancer screening | General (or target) population | 1034        | Online survey     | 3                  | 3               | 12                  |
| Ivanova, 2019 [64] | USA     | DCE      | Soft tissue sarcoma | Patients | 76 patients, 160 oncologists | Online survey | 5                  | 3               | 12                  |
| Jan, 2000 [71]    | Australia | DCE   | Public health research | General (or target) population | 231         | Paper-based survey | 6                  | 2–3             | 9                    |
Table 1 (continued)

| First author, year | Country | DCE/BWS3 | Clinical area | Subject group | Sample size | Main study design | Number of attributes | Number of levels | Number of choice sets |
|--------------------|---------|----------|---------------|---------------|-------------|-------------------|---------------------|-----------------|----------------------|
| Kistler, 2015 [74] | USA     | DCE      | Cancer        | General (or target) population | 116         | Face-to-face survey | 4                   | 3               | 10                   |
| Laba, 2012 [77]    | Australia | DCE      | Medication non-adherence | General (or target) population | 161         | Online survey       | 8                   | 2–4             | 10                   |
| Lee, 2008 [39]     | USA     | BWS3     | Haemophilia    | Doctors       | 30          | Face-to-face survey | 12                  | 2–4             | 12                   |
| Liu, 2018 [67]     | USA     | DCE      | GP appointments | Patients     | 132, 3 unknown | Online survey       | 5                   | 2–5             | 8–10                 |
| Lloyd, 2011 [68]   | UK      | DCE      | Diabetes      | Patients      | 252         | Paper-based survey  | 8                   | 3               | 27                   |
| Lokkerbol, 2019 [91]| Europe  | DCE      | Anxiety       | Patients      | 126         | Online survey       | 4                   | 3               | 12                   |
| Mansfield, 2016 [54]| USA     | DCE      | Renal cell carcinoma | Patients | 378         | Online survey       | 5                   | 3               | NS                   |
| Mansfield, 2017 [66]| Europe  | DCE      | Type II diabetes | Patients | 474 Germany, 401 Spain | Online survey       | 7                   | 2–4             | 8                    |
| Marshall, 2007 [63]| Canada  | DCE      | Colorectal cancer screening | General (or target) population | 547         | Paper-based survey  | 5                   | 2–4             | 12                   |
| Marshall, 2018 [49]| Canada  | DCE      | Total joint replacement | Patients | 422         | Paper-based survey  | 5                   | 2–4             | 12                   |
| Meads, 2017 [93]   | UK      | DCE      | Cancer pain   | Patients      | 248         | Paper-based survey  | 7                   | 2–3             | 6                    |
| Mohamed, 2015 [50] | Europe  | DCE      | Thyroid cancer | Patients      | 134         | Online survey       | 4                   | 3–4             | 12                   |
| Muhlbacher, 2011 [43]| Europe  | DCE      | Multiple myeloma | Doctors     | 243         | Online survey       | 8                   | 2–3             | 8                    |
| Muhlbacher, 2015 [56]| Europe  | DCE      | Chronic pain  | Patients      | 1324 DCE, 24 pretest interviews | Paper-based survey  | 7                   | 2               | 8                    |
| Muhlbacher, 2015 [86]| Europe  | DCE      | Acute coronary syndrome | Patients | 68          | Face-to-face survey | 5                   | 3               | 13                   |
| Naik-Panvelkar, 2012 [61]| Australia | DCE      | Asthma services | Patients | 80          | Paper-based survey  | 8                   | 2–3             | 9                    |
| Naik-Panvelkar, 2012 [85]| Australia | DCE      | Asthma        | Patients      | 80          | Paper-based survey  | 8                   | 2–3             | 9                    |
| Naunheim, 2017 [90] | USA     | DCE      | Ear, nose and throat clinic | General (or target) population | 161         | Online survey       | 5                   | 3–5             | 14                   |
| Naunheim, 2018 [87] | USA     | DCE      | Subglottic stenosis | General (or target) population | 162         | Online survey       | 5                   | 2–4             | 14                   |
| Qin, 2017 [47]     | Europe  | DCE      | Type II diabetes | Patients     | 510 DCE, 50 interviews | Online survey       | 8                   | 2–4             | 16                   |
| Schmidt, 2017 [55] | Europe  | DCE      | Lung and colon cancer | Patients | 310         | Online survey       | 5                   | 3               | 10                   |
| Tada, 2019 [51]    | Asia    | DCE      | Psoriasis     | Patients      | 395         | Online survey       | 6                   | 2–4             | 16                   |
| Tinelli, 2012 [72] | UK      | DCE      | Cancer        | Patients      | 183         | Paper-based survey  | 4                   | 3–5             | 16                   |
experiment. Many focused on the factors influencing understanding or completion of a DCE.

### 3.1 Applied Discrete Choice Experiments (DCEs)

Fifty-two applied DCEs were identified. Most were conducted with patients \((n = 35)\) and sample sizes ranged from 30 [39] to 1791 [44]. The most common clinical areas were diabetes and cancer. Twenty-four of the DCEs were conducted online, 18 were paper-based, and 8 were face-to-face interviews. An additional two DCEs were protocol papers describing DCEs yet to be conducted [45, 46].

Understanding was assessed in three ways: using pretesting to test or confirm participant understanding \((n = 18)\); including tests of understanding within the DCE survey, such as a repeated or dominated choice set \((n = 22)\); and referring to the concept of understanding in the discussion \((n = 4)\). There were eight additional studies that addressed understanding in both the pretesting phase and with tests in the DCE survey.

#### 3.1.1 Applied DCEs Addressing Understanding in the Pretesting Phase

The 18 applied DCEs addressing understanding in the pretesting phase all used the concept of understanding as a way to modify or revise the DCE instrument before final roll out [44–61]. Most used pretesting to test or confirm understanding in relation to the terminology of attributes and medical concepts. For example, “… comprehension and relevance of the attributes … as well as the survey instructions” [52] and “wording used in the questionnaire was correct and understood by the target population” [58]. However, many also took a broader view of understanding and used the pretesting process to assess understanding of the choice task; for example, whether participants “understood the attribute definitions, accepted the hypothetical context of the survey, and were able to complete the choice questions as instructed” [50]. Similarly, Bridges et al. [53] completed six pretesting interviews to assess whether participants “understood the survey and were willing to trade off among the attributes and levels”. Despite each of the studies in some way describing the use of pretesting to assess or confirm understanding, nearly one-third \((n = 7)\) did not report the results of their assessment. Others gave minimal information, such as “minor changes were made to the wording to improve respondent comprehension” [50].

All except one study implied that understanding was established to be good enough to continue with the DCE. The exception was a protocol paper that described focus groups and 1:1 interviews with cancer survivors and oncology health professionals to develop a DCE about preferences for cancer care among people with cancer [46]. They found “Half of the participants felt that the questionnaire was confusing and difficult to interpret, which suggested that the questionnaire might be particularly burdensome and cognitively demanding to our group of patients”, and subsequently made changes to the text and layout to improve understanding [46].
3.1.2 Applied DCEs Including a Test of Understanding Within the DCE Task

The 22 applied DCEs that included a test of understanding within the DCE task were spread across year, country, clinical area, sample size and survey administration, and the definition of understanding was similarly varied [62–83]. While many studies referred to relatively generic concepts of understanding, such as the task or attributes and levels [e.g. 82], other studies took a more targeted approach and related the concept of understanding back to the underlying assumptions of rational decision making, referring to concepts of consistency [62–64, 77], dominance or non-satiation [67] and rationality [77, 78]. Some studies referred to engagement with the task as an indicator of understanding [70, 71, 79], while others referred to participants understanding the concept of making a choice [68, 72].

Despite these different definitions of understanding, methods to assess understanding were relatively consistent. Over half used a dominated choice set [63, 64, 68–71, 73–78, 82], with other approaches including a repeated choice set [64, 77, 79], analysis of dominant preferences [63, 67], inclusion of debriefing questions [65, 76, 80, 83], inclusion of quiz questions [65, 66], inclusion of a numeracy scale [66, 75] and use of the root likelihood approach in Sawtooth [62]. Fourteen studies used the understanding results to exclude participants from the analysis [62–64, 67, 68, 70, 71, 73, 74, 77–80, 82], two used them to describe the sample [65, 69], one included them only in the discussion section [72], and the remaining did not describe how they used the results of their understanding assessment [66, 75, 76, 81, 83].

Where reported, rates of passing the various tests of understanding varied and were spread across the studies that excluded participants based on the results of these

Table 2 Characteristics of publications included in the scoping review, by category: pretesting studies

| First author, year | Country | DCE/BWS3 | Clinical area | Subject group | Sample size | Main study design | Number of attributes | Number of levels | Number of choice sets |
|--------------------|---------|----------|---------------|---------------|-------------|-------------------|---------------------|-------------------|---------------------|
| Abdel-All, 2019 [96] | India | DCE | Health workforce retention | General (or target) population | 20 | Face-to-face interviews and focus groups | 5 | NS | NS |
| Coast, 2007 [98] | UK | DCE | Dermatology | Patients | 19 | Qualitative interviews | 4 | 2–4 | NA |
| Helter, 2016 [97] | NS | DCE | Alcohol misuse | General (or target) population | 12 expert interviews, 5 focus groups | Literature review and qualitative focus groups | 6–9 | NS | NS |
| Janssen, 2016 [40] | USA | DCE and BWS3 | Diabetes | Patients | 25 | Literature review, stakeholder engagement and qualitative interviews | 6 | 3 | NS |
| Katz, 2018 [95] | USA | DCE | Tobacco treatment | Patients | 48 | Qualitative face-to-face interviews | 9 | 24 | 15 |
| Klojgaard, 2012 [94] | Denmark | DCE | Spinal disease | Patients and doctors | 2 clinician interviews, 3 patient interviews | Stepwise series of qualitative approaches to aid the design of a DCE | NS | NS | NS |
| McGrady 2018 [99] | USA | DCE | Cancer | Patients | 20 | Literature review, cognitive interviews and pretesting | 4 | 3 | 9 |

BWS3 best–worst scaling type 3, DCE discrete choice experiment, NS not specified, NA not applicable
| First author, year | Country | DCE/BWS | Clinical area | Subject group | Sample size | Main study design | Number of attributes | Number of levels | Number of choice sets |
|-------------------|---------|---------|---------------|---------------|-------------|-------------------|---------------------|-----------------|---------------------|
| Bech, 2011 [10]   | Denmark | DCE     | Dental care   | General (or target) population | 1053        | Online survey with substudy examining the impact of number of choice sets on choice difficulty | 6                   | 2–4             | 5, 9, or 17         |
| Cheraghi-Sohi, 2007 [103] | UK   | DCE     | Primary care  | General (or target) population | 20          | Qualitative interviews using the think-aloud technique | 6                   | 2–4             | 8                   |
| Kenny, 2003 [100]  | Australia | DCE    | Varicella vaccination | General (or target) population | 34          | Qualitative telephone interviews after completion of a DCE | 7                   | NS              | 16                  |
| Kenny, 2017 [106]  | Australia | DCE     | Primary care  | General (or target) population | 1208        | Online survey with participants randomised to two different presentation formats | 10                  | 3               | 18                  |
| Maddala, 2003 [107] | USA    | DCE     | HIV testing   | General (or target) population | 353         | Paper-based survey with alternative presentations | 6                   | 2–4             | 11                  |
| Ryan, 2009 [27]    | UK      | DCE     | Bowel cancer screening | General (or target) population | 18          | Qualitative face-to-face think-aloud interviews | 5                   | 3               | 10                  |
| Ryan, 2010 [108]   | UK      | DCE     | Rheumatology   | Patients        | 189         | Paper-based survey with substudy examining rationality | 6                   | 2–4             | 8                   |
| San Miguel, 2005 [101] | UK    | DCE     | Primary care  | Patients        | 1343        | Paper-based survey with substudy examining factors influencing rationality | 5                   | NS              | 6, 8, or 10         |
| Scott, 2002 [18]   | UK      | DCE     | Primary care  | General (or target) population | 4287        | Substudy examining frequency of, and factors relating to, dominant preferences | 4                   | 2–4             | 15                  |
| Severin, 2013 [42] | Europe  | DCE and BWS3 | Genetic testing | General (or target) population | 31 DCE, 26 BWS3 | Qualitative interviews comparing completion of a DCE and BWS3 | 6                   | 2–3             | 12                  |
| First author, year | Country | DCE/BWS3 | Clinical area | Subject group | Sample size | Main study design | Number of attributes | Number of levels | Number of choice sets |
|-------------------|---------|----------|---------------|---------------|-------------|-------------------|---------------------|----------------|---------------------|
| Skedgel, 2013 [109] | UK      | DCE      | Healthcare priority setting | General (or target) population | 604        | Online survey comparing DCE vs. constant-sum paired comparison for societal preferences | 6                   | 3               | 10                  |
| Spinks, 2016 [9]   | Australia | DCE | Complementary medicine | General (or target) population | 32         | Eye-tracking laboratory study exploring how complexity impacts attribute non-attendance | 3–8                 | 2–4             | 8                   |
| Van Dijk, 2016 [41] | USA     | DCE and BWS3 | Hip replacement | General (or target) population | 429        | Online survey comparing preferences obtained from a DCE and BWS3 simultaneously | 5                   | 4               | 8 DCE or 12 BWS3    |
| Vass, 2019 [105]   | UK      | DCE      | Breast cancer screening | General (or target) population | 19         | Qualitative think-aloud interviews | 3                   | NS              | 5                   |
| Veldwijk, 2015 [104] | Europe | DCE      | Rotavirus vaccination | General (or target) population | 959        | Online survey with two versions | 5                   | 3               | 9                   |
| Veldwijk, 2016 [102] | Europe | DCE | Rotavirus vaccination and prostate cancer screening | General (or target) population | 70         | Face-to-face or telephone qualitative interviews after completion of a DCE | 5                   | 2–4             | 9 or 16            |

BWS3 best–worst scaling type 3, DCE discrete choice experiment, HIV human immunodeficiency virus, NS not specified
| First author, year | Definition of understanding | How they used understanding | How they tested understanding | Results of understanding tests |
|--------------------|-----------------------------|----------------------------|------------------------------|------------------------------|
| Adam, 2019 [82]    | “Patients’ understanding of the attributes and levels” | To exclude participants | “The questionnaire contained one choice task with a dominated alternative” | “Five were defined as ‘irrational’ responses. The ‘irrational’ responses were given by patients from the GM group. These respondents were mostly male (3 men, 1 woman, and 1 ‘not stated’), with a mean age of 48.8 years (SD 16.8) and a mean duration of education of 11.6 years (SD 1.1). Three of these patients reported having a chronic condition” |
| Becker, 2018 [79]  | “Respondents had read, understood and engaged constructively with the choice task” | To exclude participants | “Validity checks … the chosen options were found to be the same across all choice tasks indicating that respondents had not necessarily considered trade-offs between the presented scenarios” | Two questionnaires were excluded |
| Bottomley, 2017 [57] | “Participants had little trouble in understanding the DCE task” | To revise DCE instrument | “One-on-one interviews” method to elicit understanding not reported | Participants had little trouble in understanding the DCE task |
| Bridges, 2012 [53] | “Understood the survey and were willing to trade off among the attributes and levels” | To revise DCE instrument | “Guidelines for patient-reported assessment of outcomes were used to facilitate comprehension by respondents, which was tested using open-ended interviews” | “Patients from the UK diagnosed with NSCLC who confirmed that they understood the survey and were willing to trade-off among the attributes and levels” |
| Brown, 2011 [38]   | “Complexity of the choice task exercises … length of the instrument” | In the discussion, to justify choice of DCE instrument | Not tested | “Lee et al. reported no respondent complaints about the complexity of the choice task exercise (using a similar exercise) or length of the instrument” |
| Buchanan, 2016 [80] | “Difficulty, indicating … understood the choice questions” | To exclude participants | Self-reported difficulty of the DCE task | “Most respondents (97%) passed the rationality check, with 9% rating the DCE as difficult” |
| Byun, 2016 [70]    | Patients and physicians gave their attention to the questionnaire | To exclude participants | Dominant choice set | “98.8% of respondents rationally preferred the dominant COX-2 inhibitor when informed regarding the trade-offs between the benefit-risk attributes, meaning that patients and physicians gave their attention to the questionnaire” |
| First author, year | Definition of understanding | How they used understanding | How they tested understanding | Results of understanding tests |
|--------------------|-----------------------------|----------------------------|-----------------------------|-------------------------------|
| Cernauskas, 2018 [88] | “Understood the task and made consistent choices” | To revise DCE instrument | Pilot testing and repeated choice set | “Pretest showed that all respondents understood the task and provided valid answers, but it also led to changing the wording of several attributes to eliminate any ambiguity in meaning and enhance respondents’ comprehension” AND “seven responses were excluded from the analysis due to the lack of consistency between the first and last choice sets which were identical. This implied these respondents did not perhaps understand the choice task” |
| Damen, 2011 [69] | “Passed the dominant question, demonstrating their understanding of the DCE task” | To describe sample | “A dominant choice set (i.e. a choice set in which both alternatives used implant material but one was characterised by logically preferable levels on all other attributes) and was included to test for rationality” | “In total, 270 of 272 patients (99%) passed the dominant question, demonstrating their understanding of the DCE task” |
| de Bekker-Grob, 2013 [81] | “Experienced difficulty of the questionnaire” | Not reported | Not reported | “93% of the respondents passed the rationality test that was included in the questionnaire, and 76% of the respondents did not find the DCE questions difficult” |
| De Freitas, 2019 [52] | “… comprehension and relevance of the attributes … as well as the survey instructions” | To revise DCE instrument | “Pretest interviews” | “Participants … were able to answer all the questions, and … the instructions were clear and easy to understand. Some participants provided feedback about the wording of some of the attribute levels …” and “no changes to the number of choice tasks or to the experimental design were made on the basis of the pretest interviews” |
| De Vries, 2015 [73] | “Understand the task” | To exclude participants | “This dominant choice set was added to identify the responders who may not understand the task” | NS—10 participants were excluded (assumed because they failed the dominant choice set) |
| First author, year | Definition of understanding | How they used understanding | How they tested understanding | Results of understanding tests |
|-------------------|-----------------------------|-----------------------------|-------------------------------|------------------------------|
| Fifer, 2018 [89]  | Online pilot with targeted feedback to ensure logic and understanding. Measured: time to complete survey, response patterns, question regarding understanding of the task | To revise the DCE instrument and to exclude participants | Online pilot with targeted feedback to ensure logic and understanding. Measured: time to complete survey, response patterns, question regarding understanding of the task | Pretesting: “No changes were made to the overall survey and DCE as participants reported the attributes were relevant and the survey easy to understand” AND in the discussion—“Literacy and language skills were not tested and participants may not have had an adequate understanding of the choice tasks”. No results given for validity checks and it is not clear if anyone was excluded from the analysis |
| Gregor, 2018 [62] | “… consistency of responses was verified with root likelihood approach” | To exclude participants | Root likelihood approach (referenced to Sawtooth software) | 93 of 744 respondents were excluded from the analysis due to inconsistent survey responses |
| Hauber, 2016 [44] | “Ability to understand and accept the attributes and levels … and … willingness to trade among attributes in choosing between hypothetical device profiles” | To revise the DCE instrument | “The draft survey was pretested using in-person interviews … asked to complete a paper-and-pencil version of the survey instrument” | “Based on the pretest interviews, the survey instrument was finalised” |
| Hauber, 2017 [48] | “Clear and comprehensible” survey questions—understanding of definitions and instructions and hypothetical context of survey | To revise the DCE instrument | Qualitative pretests—“Interview participants were asked to think aloud as they completed the draft survey. Participants were also asked a series of debriefing questions to determine whether they understood the definitions and instructions, accepted the hypothetical context of the survey, and successfully completed the choice questions as instructed” | Not specified |
| Heringa, 2018 [59] | Not specified, but mention health literacy, risk understanding and task understanding in the discussion | Adjust the wording of the DCE | “In the third step, the questionnaire was pretested by patients and pharmacists for understanding, feasibility and wording” | “The questionnaire was adapted according to the feedback in a cyclic process until after three cycles no new issues were identified and good understanding was reached” |
| Hofman, 2014 [75] | “Understanding of the DCE task” and “to gain more insight into respondents’ understanding of the DCE task, i.e. comparing risks and percentages, we included the Subjective Numeracy Scale (SNS)” | NS | “We assessed respondents’ understanding of the DCE task by including a dominant choice set as a rationality test. To gain more insight into respondents’ understanding of the DCE task, i.e. comparing risks and percentages, we included the Subjective Numeracy Scale” | “The relatively high score for subjective numeracy score indicates that our sample probably did understand the risks and percentages they had to compare in the DCE task” |
| First author, year | Definition of understanding                                                                 | How they used understanding | How they tested understanding                                                                 | Results of understanding tests                                                                                                                                                                                                 |
|-------------------|---------------------------------------------|----------------------------|------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Hofman, 2014 [76] | “Understanding of the DCE task”             | Not specified              | “To assess respondents’ understanding of the DCE task we included a dominant choice set as a rationality test. Also, we included four items on a 5-point Likert scale to evaluate whether respondents considered the DCE questions ‘clear-unclear, ‘difficult-easy’, ‘annoying-pleasant’, and the number of questions as ‘too many-not too many’.” | “The dominant choice set was answered correctly by 490/500 of the respondents … the mean evaluation of the DCE questions were unclear-clear mean 3.48, difficulty-easy mean 3.53, annoying-pleasant mean 2.82 and ‘too many questions-not too many’ mean 2.56” |
| Hol, 2010 [78]    | “A rationality test was included in the questionnaire to determine the understanding of the questionnaire by each subject” | To exclude participants    | Dominant choice task                                                                                | A significantly higher proportion of the previously screened subjects (91%) passed the rationality test compared with the screening-naive subjects (82%, p < 0.001)                                                                                           |
| Ivanova, 2019 [64]| “… consistency of individual responses: a test-retest exercise and a dominant alternative test … [to determine] ... whether respondents sufficiently understood the evaluation task” | To exclude participants    | “… to test for consistency of individual responses: a test-retest exercise and a dominant alternative test; the test-retest exercise tested that subjects who preferred Treatment A to Treatment B at one point in the sequence of choice exercises should also prefer Treatment A to Treatment B at any subsequent point. The dominant alternative test determined whether respondents sufficiently understood the evaluation task to indicate a preference for an unambiguously better treatment profile …” | 76 of the 78 patients who completed the DCE passed the dominant alternative test, and 160 of the 206 oncologists who completed the DCE passed the dominant alternative test. Sensitivity analyses for the subpopulation defined by respondents who also passed the test-retest test were consistent with those from the main analyses |
| Jan, 2000 [71]    | “It is important to ensure that individuals being surveyed understand the tasks being presented to them and that they are taking the exercise seriously” | To exclude participants    | “Respondents’ understanding was tested by including a choice in which one scenario ‘dominated’ another” | “Two respondents provided inconsistent responses. These were removed from subsequent analysis”                                                                                                                                                                                                                                         |
| Kistler, 2015 [74]| “Understood the DCE selection process”      | To exclude participants    | “A participant who was unable to understand that one test was superior or dominant to the other was considered unable to complete the remainder of the choice questions” | “Of 277 potentially eligible participants who were approached … 9 were unable to complete the dominant choice question”                                                                                                                                                                                                 |
| First author, year | Definition of understanding | How they used understanding | How they tested understanding | Results of understanding tests |
|-------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
| Laba, 2012 [77]   | A repeated choice set and a dominant choice set. “Rather than test for survey understanding, these tests are included to investigate whether responses are ‘rational’ according to the axioms of preference-based consumer theory” | To exclude participants | “Two additional choice sets were added to each survey version to check for consistency (a repeated choice set) and internal validity (a choice set with a dominated alternative according to a priori expectations)” | “91% passed the monotonicity test generally indicating ‘rational’ interpretation of the factors as intended… For the repeated choice task, 77% of the respondents passed and the kappa statistic was 0.48 representing moderate agreement” |
| Lee, 2008 [39]    | Missing data and time to complete, as well as presence of lexicographic preferences (choosing based on one attribute)—described only in the discussion | In the discussion, to confirm choice of DCE instrument | Missing data, time to complete, presence of lexicographic preferences—described only in the discussion | “That all surveyed haematologists completed the self-administered discrete choice exercise without any missing data suggests a clear understanding of the issues involved in this experiment… Furthermore, the patterns of responses revealed no lexicographical issues among respondents” |
| Liu, 2018 [67]    | Dominant preference and non-satiation (assessed through a dominated choice set) | To exclude participants | Tested for dominant preferences (i.e. made a choice based on one attribute only) | Dominant preferences: “16.7% of the subjects showed dominant preferences in Study 1, and this number was 17.0%, 14.7%, and 16.1% in studies 2–4 respectively” Dominated choice set: “In total, 7.6% of the respondents who faced choice sets with a dominated alternative preferred the dominate one in Study 1, and this percentage was 4.0%, 4.1% and 5.7% in studies 2–4 respectively. These proportions of ‘irrational’ choices are well within the acceptable standard in a DCE (Johnson, 2007). These percentages are relatively small, so it is unlikely that subjects were confused by the task” |
| Lloyd, 2011 [68]  | “If they did not understand the concept of trading—that is, if they failed a test question that asked them to choose between 2 treatments, of which one was clearly better than the other, and in which, therefore there was no trade-off” | To exclude participants | Dominated choice set | “Four people failed the test question and were excluded from the WTP analysis” |
| First author, year | Definition of understanding | How they used understanding | How they tested understanding | Results of understanding tests |
|-------------------|-----------------------------|-----------------------------|-----------------------------|-------------------------------|
| Lokkerbol, 2019 [91] | Pretesting: “understandability and usefulness of the attributes/levels” DCE: “the difficulty of the choice task” | To revise the DCE instrument and to describe participants | Pretesting: “Pre-test with three patients”—methods for eliciting understanding not described DCE: “Respondents were asked to scale the difficulty of the choice tasks on a five-point Likert scale” | Pretest: “The understandability and usefulness of the attributes/levels was judged to be appropriate” DCE: “Respondents rated the difficulty of the DCE task on a five-point scale with a 2.81 average, which lies between easy (=2) and neutral (=3); 72.2% of the completers rated the questionnaire as not difficult (score ≤3)” |
| Mansfield, 2016 [54] | “The pretest interviews evaluated the survey instrument for patient comprehension and burden” | To revise the DCE instrument | Pretest interviews | “During the pretest interviews, most survey features worked smoothly. In general, respondents understood the attributes and could answer the choice questions. Minor changes to attribute descriptions were made to improve comprehension and readability. However, several difficulties were identified regarding comprehension of the information treatment (specifically, the description of the correlation between efficacy and toxicities). Survey revisions, including reducing the number of potentially correlated attributes to one in each DCE question, were made to help respondents understand the correlation” |
| Mansfield, 2017 [66] | Understanding of the attributes | To revise the DCE instrument | “Each of the seven attributes was described separately, and the descriptions were followed by questions about the attribute to ensure respondents’ understanding … Respondents who answered incorrectly were presented with the correct answer and an explanation before proceeding with the survey, while respondents who answered correctly were presented with the correct answer to reinforce their understanding” | Not specified |
| First author, year | Definition of understanding                                                                                                                                                                                                 | How they used understanding | How they tested understanding                                                                                                                                                                                                 | Results of understanding tests                                                                                   |
|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|
| Marshall, 2007 [63] | “... consistency of responses to assess the reliability of the responses” ... “consistency tests showed that respondents were considering trade-offs between attributes”                                                                 | To exclude participants     | “... individual responses were assessed for violation of the tenet of monotonic preferences”—assessed using two dominant pair tests. Second, “respondents with preferences whose responses seem to indicate unwillingness to trade a given attribute against other attributes. A respondent was considered unwilling to trade if they made the same choices in at least 8 or 10 scenarios with the attribute” ... “if a respondent failed either of these consistency tests, he was considered inconsistent” | “Coefficient signs were unaffected, and differences in the coefficients were insignificant using Wald tests ($p < 0.05$). Thus, we decided to retain all respondents in the final analysis” |
| Marshall, 2018 [49] | “Understanding of the questionnaire content”                                                                                                                                                                                  | To revise the DCE instrument | Not specified                                                                                                                                                                                                                                                                         | “Based on pretesting results, the questionnaire was modified”                                                 |
| Meads, 2017 [93]   | “We did not test patient’s understanding of the DCE method, although the survey was carefully explained to individuals”                                                                                                      | In the discussion, to interpret results | Not tested                                                                                                                                                                                                                                                                          | “For a small minority, there was a suggestion of counter-intuitive preferences … this may be because of a lack of participant understanding or engagement or the result of an artefact of the survey design” |
| Mohamed, 2015 [50] | “Understood the attribute definitions, accepted the hypothetical context of the survey, and were able to complete the choice questions as instructed”                                                                         | To revise the DCE instrument | 15 face-to-face semi-structured interviews … during these interviews, patients were asked to ‘think aloud’ as they completed the draft survey instrument and a series of debriefing questions to ascertain that they understood the attribute definitions, accepted the hypothetical context of the survey, and were able to complete the choice questions as instructed | “Minor changes were made to the wording to improve respondent comprehension”                                      |
| First author, year | Definition of understanding                                                      | How they used understanding                                      | How they tested understanding                                      | Results of understanding tests                                                                 |
|-------------------|--------------------------------------------------------------------------------|------------------------------------------------------------------|-----------------------------------------------------------------|-----------------------------------------------------------------------------------------------|
| Muhlbacher, 2011  | DCE: “the degree of difficulty … in performing the paired comparisons in the DCE” | To revise the DCE instrument and describe the sample             | Pretesting: “30 physicians participated in this preliminary survey by filling in the online questionnaire” | Pretesting: “The evaluation showed that the questions were clear and comprehensible to the subjects” |
|                   |                                                                                  |                                                                  | DCE: “At the end of the questionnaire, the subjects were asked to give an assessment of the degree of difficulty they had” |                                                                                                  |
|                   |                                                                                  |                                                                  | Pretesting: “The evaluation showed that the questions were clear and comprehensible to the subjects” |                                                                                                  |
|                   |                                                                                  |                                                                  | DCE: “At the end of the questionnaire, the subjects were asked to give an assessment of the degree of difficulty they had” |                                                                                                  |
|                   |                                                                                  |                                                                  |                                                                                                  |                                                                                                  |
| Muhlbacher, 2015  | “Comprehensibility and practicality”                                           | To revise the DCE instrument                                     | “Two free text questions on content validity and comprehensibility (practicality) were included in the questionnaire” | None reported                                                                                  |
|                   |                                                                                  |                                                                  |                                                                                                  |                                                                                                  |
| Muhlbacher, 2015  | Pretesting: clarity of the questionnaire design, the quality of the scales used, and the understandability of the attributes, levels, and trade-offs DCE: “consistency of responses in each set” as well as a repeated choice set and dominant choice set | To exclude participants                                         | Pretest interviews, repeated choice set, dominated choice set | Results of pretesting interviews not presented. 60 respondents were excluded after internal consistency tests and the exclusion of all invalid questionnaires |
|                   |                                                                                  |                                                                  |                                                                                                  |                                                                                                  |
| Naik-Panvelkar, 2012 | “Comprehension, interpretation, format and face validity”                      | To revise the DCE instrument                                     | Pilot testing on a convenience sample                           | “No major changes were made to the questionnaire following the pilot” |
|                   |                                                                                  |                                                                  |                                                                                                  |                                                                                                  |
| Naik-Panvelkar, 2012 | Main study: “Ease and time of completion of the DCE” | To revise the DCE instrument                                     | Questions about ease and time to complete the DCE               | Pretesting—“None of the respondents raised any issues with respect to understanding the questionnaire and so the pilot did not lead to any major modifications in the questionnaire.” Main study: The mean time for completion of the questionnaire was 15 minutes.” Results of ‘ease of completion’ questions not reported |
| First author, year | Definition of understanding | How they used understanding | How they tested understanding | Results of understanding tests |
|-------------------|-----------------------------|----------------------------|------------------------------|------------------------------|
| Naunheim, 2017 [90] | Pretesting: “questions were well understood” DCE: ‘stated comprehension’ | To revise the DCE instrument | Pretesting interviews and in the DCE included a question on ‘stated comprehension’—by asking whether patients understood the survey | “All participants indicated that they understood the format and content of the DCE… the reliability of responses was mixed: in 42.3% of cases, the most important attribute as individually measured with the DCE matched the stated importance as assessed by simple rankings of attributes by the participant” |
| Naunheim, 2018 [87] | “Understanding of the experimental design … stated comprehension and consequentiality … [and] … monotonic responses” | To revise the DCE instrument | “The survey was initially piloted in 10 patients … and responses were elicited to assess understanding through both directed questions and open-ended comments” AND “stated comprehension and consequentiality … and response consistency… were included as measures of internal validity” | Pretesting: “Nine of 10 demonstrated full understanding of the experimental design, and responses were monotonic across attributes (i.e. there was a clear best-to-worst ordinal ranking for levels within each attribute)” DCE: “All participants indicated that they understood the format and content of the DCE” AND “Results for consequentiality and response consistency not reported” |
| Qin, 2017 [47] | “… wording and comprehension as well as cognitive and overall burden” | To revise the DCE instrument | “… survey was pilot tested with respect to wording and comprehension, as well as cognitive and overall burden, with five patients in the UK” | Not specified |
| Schmidt, 2017 [55] | “The first choice set enabled us to test patients’ understanding of the DCE method because it included a dominant profile” AND “We conducted a pretest to ensure that the final questionnaire could be understood easily by the patients” | To revise the DCE instrument | Pretest interviews, dominated choice set | “The pretest showed that most patients could not answer questions about their disease state or therapy goals. Therefore, this question was excluded from the questionnaire”. Results of the dominant choice set not reported (even in the supplementary material) |
| Tada, 2019 [51] | “The questionnaire’s understandability” | To revise the DCE instrument | “A pilot study was executed” | Not specified |
| Tinelli, 2012 [72] | Understand the concept of choosing between hypothetical situations | In the discussion section | Not specified | “Many found it difficult to understand the concept of choosing between hypothetical situations and hence took up to an hour to complete. The research nurse helped them understand what they had to do” |
| First author, year | Definition of understanding | How they used understanding | How they tested understanding | Results of understanding tests |
|-------------------|-----------------------------|-----------------------------|-----------------------------|-------------------------------|
| Veldwijk, 2014 [58] | “wording used in the questionnaire was correct and understood by the target population” | Adjust the wording of the DCE | When sent pilot versions (by post) “respondents were asked to mark every question or answering category that they did not understand or found hard to grasp and they were asked to provide suggestions for improvement” | Not reported |
| Vennedy, 2016 [60] | “Understanding the task or the attribute and level descriptions” | Adjust the wording of the DCE | “Focus group interviews” | “Two additional pilot tests did not reveal any further problems in understanding the task or the attribute and level descriptions” AND “interviewer assistance provides the opportunity to identify misunderstandings of the task at early stages in questionnaire administration” |
| Whitaker, 2017 [83] | “Perceived difficulty completing the discrete choice experiment” | Not reported | “All participants were asked to rate how easy/difficult they found the scenarios to complete, and were given the opportunity to provide free-text comments on the survey” | “Most of the 601 participants found the discrete choice scenarios easy (n = 291; 48%), or very easy (n = 240; 40%), to complete, with a smaller proportion reporting they found the section difficult (n = 68; 11%) or very difficult (n = 2; 0.3%). The open-text comments also did not reveal any concerns about the discrete choice experiment” |
| Whitty, 2013 [92] | “Understand the DCE task and the hypothetical concept of paying for a service” | In the discussion, to interpret results | Not tested | Not tested |
| Wong, 2014 [46] | “Face validity … comprehension, options and wording of the DCE” | To revise the DCE instrument | “Focus group participants, of whom 10 out of 11 questionnaires were returned” | “Half of the participants felt that the questionnaire was confusing and difficult to interpret, which suggested that the questionnaire might be particularly burdensome and cognitively demanding to our group of patients” |
| Youssef, 2016 [45] | “The DCE was piloted … to ascertain patient acceptability and understanding” | To revise the DCE instrument | Pilot testing | Results not reported |
Many studies reported rates of < 5% failing their tests [64, 68–71, 74, 76, 79, 80, 82]; however, some were much higher, for example, 12.5% provided inconsistent responses [62], up to 7.6% failed a dominated choice set, and up to 17% displayed dominant preferences [67], while 18% failed a rationality test [78] and 33% failed a repeated choice task [77]. Liu et al. [67] stated “These proportions of irrational choices are well within the acceptable standard in a DCE” and cited Johnson et al. [84], although it is not clear where in this work a threshold for irrational choice prevalence is given. Other studies simply stated when testing the impact of including or excluding those with inconsistent/irrational responses, there were no significant differences in the results [63, 64]. Some studies gave only descriptive summaries of the results, such as “Responses to the knowledge assessment questions also indicated good understanding” [65] and “Many found it difficult to understand the concept of choosing between hypothetical situations and hence took up to an hour to complete” [72].

Two studies compared irrational responses by sociodemographic characteristics [78, 82]. Adam et al. [82] found that the five participants (of 263) who gave irrational responses were more likely to be male, older, and less educated than the average respondent in their DCE [82]. Hol et al. [78] identified that participants who had previous experience of the health test under study (colorectal cancer screening) were significantly more likely to pass the rationality test than previously unscreened participants.

In studies where debriefing questions were used, the rates of people reporting the survey difficult to complete were higher than the proportion who failed the rationality test. For example, one study reported 3% failed, while 9% rated the survey as difficult [80], and, in another study, 7% failed and 24% reported the survey to be difficult [81]. In a study that only included debriefing questions, 12% of respondents reported they found the scenarios difficult to complete [83]. When numeracy was tested rather than rationality, it was reported that “The relatively high score for subjective numeracy score indicates that our sample probably did understand the risks and percentages they had to compare in the DCE task” [75].

Eight additional studies assessed understanding in both pretesting and within the DCE survey [43, 85–91]. These studies were similar to the other reported studies, with pretesting results used to refine the wording and formatting of the surveys, and the rationality tests using dominant or repeated choice tests and debriefing questions. Insufficient details were available to assess whether the rates of people failing the rationality/consistency tests were lower when pretesting for understanding had also been conducted.
| First author, year | Definition of understanding                                                                 | How they used understanding | How they tested understanding                                                                 | Results of understanding tests                                                                 |
|-------------------|---------------------------------------------------------------------------------------------|----------------------------|---------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
| Abdel-All, 2019 [96] | “Comprehension (ability to understand the question as intended), retrieval of information (thinking about the question and drawing conclusions), judgement and selection of response to the question” | To revise DCE instrument  | Cognitive ‘think aloud’ interviews and focus group discussions                               | “The DCE was well received by the ASHAs and … they did not find it difficult to understand the choice sets presented to them. The introductory statement with the choice set example helped to explain the hypothetical nature of the DCE and confirmed the cognitive understanding of the ASHAs of the DCE” |
| Coast, 2007 [98] | Understanding of the technical concepts in the scenario and “understanding of specific terms” | To revise DCE instrument  | Not tested—qualitative interviews to elicit participant definitions of different concepts    | Not tested                                                                                 |
| Helter, 2016 [97] | “The final step in the process of attribute development aims to ensure that the desired meaning is evoked and that the terminology is understandable for respondents” | To revise DCE instrument  | “The literature suggests qualitative techniques (part of pretesting and piloting, cognitive interviews, think-aloud technique), or researchers judgement based on data already available” | Not reported                                                                                 |
| Janssen 2016 [40] | Understanding of the attributes in terms of names and descriptions                           | To revise DCE instrument  | Not tested—qualitative interviews to elicit participant definitions of different concepts    | “Names and descriptions of the attributes were adapted throughout the pretesting process to maximise participants’ understanding” |
| Katz, 2018 [95]  | “Two qualitative analysts analysed the think aloud data to evaluate subjects’ overall comprehension of, and any difficulties in completing, the choice tasks.” Also assessed monotonicity (dominant choice set) and stability (duplicate choice set), and non-continuity | To revise DCE instrument  | Cognitive ‘think aloud’ interviews                                                           | “Most subjects completed the DCE questionnaire without difficulty; however, not all subjects were fully engaged, and in some cases the interviewer documented signs of cognitive overload or exhaustion. In a few cases, subjects struggled with the idea of choosing between two hypothetical medications.” “Most subjects showed good comprehension of the choice tasks and clearly considered two or more attributes in choosing between medications” |
| First author, year | Definition of understanding | How they used understanding | How they tested understanding | Results of understanding tests |
|--------------------|----------------------------|-----------------------------|------------------------------|-------------------------------|
| Klojgaard, 2012 [94] | “Understand the content of the attribute and in a clear and concise manner”, especially risk-based attributes | To revise DCE instrument | During patient interviews, included discussion of ‘Framing: Perception and understandability of the given text and explanations’ and ‘… complexity and overall experience with filling out the pilot’ | “… it became very clear that the included 6 attributes were too many. The respondents had problems remembering the first attribute when looking at the later attributes, and two respondents ended up answering lexicographically or using heuristics with emphasis on the last or the two last attributes, despite not ranking these the highest.” … “Furthermore, two respondents read the word ‘ability’ as ‘aim’ because these two words are close in Danish. This fact proved to make the attributes difficult to understand and pointed to the need for reframing them.” … “None of the respondents had difficulty understanding or interpreting the [risk] attribute” … “It was also clear that the number of assigned levels should be limited because the cognitive ability of the respondents was limited, and the assignment of making choices had already proven to be difficult to grasp.” … “They were also able to explain the task ahead from reading the text only. Nevertheless, none of the respondents were able to perform the task when it was given to them, and they needed much more explanation and help to get started” |
| McGrady, 2018 [99] | “Meaning of each attribute” and “participant comprehension” | Adjust the wording of the DCE | Looked for ‘clarifying questions’ during DCE administration in the cognitive interviews | Participants in the final round “did not ask any clarifying questions during DCE administration. Of note, all Wave II participants also described the task as ‘easy’ or ‘pretty easy’” |

**ASHA** Accredited Social Health Activist (community health worker), **BWS3** best–worst scaling type 3, **DCE** discrete choice experiment
| First author, year | Definition of understanding | How they used understanding | How they tested understanding | Results of understanding tests |
|-------------------|-----------------------------|-----------------------------|-------------------------------|-------------------------------|
| Bech, 2011 [10]   | “Certainty about choices” and “perceived difficulty of the DCE questions” | As an explanatory factor for DCE completion | Self-reported certainty of answers and perceived difficulty of the DCE questions | “About two-thirds of the respondents in each group reported that they were very certain of their answers to the DCE questions. This result is very satisfactory and suggests that respondents had a good general understanding of the choice task. With respect to choice difficulty, significantly more of the respondents presented with 5 choice sets stated that the choice tasks were very easy compared to the respondents presented with 9 and 17 choice sets ... Overall, however, it would seem that self-assessed choice complexity is only weakly related to the number of choices” |
| Cheraghi-Sohi, 2007 [103] | “Rationality” (i.e. respondents who behave in line with the axioms of economic theory) ... They should also exhibit ‘compensatory decision-making’ (i.e. respondents are willing to trade decreases in one attribute for increases in another). However, there is evidence that individuals use simplifying heuristics when faced with complex decisions ... It is not clear whether behaviour which does not correspond to the assumptions underlying economic theory reflects limitations in the decision maker or task related demand characteristics” | Verify validity of the DCE approach and revise the DCE instrument | Think aloud during completion of two written DCE questionnaires | Extensive! Covers reinterpretation of attributes, reactions to the cost attribute (from dismissing its relevance to it being a dominant attribute), evidence of non-trading, effects of previous experience, and other considerations |
| Kenny, 2003 [100] | “The interpretation of technical information and understanding the task” | Verify validity of the DCE approach | Semi-structured interview, including prompts/questions about understanding (definitions) of specific attributes, difficulty with the survey and choice strategy | The technical information used to describe the programme attributes appeared to be used appropriately by participants, although their explanations indicated that their understanding did not always come from the questionnaire information. Only one participant appeared to misunderstand the stated preference task, and a small number thought that the complexity and length should be reduced |
| First author, year | Definition of understanding | How they used understanding | How they tested understanding | Results of understanding tests |
|--------------------|-----------------------------|-----------------------------|-----------------------------|------------------------------|
| Kenny, 2017 [106]  | “The assessment of accuracy of understanding through the analysis of responses where one alternative is objectively better or equivalent across all attributes” | Verify validity of the DCE approach | Dominated choice sets (×2) and “questions about how easy or difficult it was to understand the information in the choice questions” | “10.4% of respondents chose the worse alternative in at least one of the two dominated choices seen … the probability of choosing the worse alternative was significantly higher when the presentation format was style 4 (percentage only) AND “in terms of consumer ranking, style 1 was more frequently identified as the better presentation format for choosing ...” AND “the majority of respondents reported they found the information easy to understand, and this did not differ substantially by presentation style” |
| Maddala, 2003 [107] | “We examine whether the increased overlap survey was easier by comparing response consistency, dominated responses, perceived difficulty and fatigue between the two surveys” | Verify validity of the DCE approach | Dominated choice set, duplicate choice set, all choices based on one attribute, self-reported rating of difficulty of the survey, compared first half of responses with the second half | “Respondents completing the increased overlap survey did not exhibit significantly fewer inconsistent responses. The increased overlap design did not result in fewer dominant responses. Respondents did not perceive the increased overlap survey as easier. The fatigue effects were similar in both treatments and there was no evidence of a learning effect” |
| Ryan, 2009 [27] | Understanding of the task, the attributes, and risk information all discussed | Verify validity of the DCE approach | “Qualitative data from the verbal protocol analysis provide rich information about respondent’s preferences” AND “Qualitative data allow the validity of these assumptions to be explored … this allows us to examine whether respondents made a mistake, misunderstood the attribute, or interpreted the attribute differently from the researchers’ assumptions” | “Respondent 14 … completed the DCE with ease after some initial misunderstandings that she asked the reviewer to clarify” AND “… respondents make non-monotonic choices because they misunderstand an attributes meaning” AND “Respondent 1 may have failed the quantitative completeness test 1 because he struggled to understand the task initially” AND “there is some evidence that respondents had difficulty understanding risk information” |
| Ryan, 2010 [108] | Rationality and “misunderstood the DCE” | To exclude participants | | “The statistical design resulted in two choices that, on any ‘rational’ choice process, should be preferred to others. Individuals who answered one or both of these choices ‘irrationally’ were assumed either to have misunderstood the questionnaire or not be taking it seriously” | 56/189 failed at least one rationality test (41 failed one and 15 failed both)” |
| First author, year | Definition of understanding | How they used understanding | How they tested understanding | Results of understanding tests |
|-------------------|-----------------------------|-----------------------------|------------------------------|------------------------------|
| San Miguel, 2005 [101] | “Complexity of the choice task faced by individuals, defined by factors such as the number of alternatives, number of attributes, similarity between alternatives etc. Increased complexity may lead individuals to develop simplifying heuristics or to make more errors” | As an explanatory factor in the rationality of DCE completion | Difference in the dispersion of the standard deviation among attribute levels across alternatives, as an indicator of the relative ease of the choice task. In addition, asked participants if it was more difficult to complete questions with three choices compared with two | “Around 18% of respondents found choices with three alternatives more difficult to complete and around 22% said this depended on the choices” AND “as choice sets become less similar, choices become easier” AND “those who thought that the questionnaire was more difficult and those who thought that choices with three alternatives were more difficult were less likely to satisfy the tests” |
| Scott, 2002 [18] | “Ease of completion and the version of the questionnaire”, also “time to complete” | As an explanatory factor for DCE completion | Unclear—self-reported ease of completion and time for completion | Those who found the questionnaire difficult to complete and who had a university education were less likely to have a dominant preference. Those who found it difficult to complete and were educated to below secondary level were more likely to have a dominant preference. Respondents who filled out questionnaire two and found it difficult to complete were less likely to have a dominant preference. Finally, older respondents who found the questionnaire difficult to complete were less likely to have a dominant preference |
| Severin, 2013 [42] | “Understanding of the DCE format” and “understanding of the choice format” | Verify validity of the DCE approach | Dominant choice set and self-reported difficulty in understanding and answering the choice formats | “The majority of respondents to the DCE reported that they found the choice tasks not very difficult to understand. However, the respondents reported that the DCE questions were difficult to answer. In contrast, more than half the participants in the BWS exercise found the BWS tasks difficult or very difficult to understand and nearly half of the participants found the questions very difficult to answer” |
| Skedgel, 2013 [109] | “Difficulty understanding the tasks and of answering the tasks” | Verify validity of the DCE approach | “Respondents were asked to rate the … the difficulty of understanding the tasks and of answering the tasks on 7-point scales ranging from extremely easy to extremely difficult” | “There was no significant difference between the two questionnaires in the proportion that rated the tasks ‘somewhat difficult’ or ‘extremely difficult’ to understand”, overall or within subgroups |
| First author, year | Definition of understanding | How they used understanding | How they tested understanding | Results of understanding tests |
|--------------------|-----------------------------|-----------------------------|-------------------------------|-------------------------------|
| Spinks, 2016 [9]   | “Processing additional information” | Not specified | Not specified | “In general participants reported being engaged with the survey and although many stated that the choice sets with more information took longer to process, the information itself was not difficult to understand” |
| Van Dijk, 2016 [41] | “Respondents rated the difficulty of the choice tasks associated with BWS and DCE” | Verify validity of the DCE approach | “Respondents rated the difficulty of the choice tasks associated with BWS and DCE with a number ranging from 1 (very easy) to 5 (very difficult)” | The mean completion difficulty of the DCE was lower than for BWS but not significant. In addition, no significant differences were found between the education groups rating the choice set difficulty |
| Vass, 2019 [105]   | “How respondents complete choice tasks … [and] … whether their behaviour aligns with a priori expectations or whether it results in violation of the underlying utility theories” | Verify validity of the DCE approach | Think-aloud interviews to observe decision making in a DCE and in-depth discussion of risk presentations | “The findings of this study suggested most of the women included in the sample were able to trade-off the attributes presented and understand the choice tasks. Although sometimes unwilling to trade-off the cost attribute, this was clearly a preference rather than an expression of cognitive burden or confusion” |
| Veldwijk, 2015 [104] | “Consistency of choices was used as a proxy for direct attribute level understanding” and “respondents’ level of understanding of the choice tasks in words and graphics, their preference for either presentation of the choice tasks and their interpretation of the words and graphics” | Verify validity of the DCE approach and revise DCE instrument | “Respondents’ level of understanding of the choice tasks in words and graphics, their preference for either presentation of the choice tasks and their interpretation of the words and graphics (i.e. either as a numeric value or as a low-medium-high categorized variable) were measured” AND “Consistency of choices was used as a proxy for direct attribute level understanding” | “These results suggest that the use of words in choice tasks provided more accurate responses than the use of graphics.” Results of questions about ‘level of understanding of the choice task’ and ‘preferences for presentation of the choice tasks’ not presented |
3.1.3 Applied DCEs that Referred to Understanding in the Discussion

Of the 52 applied DCEs identified, four simply referred to the concept of understanding within the discussion [38, 39, 92, 93]. In these studies, understanding was referred to as an indicator of validity of the results. For example, “That all surveyed haematologists completed the self-administered discrete choice exercise without any missing data suggests a clear understanding of the issues involved in this experiment” [39], and “For a small minority, there was a suggestion of counter-intuitive preferences … this may be because of a lack of participant understanding or engagement or the result of an artefact of the survey design” [93].

3.2 Pretesting Studies

Seven studies described the process to develop a DCE—either identifying attributes and levels and/or pretesting the draft DCE instrument with an assessment of understanding [40, 94–99]. Most were published after 2015 and half were conducted in the US. DCE topics covered a range of clinical areas, such as diabetes [40], cancer [99], dermatology [98], and workforce retention [96]. All used qualitative interviews [40, 94–96, 98, 99] and/or focus groups [96, 97].

Most studies focused their assessment of understanding on participants’ understanding of the terminology in the attributes, choice sets, or survey. For example, in their focus group discussions, Helter and Boehler [97] defined understanding as “The final step in the process of attribute development aims to ensure that the desired meaning is evoked and that the terminology is understandable for the respondents”; and Coast and Horrocks [98] report testing participants’ ‘understanding of specific terms’. These types of studies usually presented results descriptively, such as “Names and descriptions of the attributes were adapted throughout the pretesting process to maximise participants’ understanding” [40].

However, some studies also included an assessment of understanding of the choice task itself. In a think-aloud study, Katz et al. [95] found “Most subjects … completed the DCE questionnaire without difficulty; however, not all subjects were fully engaged, and in some cases the interviewer … documented signs of cognitive overload or exhaustion. In a few cases, subjects struggled with the idea of choosing between two hypothetical medications … Most subjects showed good comprehension of the choice tasks and clearly considered two or more attributes in choosing between medications”. Similarly, in their cognitive interviews and focus group discussions, Abdel-All et al. [96] examined multiple aspects of understanding, which they describe as “comprehension (ability to understand the questions as intended), retrieval of information (thinking about the question and
drawing conclusions), judgement and selection of response to the question”. They found “The DCE was well received … and … they did not find it difficult to understand the choice sets presented to them” [96].

One study did not specifically define understanding, but detailed the issues identified during their patient interviews [94]. These included respondents’ understanding of terminology, i.e. “two respondents read the word ‘ability’ as ‘aim’ because these two words are close in Danish. This fact proved to make the attributes difficult to understand and pointed to the need for reframing them”, and understanding the choice task, i.e. “… it became very clear that the included six attributes were too many … and two respondents ended up answering lexicographically or using heuristics with emphasis on the last or the last two attributes, despite not ranking these the highest” [94].

3.3 Studies of DCE Understanding

Sixteen studies were specifically about the concept of understanding in the context of DCEs [9, 10, 18, 27, 41, 42, 100–109]. Published between 2002 and 2019, they were primarily from the UK [18, 27, 101, 105, 108, 109] and Europe [10, 42, 102, 104], and were conducted in a range of clinical areas, including vaccination [100, 102, 104], screening [27, 102, 105] and primary care [18, 101, 103, 106]. All were conducted in the general (or target) population, with the exception of the study by Veldwijk et al. [102], who included both the general population and patient groups, and Ryan and Bate [26] and San Miguel et al., [101] who used only a patient sample. The sample sizes ranged from 19 [105] to 4287 [18]. All included a DCE, with two also including a BWS3 task to compare the two approaches [41, 42].

3.3.1 Qualitative Studies of DCE Understanding

There were six qualitative studies in this group [27, 42, 100, 102, 103, 105]. Two were retrospective investigations of understanding in participants who had previously completed a DCE, and aimed to verify the appropriateness of DCEs as a method in their clinical area [100, 102]. They considered understanding to relate to both the information presented, such as definitions of attributes and levels, and the ‘complex decision strategies’ used when the task is understood. Both studies found that participants appeared to understand the technical information within the choice task, and the choice task itself. For example, “The majority of the participants seemed to have understood the provided information about the choice tasks, the attributes, and the levels. They used complex decision strategies (continuity axiom) and are therefore capable to adequately complete a DCE. However, based on the participants’ age, educational level and health literacy additional, actions should be undertaken to ensure that participants understand the choice tasks and complete the DCE as presumed” [102].

Three papers were prospective think-aloud studies, to assess decision-making processes [103] within a DCE and confirm participants were trading off [105] and choosing rationally [27]. All reported that most, but not all, participants were able to understand the concept of making a choice and make rational trade-offs in line with the assumptions of decision making. For example, one study found some participants reinterpreted the attributes, reacted in different ways to the cost attribute (from dismissing it to considering it a dominant attribute), showed evidence of non-trading, and brought their own experiences to the choice task [103].

The last qualitative study [42] compared the feasibility of DCE and BWS in their clinical context (genetic testing) by interviewing participants about their understanding of the choice format, as well as including a dominant choice set and self-reported difficulty questions. They found respondents completing the BWS task were more likely to report difficulties in both understanding and answering the choice task than those completing the DCE task [42].

3.3.2 Quantitative Studies of DCE Understanding

Among the 16 studies of DCE understanding, 9 were online or paper-based surveys [10, 18, 41, 101, 104, 106–109]. Four of these were designed to compare two different presentation versions of a DCE instrument, such as words or graphics [104], level overlap [107], general presentation format [106], and the impact of number of choice sets on choice difficulty [10]. The other studies examined various assumptions of decision making, such as rationality [101, 108] or dominant preferences [18], or compared a DCE choice task with another choice task—BWS3 [41] or Constant Sum Paired Comparison [109]. These studies measured understanding through consistency of preferences [101, 104, 107], dominated preferences [106, 107], duplicate choice set [107], participant perception of difficulty or format preferences [10, 18, 41, 101, 104, 106, 107, 109], time to complete the survey instrument [18], and survey fatigue [107].

The results were mixed for how task presentation impacts consistency and dominance. While some studies found alternative task presentations could improve consistency [104, 106], others did not [107]. It was noted that participants who reported the task as being difficult were less likely to satisfy tests of rationality such as dominance or consistency [18, 101]. Neither of the studies comparing the ease of DCE completion with other study designs found a significant difference in self-assessed difficulty of the different tasks [41, 109].

Finally, there was one laboratory-based study among the 16 studies of DCE understanding, in which 32 participants undertook a DCE within an eye-tracking system [9]. The
study explored how the number of attributes in the choice scenario impacted attribute non-attendance. Understanding was conceptualised as ‘processing additional information’, and the study found “participants reported being engaged with the survey and although many stated that the choice sets with more information took longer to process, the information itself was not difficult to understand” [9]. However, this paper does not directly link the processing of information or attribute non-attendance with the concept of ‘understanding’ within a DCE.

4 Discussion

This scoping review aimed to identify how the concept of participant understanding is conceptualised in the DCE literature in the health context. We identified 75 DCE and BWS3 studies that included some consideration or assessment of participant understanding. They included 52 applied DCEs, 7 pretesting studies and 16 studies specifically to examine some aspect of DCE understanding.

4.1 How is Participant Understanding Defined Within the Health DCE Literature?

As with many key terms in the DCE literature, there is inconsistency in how participant understanding is defined. It appears that there are two primary ways ‘understanding’ is conceptualised within the health DCE literature. The first is the understanding of the general choice scenario, such as the medical terminology or levels of risk used in the attributes and levels. There has been consistent evidence in the general survey and DCE literature that specialised medical terminology [110] and calculations or presentations of risk and probability [2, 3] are difficult for many people to accurately interpret. This misinterpretation can negatively impact survey responses, including reduced response rates [14] and increased use of simplifying strategies [15], opt out selection [16], non-transitivity of choices [17], and non-trading [18] and missing responses [19]. Our review finds this type of understanding is typically referred to in applied DCE studies and tested using qualitative methods in the pretesting phase of DCE development. However, a growing body of work is examining the influence of alternative presentation formats for concepts and choices, to aid participant understanding and increase the validity of participant responses. Additionally, although not identified in this review, there is also interest in the use of novel presentation formats, such as video [111], to improve the instructions and definitions given to DCE participants. It is possible that having personal experience of the choice scenario may assist with understanding of attributes and complex concepts such as risk, as found in a study of preferences for colorectal cancer screening where previously screened subjects were more likely to pass the rationality test compared with screening-naive subjects [78]; however, to date there is insufficient literature to confirm this.

The second way ‘understanding’ is conceptualised within the DCE literature is the need to understand the concept of making a choice. Our review suggests this is seen in the literature as a key component of the rational decision-making process. This is reliant on participants feeling like the choice is realistic and one that they are ‘qualified’ to make [112], and although it can also be linked to the clarity of instructions and formatting within the survey instrument, it is more often related to the face validity of the decision-making process. Our review found that while this aspect of understanding is addressed in applied DCEs using tests such as duplicate or dominant choice sets, or studied specifically through both qualitative and quantitative methods, there is little consensus of the best way to measure or maximise this component of understanding. Assumptions that participants with good numeracy or health literacy will understand a DCE task also require further investigation.

Rarely seen in the literature in this review was the concept of engagement as a key component to understanding. Both understanding the choice scenario and understanding the concept of making a choice are reliant on participants being willing to engage with the task and process the information. It is clear from general survey literature that people may be more or less willing to engage with survey tasks due to feelings about the relevance or importance of the task [113, 114], personal characteristics (e.g. intellectual capability, attention span) [115], or familiarity with the concepts (such as having done DCE surveys before) [78]. While DCE response rates are often reported and have been associated with DCE complexity and relevance [116], there has been relatively little exploration of a broader conceptualisation of participant engagement as a component of understanding in the context of DCEs, such as dropout rates, time taken, topic relevance, and use of incentives.

4.2 How is Participant Understanding Measured and Used Within the Health DCE Literature?

There appear to be three primary methods to measure or assess participant understanding in the health DCE literature: qualitative methods in pretesting, rationality tests within the DCE, and self-reporting within the DCE. We did not find any studies including econometric approaches, such as the analysis of attribute non-attendance [28] or controlling for inconsistency and fatigue by allowing for unobserved preferences or scale heterogeneity [17, 117]. Regardless of the method used to assess understanding, the reporting of these methods, their results, and the implications for analysis and interpretation are not consistent.
While the use of qualitative methods, particularly in the pretesting phase, are important in developing high-quality DCEs [22], their use does not guarantee understanding during choice task completion. Data collection modes or participant characteristics may differ from pretesting to final rollout [118]. For example, pretesting of attributes and levels is often recommended or conducted using face-to-face interviews, even for paper-based or online DCEs [23]. Similarly, pilot testing may use a sample recruited from a different pool of potential respondents.

There were insufficient details in the included studies to assess whether studies including pretesting for understanding had lower rates of participants failing rationality tests in the final DCE.

Within the DCE instrument itself, quantitative approaches such as duplicate or dominant choice sets are often used to assess rational decision making. Rationality tests or validity checks are frequently cited to assess particular axioms of human decision making [1, 24–26], and exclude irrational, inconsistent or incomplete responses [24, 26, 27]. However, in this review, the meaning and implications of these assessments is described in various ways by different authors, suggesting a lack of clarity around the true purpose and interpretation of these tests. Liu et al. [67] suggested that their proportion of ‘irrational choices’ was “well within the acceptable standard in a DCE”, however these standards are not widely known or used. It also appears that while many studies state they will use the results for exclusion of irrational respondents, this is rarely done in the primary analysis. Using these checks as a sensitivity analysis is consistent with both qualitative [27, 119] and quantitative [24] work, suggesting that ‘failing’ tests such as these does not necessarily reflect irrational or uninformative responses, or a lack of understanding of the task [27, 100, 101, 119].

Finally, self-reported ‘debriefing’ questions are often used to assess understanding within the DCE instrument. Ryan and Gerard [29] found 10 of 34 studies reported the results of debriefing questions around ease of completion; 40% of these studies reported that participants expressed difficulty, ranging from 20 to 35% of participants. More recently, a survey of health DCE authors found about half included debriefing questions, but the wording varied widely and the results were often not analysed or reported [25]. There appears to be limited literature to establish whether self-reported difficulty with a DCE is related to response validity or reliability.

### 4.3 Implications and Next Steps

There is inconsistency in how participant understanding is defined and characterised. This review provides a standardised conceptualisation of participant understanding and how it fits with other key components of DCE reliability and validity (summarised in ‘Supplementary Material B: Definitions of Key Terms in Relation to Participant Understanding’).

It would appear the concept of ‘understanding’ is commonly discussed as an important component of establishing the validity of DCE instruments, and numerous DCEs use pretesting, rationality checks and debriefing questions to measure or improve understanding. Despite this, there are relatively few studies specifically examining the concept of understanding within DCEs and how it can be measured or improved. The studies that do assess the impact of understanding on some aspect of DCE completion are primarily around alternative presentation formats, or design aspects such as the number of alternatives or choice sets. The existing assessments are primarily designed to assess a single aspect of understanding, such as debriefing questions asking about understanding the concept of making a choice, or an indicator for a lack of understanding, such as a dominated choice set. While assessments of rationality in completing a choice task are important, many may capture some aspects of understanding as well as some aspects of task completion that are unrelated to understanding itself, and more work is required to tease apart these concepts. It is likely that to truly capture overall understanding in terms of the choice context, choice task and task engagement, a suite of tests or assessments will be required.

For those conducting DCEs, our results suggest a need to carefully consider which aspects of understanding are critical to the choice context and ensure the methods to improve and assess understanding can be justified. Ensuring DCEs can be understood by participants will allow individuals and groups who may not participate in DCEs if the tool is too complex to have their preferences recorded. Similarly, improved understanding of a DCE instrument will increase the robustness of the results and ideally lead to improved health or healthcare experience for the community under study. For those using the results of DCEs to inform policy or practice, understanding and identifying the importance, potential risks and implications of participant understanding in DCEs may be an important component of interpreting the results, and improved participant understanding may increase the impact of these studies through increased confidence in their results.

There remain several avenues of future research to improve how we conceptualise, measure, and improve participant understanding in DCEs. Figure 2 illustrates how the three components of DCE understanding identified in this review, i.e. understanding the concept of making a choice, understanding the scenario, and being willing to engage, relate to different aspects of the DCE survey and participant. Future research to establish how each of these components relates to the processes of rational decision making by DCE participants and how they can best be measured is required.
and may allow identification of methods or strategies to improve understanding by targeting specific components [30, 120].

The methods to measure or assess understanding identified in this review, i.e. qualitative pretesting, rationality tests, and self-reported debriefing questions, appear to be focused primarily on understanding the scenario or understanding the concept of choosing, with considerable intersection between the two. These (and other) strategies may be mapped to one or more of the components of understanding in Fig. 2, allowing a greater appreciation for the implications of failing these assessments. Ongoing research into the impact of various design features, such as task or risk presentation formats on the different components of understanding, and how they are best assessed is also required [111, 121], along with the value of including psychological instruments [122] and econometric techniques [24]. There remains little literature around the use of debriefing questions within DCEs [25], and an opportunity to develop and test a standardised set of questions that can address the different components of understanding may be useful.

4.4 Strengths and Limitations

This is a broad scoping review of how understanding is conceptualised within the health DCE literature. While this allows a general overview of the topic and is particularly useful as a first examination of the topic, this review has several limitations.

The broad conceptualisation of understanding taken in searching and extracting the literature made it difficult to balance sensitivity and specificity within the search strategy. Given the frequency of ‘understanding patient preferences for …’ statements in the stated preference literature, the search strategy needed to be relatively generic, leading to the need for high levels of manual review and hence potential bias and errors in the study selection and data extraction. There may also be pockets of literature that address the concept of understanding but which use different terminology to describe the concept, and thus were missed in our search.

We also likely did not capture all the applied DCEs that include some aspect of understanding within our search strategy, representing a possible selection bias. This is consistent with the scoping review methodology, where comprehensiveness is not necessarily the goal, and still demonstrates that understanding is often considered and included in applied choice experiments despite having relatively little research around how it is conceptualised or what it means. In addition, we know that many people who include tests of understanding within their DCE do not always analyse or report their results, therefore this is probably an underestimate of the scope of understanding within applied DCEs. We recommend authors to report their approach to and results of assessing understanding, at least in an appendix to their manuscript.

In addition, we did not look at DCE research outside the field of health. There could certainly be methodological papers that have addressed the concept of understanding within DCEs in other topic areas. If this is the case, it is interesting that there has been relatively little carry through to the health context, perhaps reflecting the unique characteristics of choices made about health and healthcare compared with other, less personal or emotional topics.

Finally, using the scoping review methodology means we did not include a formal evaluation of the quality of the evidence, and, by the nature of the study, we are unable to provide a synthesised result or answer to a specific
question [123]. Rather, we provided an overview of the available literature and how it conceptualises understanding [123].

5 Conclusion

While the concept of understanding appears to be an important component of DCE studies in health, relatively few studies specifically examine the concept within their DCEs, or consider how understanding can be measured or improved. Within the health DCE literature, understanding is typically defined in two ways: understanding of the general choice scenario, such as the medical terms or levels of risk, or understanding the concept of making a choice. However, the impact on understanding of participant willingness to engage with the choice task is a gap in the literature.

The most common methods to measure or assess participant understanding in the health DCE literature are qualitative pretesting, rationality tests within the DCE, and self-reported debriefing questions. Regardless of the method used to measure understanding, the reporting of these methods, their results, and the implications for analysis and interpretation are not consistent, and there remains significant scope for further research into each of these methods and how they relate to and address participant understanding.

For those conducting or using the results of health DCEs, we suggest careful consideration of which aspects of participant understanding are most important in the specific choice context, a critical selection and justification of methods to assess understanding, and transparent reporting of these methods and results.

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Conflict of interest Alison Pearce, Mark Harrison, Verity Watson, Deborah J. Street, Kirsten Howard, Nick Bansback and Stirling Bryan declare they have no conflicts of interest.

Ethical approval Ethics approval and/or informed consent were not required for this study.

Registration As a scoping study, registration of this review was not possible in PROSPERO.

Data availability statement The full data extraction dataset is available from the authors on request.

Author’s contribution Initial idea for the study: AP. Feedback on the initial proposal: AP, VW, NB, SB, KH, MH. Confirmation of the inclusion criteria: AP, VW. Full-text reviews completed: AP, NB, MH, KH, DS. Draft manuscript: AP. Critical revision of the manuscript: AP, SB, MH, DS, VW, NB, KH. All authors confirm they have approved the final version of the manuscript to be published and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. Alison Pearce will act as the overall guarantor.

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