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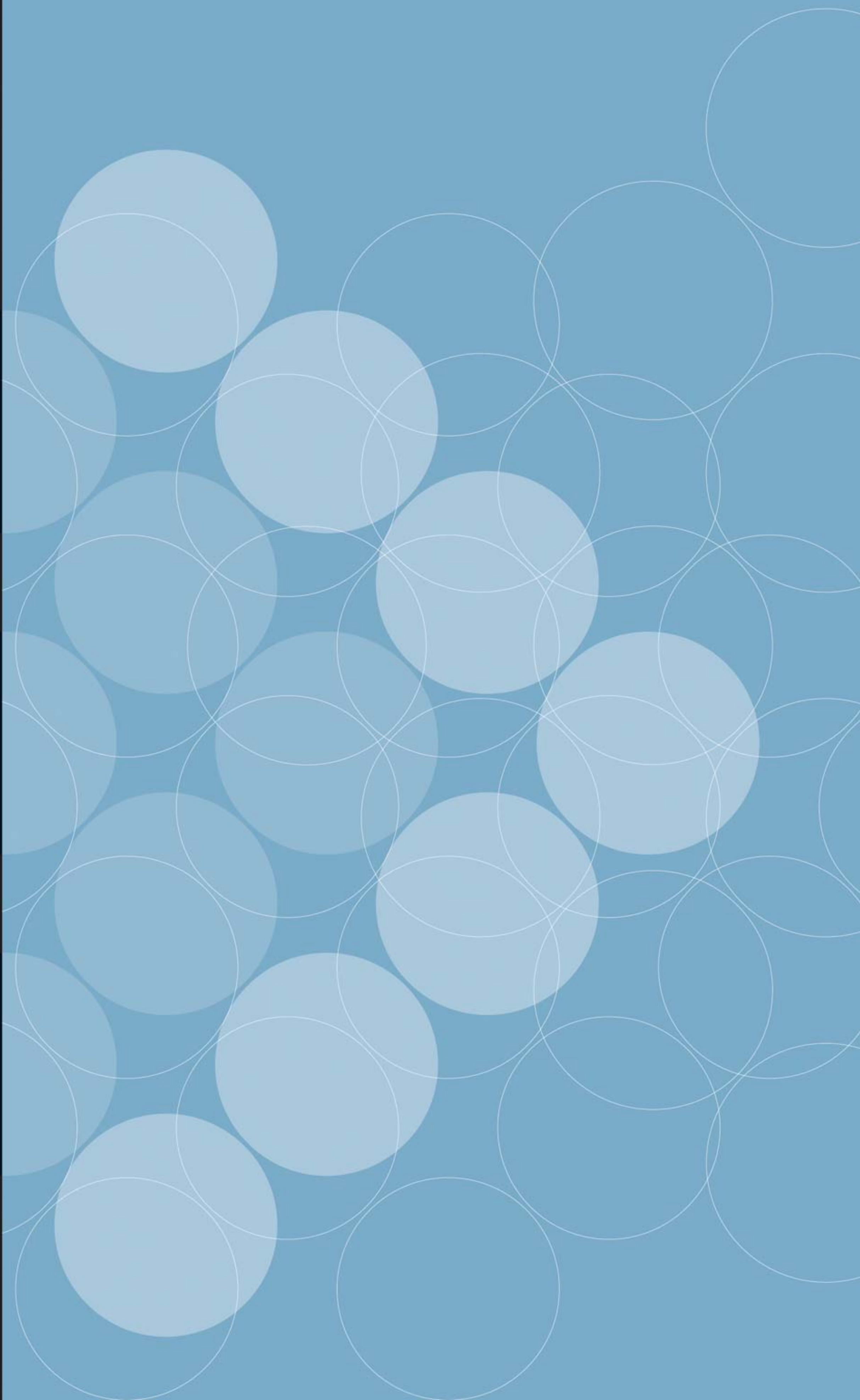

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Use of Discrete Choice Experiments in health economics: An update of the literature*

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Abstract

The vast majority of stated preference research in health economics has been conducted in the random utility model paradigm using discrete choice experiments (DCEs). Ryan and Gerard (2003) have reviewed the applications of DCEs in the field of health economics. We have updated this initial work to include studies published between 2001 and 2007. Following the methods of Ryan and Gerard, we assess the later body of work, with respect to the key characteristics of DCEs such as selection of attributes and levels, experimental design, preference measurement, estimation procedure and validity. Comparisons between the periods are undertaken in order to identify any emerging trends.

* This research was supported by the NHMRC through a Program Grant.

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Abstract

The vast majority of stated preference research in health economics has been conducted in the random utility model paradigm using discrete choice experiments (DCEs). Ryan and Gerard (2003) have reviewed the applications of DCEs in the field of health economics. We have updated this initial work to include studies published between 2001 and 2007. Following the methods of Ryan and Gerard, we assess the later body of work, with respect to the key characteristics of DCEs such as selection of attributes and levels, experimental design, preference measurement, estimation procedure and validity. Comparisons between the periods are undertaken in order to identify any emerging trends.

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Contents

Objective

The aim of this report is to update a previous review (Ryan and Gerard 2003) of discrete choice experiments (DCEs) applied to a health economics context. Studies published from January 2001 are assessed and evaluated with respect to the key characteristics of a DCE such as selection of attributes and levels, experimental design, preference measurement, estimation procedure and validity. This paper is itself an update of Belkar and Fiebig (2004) and so comparisons are made between three periods.

Method

For full details of the methodology applied, see Ryan and Gerard (2003). In brief, a literature search was conducted to identify published studies using DCEs with a health economics application. The following databases were used: Medline, Embase, Social Science Citation Index, PsychINFO, and EconLIT. Note that the HEALTHSTAR and Health Management Information Consortium databases used in the Ryan and Gerard study were unavailable. This is not believed to present a serious problem because almost all the papers reviewed were found in more than one database. The subsequent terms were used to locate suitable studies: ‘conjoint’, ‘conjoint analysis’, ‘conjoint measurement’, ‘conjoint studies’, ‘conjoint choice experiments’, ‘part-worth utilities’, ‘functional measurement’, ‘paired comparisons’, ‘pairwise choices’, ‘discrete choice experiments’, ‘discrete choice modelling’, ‘discrete choice conjoint experiments’, and ‘stated preference’. In addition, papers were identified from the bibliographies of the included studies and selected websites of academic institutions (primarily centres specialising in health economics) to identify discussion papers and conference papers. Only experimental studies grounded in random utility theory (RUT), written in English, applied to health care (as opposed to solely regarding methodology or theory) and based on choice-based response data (as opposed to rating or ranking exercises) were included.

Results

Table 0: History of this review

Stage	*Period Start*	*Period End*	*Months*	*Papers*	*Authors*
I	1990	2000	~120	34	Ryan and Gerard
II	January 2001	June 2004	42	25	Belkar and Fiebig
III	July 2004	August 2007	37	80	Castle and Fiebig

Ryan and Gerard (2003) suggest that stated preference experiments with survey instruments eliciting rankings can be translated into discrete choice experiments for the purposes of analysis. However they did not find any studies which used this method and our experience of ranking-based studies was the same. All the included studies were based on RUT. If a study's focus was chiefly methodological but an original experiment was conducted as a demonstration, discretion was used in the decision of whether to include it.

January 2001 to June 2004

The literature search generated 55 studies (excluding duplicates) based on a health economics framework, the majority being located through the terms 'conjoint analysis', 'discrete choice experiments' or 'stated preference'. Of these, 50 full references were obtained and through a careful reading 29 of these were excluded. The excluded studies were either solely concerned with methodology or theory of DCEs, used ranking or rating based conjoint analysis, adaptive conjoint analysis, or an earlier publication based on the same experiment was already included in this review or was conducted prior to 2001. The remaining 21 studies were included. A further 7 available studies were identified from bibliographies and academic websites, resulting in a total of 28 studies for analysis (see appendix 1). However, 3 of these articles (marked with an asterisk in the appendix) were included in Ryan and Gerard (2003) and so only 25 studies will be included in the analysis of DCEs produced since 2001.

July 2004 to August 2007

The third period included a far greater number of relevant papers. There were 102 papers which cited the 25 papers included in the previous period. In addition, out of the database search 254 papers were selected from several thousand initial search results leaving a total of 307 unique papers.

For the third period a slightly different approach was taken for the database search. After examining the search databases we discovered that reliable results could be obtained by using broader phrases which enclosed several of the existing phrases. For instance 'discrete choice' encloses 'discrete choice experiment'. Any result found by the latter phrase will also be found by the former. Based on this, we restricted the search phrases to 'conjoint', 'functional measurement', 'paired comparison', 'stated preference' and 'discrete choice'. Since the results from these phrases needed to be exhaustively reviewed by hand, using additional terms did not discover any additional papers. Another issue discovered is that the search databases treat plural and singular forms of the same search term differently (in contrast to the case of web search engines). Using a singular term resulted in a larger number of results, but did not include results where the term was only used in plural form. This should not reduce the proportion of relevant papers found in the third period, but if the selected search terms were followed strictly it is possible that some papers were missed in earlier periods.

From the initial list of 307 papers, a reading of the abstracts eliminated a further 167 papers leaving 140 papers to read thoroughly. Full-text copies of six of these papers could not be located and were excluded. A further 54 papers were excluded based on careful reading, leaving the 80 relevant papers covered here.

Background

Table 1 summarises the background details of the DCE studies in the period of 1990-2000 (reproduced from Ryan and Gerard (2003)), from January 2001 to June 2004 and from July 2004 to August 2007. The number of DCE studies produced has clearly increased dramatically since the 1990s. The UK remains the largest producer of DCE studies, however the country of origin has diversified markedly. In the past few years a number of studies have been conducted in low income nations, such as China, Vietnam, Ghana and South Africa. Research conducted in these countries faces challenges particular to DCEs including problems measuring willingness-to-pay (WTP) for respondents with dramatically different incomes. The US has also become more involved, maintaining its share of DCE research even as the field expands rapidly.

Table 1: Background of DCEs

Item	*Category*	*Period*					
		1990-2000		2001-2004		2005-2007	
Total		34	100%	25	100%	80	100%
Country	UK	20	59%	10	40%	24	30%
	Australia	6	18%	5	20%	8	10%
	Denmark	0	0%	5	20%	4	5%
	USA	7	21%	3	12%	15	19%
	Other	1	3%	2	8%	29	36%
Year	1990-1997	8	24%				
	1998-1999	13	38%				
	2000	13	38%				
	2001			2	8%		
	2002			10	40%		
	2003			10	40%		
	2004 [a]			3	12%	13	16%
	2005					23	29%
	2006					33	41%
	2007 [b]					11	14%
Area	Economic evaluation	17	50%	22	88%	53	66%
	Insurance plans	5	15%	0	0%	3	4%
	Other	12	35%	3	12%	24	30%
Source [c]	Patient	10	29%	12	48%	41	51%
	Community	11	32%	4	16%	26	33%
	Other	13	38%	11	44%	22	28%

a. Period from 2001 to 2004 includes papers published prior to July 2004
b. Until August 2007
c. Some papers published after 2001 used more than one preference source so columns sum to more than 100%

The vast majority of studies focused on the economic evaluation of health care products. However, other topics of interest included insurance plans and labour issues (e.g. evaluation of job characteristics of health care professionals). Given the considerable proportion of surveys that evaluated preferences for health care products it is no surprise that a large number of studies surveyed patients. In fact, analysing patients' preferences appears to be a growing trend, with less than a third of studies using patients from 1990 to 2000 compared to half of the studies after 2001. Despite the field's growth, research investigating insurance preferences is very uncommon. The three insurance papers we did discover were related to preferences for national health insurance systems and not particular insurance policies.

When evaluating the benefits of a health product the elicitation of doctors' preferences can be as informative as that of a patient, as it is often doctors' opinions that influence patients' decisions. Given this, several studies did use health care professionals such as GPs and nurses. Obtaining preferences from health care professionals does appear to becoming less common however. In the 2004-2007 period only 14 papers (18%) surveyed health professionals. This trend is matched by discussions within the literature emphasising the importance of understanding patient preferences. In fact, one of the claimed benefits of DCEs is that they facilitate shifting decision-making control from professionals to patients. They allow effective aggregation of patient preferences where previously decisions might chiefly have been based upon opinions of experts.

Ryan and Gerard's original paper did not record any papers that surveyed two populations, but this is a fairly common approach. Although, clearly the distinction between two populations and one population differentiated by some attribute may be fine. Approximately 10% of research papers between 2001 and 2007 surveyed two populations. This was typically a comparison between patients and health professionals or occasionally between patient and community preferences. Explicitly surveying two distinct groups is only one method of comparing sub-populations and it was more common to delineate groups using characteristics of the respondent, such as gender or age. While it was rare for researchers to interact experimental attributes they frequently interacted attribute levels with demographic characteristics. This is no doubt partly because interacting attributes required more complex experimental design, but it was also rare to find a theoretical justification for interacting attributes with each other.

Attribute selection and level setting

The majority of studies from 2001 used existing literature in conjunction with focus groups and consultation with experts and/or patients to decide which attributes were important for decision-making. Although some studies used detailed methods to ensure the levels used encompassed a comprehensive range, some appeared to choose a far more arbitrary range.

Table 2 summarises various aspects of attribute selection, namely the number and nature of attributes. The number of attributes used in the studies published between 1990 and 2000 ranged from 2 to 24 whereas the range was much smaller, only 3 to 11, for the period 2001-2004. In both periods the majority of studies contained six or fewer attributes with a mode of six. This tendency continued in the third stage, with over half the studies having from 4 to 6 attributes. Although there appears to be an assumption that a large number of attributes make the task too complicated, only one study in the second period and no studies in the third period assessed the reliability of responses given a change in the number of attributes (from three to four). In the third period it was common for study designs to follow a specific earlier study or one of several well-known methodological papers (mostly from Louviere, Zwerina or Ryan). Issues such as the number of attributes and the number of levels were rarely discussed in detail and justification for a design was largely deferred to other papers. However, a number of papers did conduct pilot studies and in some cases changed the survey design based on difficulties they encountered.

Table 2: Attribute selection

Item	*Category*	*Period*					
		1990-2000		2001-2004		2005-2007	
Number of attributes [a]	2-3	5	15%	3	12%	18	23%
	4-5	10	29%	11	42%	25	31%
	6	9	26%	6	23%	19	24%
	7-9	4	12%	3	12%	10	13%
	10+	6	18%	3	12%	8	10%
Attributes covered [b]	Monetary measure	19	18%	13	19%	56	12%
	Time	25	24%	13	19%	49	11%
	Risk	12	11%	13	19%	49	11%
	Health status	19	18%	7	10%	101	22%
	Health care	28	26%	7	10%	123	27%
	Other	3	3%	15	22%	73	16%

a. Totals more than 25 for 2001-2004 as one study included two sets of attributes
b. Totals more than the number of studies as each study uses many attributes

In the second period just over half the studies incorporated a monetary attribute such as the cost of a treatment, travel costs or income. The proportion increased slightly in the third period and was included in virtually all cases where a cost attribute was at all realistic. The inclusion of a monetary measure allows for estimation of willingness-to-pay, which is valuable information for new services or for existing services where charging is infeasible. Several papers noted the difficulty in Europe particularly, where patients pay for very little of their own health care. For papers hoping to determine the absolute value of a hypothetical product the experiment required the inclusion of a “opt out” choice. This option was typically the status-quo, which in many cases was a competing form or level of health care provided for free by the government. In these cases determining how valuable a hypothetical product might be is difficult. For instance, one can imagine a DCE where the government hoped to obtain tax-payer valuation of an existing free service, but where “no health care” is not a reasonable “opt-out” choice. This was less of an issue in the US and less developed countries where patients are accustomed to paying for health care.

Where a cost variable was not included, a measure of time frequently served as an indicator of the relative value of other attribute levels. In cases where WTP could be measured this was preferred, but in some contexts it was more appropriate to value trade-offs in one attribute with respect to changes in waiting time. An unusual example of this was found in one paper which suggested patients were willing to wait an additional two hours to see a GP in exchange for accurate information on the expected wait time. There appears to be a definite trend away from time related attributes. In the first period 24% of all attributes were time-related, but by the third only 11% were. Time-related attributes had also been more common than a cost attribute in the first period, but this preference has reversed. As a measure of the utility obtained from other attributes, cost offers a more natural comparison than time and WTP is used even in contexts where actual user fees would be unlikely. Cost is also more likely to be linearly related to utility than is time, at least in the domains relevant to health care. This assumption is almost always made for both cost and time, but may be more reasonable for cost. Other measures of time were also used, such as travel time and life expectancy but these were rare.

Despite problems communicating the impact of changes in risk levels, a number of papers used an attribute related to risk. Risk was usually measured as the chance of success or failure (e.g. chance of side effects, chance of detection) or as a level of certainty (e.g. certainty of budget expenditure). A number of different techniques were used to describe and explain risks to respondents. Especially for marginal changes in the risk of very unlikely events, respondents struggled to comprehend the distinction. Some studies used graphical representations to characterise risk. Others applied risk probabilities to specific situations that might be familiar to the respondent to give them a more concrete sense of the risk involved. Throughout the literature, health professionals were found to be less risk averse than patients. One paper suggested that this may be mostly due to the fact that health professionals are in a better position to observe what a given risk probability translates to in practice. Perhaps because patients may only get “one roll of the dice”, typical or “mean” welfare outcomes are less meaningful to them.

With respect to the studies produced after 2000, measures of health status include severity of symptoms and illness and quality of life measurements. Many studies incorporated several attributes describing different levels of symptoms and side effects under different treatments. The attributes included in the health care category in Table 2 ranges from the overall health care system available (such as availability of vaccines, financing and choice of hospital), to attributes regarding individual care, such as continuity of care and affability of doctors. When compared to the attributes covered in 1990-2000, there was a large disparity with regard to health status and health care. This, however, could be due to the possibility that the classification of attributes belonging to the health care, health status and consequently the other category, may differ between this paper and that of Ryan and Gerard (2003). Some papers merely aimed to assess the relative importance of a long list of health care or health status attributes. A small number of these papers may have had a large impact on the proportional representation of each attribute type.

Experimental design and choice sets

Table 3 describes various aspects of design choice in DCEs. Of those studies that reported the type of design, virtually all used a fractional factorial design. The large number of possible combinations of attributes rendered it impractical to use a full factorial design for all but four studies in the 1990 to 2000 period. Prior to 2005, over half of the designs examined were generated using software packages, the most popular being SPEED and Orthoplan in SPSS. In the third period, this changed somewhat with growing recognition of the complexity of stated preference experimental design. Researchers were much more likely to design the experiment themselves, based on progress in the study of optimal research designs. Here, these studies have been recorded as not reporting the source of their design, however the majority of them used some form of design theory to inform the design process. By far the most common reference was to Zwerina et al (1996) who developed a method for constructing D-efficient choice designs.

Table 3: Experimental design and choice sets

Item	*Category*	*Period* 1990-2000		2001-2004		2005-2007	
Design Type	Full factorial	4	12%	0	0%	8	10%
	Fractional factorial	25	74%	24	96%	70	88%
	Not reported	5	15%	1	4%	2	3%
Design Source	Software packages	19	66%	14	56%	32	40%
	Catalogue	2	7%	2	8%	4	5%
	Expert	4	14%	5	20%	2	3%
	Not reported	4	14%	4	16%	42	53%
Design Plan	Main effects only	25	74%	13	52%	65	81%
	Main effects and selected two-way interactions	2	6%	6	24%	11	14%
	Full factorial	4	12%	0	0%	3	4%
	Not reported	3	9%	6	24%	1	1%
Allocation of scenarios to choice sets	Binary (yes or no)	2	6%	4	16%	7	9%
	Pairwise (random)	15	44%	13	52%	15	19%
	Pairwise (other)	9	26%	4	16%	32	40%
	Greater than 2 choices	5	15%	4	16%	25	31%
	Not reported	3	9%	0	0%	1	1%

In terms of design plan, over half the studies reviewed in the second period used an orthogonal main effects design although there was a growing tendency to include some two-way interactions. In the third period main effects designs dominated the literature even more, which may be partly due to the greater number of researchers constructing their own designs and looking to Zwerina’s preference for orthogonality.

With respect to the construction of choice sets the preferred methods have changed substantially. Pairwise choice sets were used by 68% of studies in the second period and by 80% of the studies in the third period. Increasingly, the process of allocating alternatives to choice sets has become part of the overall design process. Only 19% of studies randomly paired alternatives in the third period.

Clearly there have been few studies employing more than two alternatives per choice set,. Within this ‘greater than two’ choice category, choice sets involving a pairwise choice plus an opt-out option (i.e. choose between A, B or neither) are included. In the 2001-2004 period, three studies (12%) incorporated this opt-out structure. In the last period this increased to 17 studies (21%). In some cases the opt-out choice was a hypothetical situation specified by the researcher, but mostly it represented the status quo for the respondent themselves. A number of studies discussed the problems with forcing a choice between two unappealing alternatives and many recognised that an opt-out offered respondents a more realistic experiment. The binary option is akin to the pairwise choice with an opt-out, only with a single alternative presented.

Measurement of preferences, response rate and comprehension

Table 4 suggests a shift towards smaller experiments in 2001-2004 which reversed in 2005-2007. Shorter surveys were thought to be more valid, because respondents were more likely to think about their responses. However, it seems that respondents are willing to answer longer surveys and the understanding they gain during the survey process improves the quality of their responses. Longer surveys also have obvious efficiency benefits. During 2001-2004, a number of studies used two versions of their survey using a different number of choices so as to test whether respondents’ decisions changed when presented with more choice sets. None of the studies in the last period did this and none mentioned any problems with survey length. However, only a third of the studies in the final period stated that they had measured how long the survey took and only 16% said they asked respondents about difficulties completing the survey.

The bulk of studies from 1990-2000 used self-complete questionnaires and although computer and internet surveys have increased in popularity, the dominance of traditional methods of survey administration has continued. In the third period, self-complete questionnaires were much less likely to be solicited via mail. This can be seen in the statistics for the number of mail reminders, figures only relevant to postal surveys. It is surprising that internet questionnaires have not become more popular in recent years. It may be attributable to the complexity of constructing DCEs because one of the benefits of the internet is it allows researchers to publish questionnaires online quickly and cheaply. The preference for offering all respondents identical surveys also nullifies a key benefit of the dynamic nature of online surveys. It is also likely that the lack of suitable software plays a role in inhibiting the growth of online DCEs.

Table 4: Measurement of preferences, response rate and comprehension

Item	*Category*	*Period*					
		1990-2000		2001-2004		2005-2007	
Number of choices per respondent	8 or less choices	13	38%	15	60%	33	41%
	9-16 choices	18	53%	7	28%	30	38%
	More than 16	2	6%	3	12%	13	16%
	Not reported	1	3%	0	0%	4	5%
Administration of survey [a]	Self-complete questionnaire	27	79%	17	65%	46	57%
	Interviewer administered	3	9%	8	31%	21	26%
	Computer questionnaire	3	9%	1	4%	7	9%
	Internet questionnaire	-		-		7	9%
	Not Reported	1	3%	0	0%	0	0%
Reminders	None	6	22%	1	6%	6	8%
	1-2 reminders	12	44%	8	47%	13	16%
	More than 2 reminders	0	0%	1	6%	3	4%
	Not Applicable/Not Reported	9	33%	7	41%	58	73%
Response rate (%)	90-100	7	21%	2	8%	14	18%
	70-<90	7	21%	4	16%	18	23%
	50-<70	7	21%	10	40%	11	14%
	30-<50	6	18%	5	20%	11	14%
	<30	2	6%	0	0%	5	6%
	Not reported	5	15%	4	16%	21	26%
Ease of task as perceived by subject	Reported	10	29%	3	12%	13	16%
	Not reported	24	71%	22	88%	67	84%
Completion time	Reported	5	15%	6	24%	26	33%
	Not Reported	29	85%	19	76%	54	68%

a. Totals include two studies where there was an option of an interview or questionnaire

The response rates, although wide-ranging across surveys in all three periods, appear to be fairly constant. They were noticeably lower in the second period, but this hasn't become a trend. In the third period there were many studies that did not sample from a defined population so it was not possible to determine a true response rate. Frequently they reported a response rate of 95% or higher, representing the number of respondents who answered the survey accurately. However, in these cases we marked the response rate as "Not Reported" since the statistic was not meaningful. It is discouraging to see that the number of studies that asked respondents to report on ease of completion has decreased significantly. Moreover, despite an increase in the number of studies reporting completion time, the figure is still very low.

Estimation and validity

Table 5 summarises the type of econometric model used to analyse the DCE along with a variety of validity measures to test the accuracy and appropriateness of the DCE. Given the extensive use of binary and pairwise choice sets it is no surprise that the probit and logit are the most commonly used model. In particular, the random-effects probit remains a popular choice model, as it allows for a multiple response structure typical of DCE data. In the third period however, some form of a logit model was the most popular, although it was rare for this to be a pure binomial logit model. More frequently, it was a multinomial logit or a customised logit model. One of these in the latter category used a design of only one choice per respondent but the other failed to account for the multiple respondents characterised in their design.

It appears that the definition of "face" validity used by this paper is different from that used by Ryan and Gerard. In the latter two periods the vast majority of studies were categorised as having face validity, but it is a difficult concept to measure. "Theoretical" validity is similarly imprecise and difficult to measure, so comparison across time is probably not meaningful. We have interpreted face validity as conducting pilot studies prior to the actual experiment and modifying surveys where necessary or consulting with experts and respondents in the formulation of the survey. This process was very common (a strong majority conducted pilot studies) in studies published after 2000. This is in contrast to the period prior to 2001 when only two studies (6%) indicated that such tests were undertaken. However, this may well be due to Ryan and Gerard (2003) defining face validity differently, only including those that conducted pre-pilot studies. The bulk of studies in the first and last periods and all the studies in the middle period considered theoretical validity, at least, by verifying expected signs after model estimation.

The majority of studies tested for lexicographic responses. Rationality and willingness to trade are both simple to test for, although the appropriate response to violations of these assumptions isn't clear. In most cases excluding respondents who violated rationality assumptions or did not trade did not substantively affect the results, so studies that tested for these issues typically included these observations anyway. In the first two periods, only one study tested for reliability (i.e. testing more than once over a time period). The proportion of studies testing for reliability increased in the third period. Studies were also more likely to consider convergence of DCE results with other research methods, although this validity criterion is vaguer than testing for reliability over time. There have been some doubts about the general validity of DCEs and this may have prompted greater concern with ability to generalise from DCE results.

Table 5: Estimation and validity

Item	*Category*	*Period*					
		1990-2000		2001-2004		2005-2007	
Econometric model	Probit/ ordered probit	3	9%	1	4%	5	6%
	Random-effects probit	17	50%	17	68%	21	26%
	Logit (incl. RE logit, MNL)	9	26%	7	28%	32	40%
	Other	3	9%	0	0%	19	24%
	Not reported	2	6%	0	0%	3	4%
Validity	Face	2	6%	20	80%	64	80%
	Theoretical	22	65%	25	All	53	66%
	Convergent	4	12%	4	16%	20	25%
	Rationality	18	53%	14	56%	39	49%
	Compensatory Decision Making	12	35%	8	32%	30	38%
	Reliability	1	3%	0	0%	10	13%

Conclusion

The number of discrete choice experiments for application in healthcare is growing rapidly, with 34 studies being analysed between 1990 and 2000 (3 per year), compared with 25 between 2001 and 2004 (7 per year) and 80 between 2004 and 2007 (27 per year).

Despite the large number of healthcare products and issues being evaluated using DCEs, the methods and design employed are quite similar. Most studies used main effects fractional factorial designs generated from software packages for the purpose of economic evaluation. The majority of studies reviewed presented a small number of pairwise choice sets to respondents in the form of a questionnaire. Attributes are usually chosen based on consultations and a literature review and pilot studies are used to refine the surveys. The use of a random-effects model captures the multiple response structure of the experiment and checking for theoretical validity by comparing parameter signs against a priori expectations is de rigeur.

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Appendix: Studies reviewed

January 2001 to June 2004

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