

Understanding Conjoint Analysis Applications in Health



Sheryl L. Szeinbach, PhD, College of Pharmacy, Ohio State University, Columbus, OH, USA; Spencer E. Harpe, PhD, School of Pharmacy, Virginia Commonwealth University, Richmond, VA, USA; Terry Flynn, PhD, Centre for the Study of Choice, University of Technology Sydney, NSW, Australia; Andrew Lloyd, DPhil, Oxford Outcomes, Oxford, UK; Eberchukwu Onukwugha, PhD, School of Pharmacy, University of Maryland, Baltimore, MD, USA; John F.P. Bridges, PhD, John Hopkins Bloomberg School of Public Health, Baltimore, MD, USA; Axel C. Mühlbacher, PhD, Duke University, Durham, NC, USA, Hochschule, Neubrandenburg, Germany; Elizabeth Molsen, RN, ISPOR, Lawrenceville, NJ, USA

Authors are members of the ISPOR Conjoint Analysis Working Group.

Introduction:

Is There A Demand For Conjoint Analysis (CA) In Health Care Decision Making?

Conjoint analysis (CA) and discrete choice (DC) methods to measure patient and other stakeholder preferences are increasingly used in outcomes research, and even more broadly in health care and medicine. They are used as a means to identify and evaluate the relative importance of aspects of health outcomes and health care services. These methods are used to elicit preferences and values for clinical services, treatment options, and health status from a range of stakeholders, including those of the patient. Regulators and evaluators of health care have also demonstrated an increased interest in understanding what stakeholders prefer and value.

Moreover, patient-preference methods, such as CA, are growing in importance from a policy perspective. The FDA and Health Canada have called for evidence on patient preferences to inform benefit-risk assessments associated with pharmaceutical and device licensing and other regulatory decisions. In Germany, the assessment of patient-relevant benefits is mandatory, thus necessitating the consideration of preference-based outcomes. The Institute for Quality and Efficiency in Healthcare (IQWiG) is conducting a pilot to test the possibility of developing a weighting system for benefits and risks through patient-preference methods.

Despite the success experienced by researchers using CA, the technique is, at best, described by a variety of terms and methodological approaches (including stated preference surveys, discrete-choice analysis, discrete experiments, and choice modeling). This variation in terminology and study design makes it challenging to review papers, and difficult to find studies via standard databases like Medline. Thus, the purpose of this article is to address the history and development of CA and to define terms that are essential for understanding the basic principles and its application in health care and medicine.

The Case for Information on What People Value In Health Care

Conjoint analysis is a statistical method to determine how people value different features that make up an individual product or service. It can be defined as a general approach for measuring the stated preferences of respondents for goods and services, defined over a range of attributes and levels. The objective is to determine what combination of a limited number of attributes (aspects) is most influential on respondent choice or decision making.

If a health care intervention results in several positive effects, as well as some adverse effects, the decision-making body has to judge the implicit trade-offs. Therefore, methods to elicit patient preferences yield endpoints that can be divided into separate parts or sub-dimensions. They can be evaluated with respect to the relative contribution of each dimension for preference, and these endpoints can be combined to generate a summary or global measure for preference. Conjoint analysis in health care allows a more detailed perspective of the decision-making process underlying patient preferences.

Background and Recent History of CA

What is CA?

The notion of conjoint measurement is based on the assumption that the effects of two attributes can be quantified simultaneously if the properties of the valuation of the joint effect allow for summation and ordering [1]. The term "conjoint" refers to the idea that several attributes can be "considered jointly" [2]. In an early review on the topic, Green and Srinivasan found that CA referred to a number of paradigms in psychology, economics, and marketing concerned with the quantitative description of preferences or value trade-offs for a set of alternatives that were pre-specified in terms of levels of different attributes [3,4].

Conjoint analysis and DC experiments were of critical importance in transport economics and have become increasingly important in marketing because they are the only methods that: 1) are consistent with revealed preference data, and 2) can model the decision not to demand.

Like multi-attribute modeling, CA aimed to support decision-makers faced with making numerous and conflicting evaluations. During the early stages of development, it was important for researchers to understand how CA differed from other types of multi-attribute modeling, such as the analytic hierarchy process (AHP), where axioms of the method are not founded in economic theory and are not based on testable descriptions of rational behavior. Expectancy-value theory (further the theory of reasoned action and theory of planned behavior) lead to expectancy-value models evaluating attitudes, beliefs, and norms, where behavior is the outcome variable of interest [5]. The total utility or outcome is usually determined by composing a weighted sum of the attribute ratings.

Conversely, CA typically relies on a de-compositional approach [3]. In early conjoint models, participants were usually presented with a set of profiles, where each profile contained a pre-designed mix of attributes and attributes levels to be evaluated by participants. Preference scores could be obtained either as an average contribution from each of the attributes or as a contribution (part-worth) from each attribute.

Transition to Choice-Based Models

Early CA models provided a significant contribution to the field of decision making, yet researchers still needed to link model predictions to real life economic decisions, typically, the decision to use a good or service. More specifically, there was a need to ground the methods in an underlying behavioral framework with testable predictions.

This occurred when Jordan Louviere and colleagues (see Louviere & Woodworth 1983, for example) capitalized on the work by McFadden that showed choice behavior could be modeled within a regression framework using multi-nominal logit models or probit models, if respondents conformed to a simple theory of decision making called random utility theory [6,7]. These particular tasks in which participants could make a DC between two or more alternatives, came to be called choice-based conjoint (CBC), stated preferences (SP), or discrete-choice experiments (DCE).

Who Is Conducting CA In Health Care?

The extension of CA to the field of health economics and pharmaceutical economics occurred when researchers noted that utility weights obtained using the time trade-off and standard gamble technique [8] could be obtained using a CA approach. With this discovery, DCEs appeared to be well-suited for this application. They have been used in: cost-effectiveness analysis where the process of care was important; in contingent valuation studies to assess willingness-to-accept (pay); to assess health status, quality-adjusted life-years (QALY) and health-related quality of life (HRQoL); and for valuing PROs to assess perceived risk and preference for various treatment options [9-14]. The decision to use CA techniques was determined according to the economic goals for the study and whether health effects were captured on the cost side or as a consequence of a decision process.

Do Cost Considerations Come Into Play?

In cost-effectiveness analysis, DCEs have been used to elicit responses regarding social choices in the context of resource allocation focusing on services [15] and the monetary value of treatment [16]. Because they are consistent with economic theory, choice-based conjoint models to assess willingness-to-pay (WTP) and willingness-to-accept (WTA) have served as a vehicle for eliciting the value placed on alternatives presented in each decision profile. Monetary terms were used to represent value, which were often incorporated into the decision task at pre-determined levels or elicited as direct open-ended responses.

As exemplified from these studies [17,18], the ability to examine incremental changes in quality-adjusted life years (QALY) provided additional information about the estimates regarding stakeholder WTP for emerging programs, treatments, and services. Although these studies have provided a wealth of information from an economic standpoint, the acceptance of these techniques is not without controversy. Much of the discussion focuses on the consideration of costs within budgetary constraints and the use of monetary values in WTP and WTA studies, which has led to numerous discussions including discrepancies, appropriate use, and limitations [19-21].

Can PROs Be Identified And Weighted?

Stated preference (SP) approaches use hypothetical data to estimate preferences for various services, treatments, behaviors, and other outcomes. Contingent valuation and DC experiments are common examples that use a SP approach. Unlike revealed preferences, which are obtained from after-market, large databases, SP techniques use an ex ante approach to obtain preference information. These studies typically examine preferences related to treatment options, risk reduction, health care programs wait times, service delivery, screening programs, and health care resource allocation. Studies have also focused on various disease areas including allergy rhinitis and ADHD, asthma, multiple myeloma, cardiovascular, and osteoporosis [22-24].

Pitfalls of CA: Issues and Options

Although SP approaches provide useful estimates for PRO, the conditions under which these studies are conducted impose certain limitations. It may be difficult to extrapolate decision outcomes beyond the scope of attributes provided in the choice set. In addition, the same perceptual asymmetry that exists between WTA and WTP also apply to the manner in which PRO measures are defined, manipulated, or modified.

Specifically, preference measures need construct validity to determine whether they are capturing the true meaning of preference rather than what preference might be or should be under ideal conditions or under hypothetical situations. For example, the propensity for preferences to change with respect to symptom severity, overall health status, and future circumstances cannot be overlooked in study design. This observation is especially true for cost-effectiveness analyses where multiple interventions and treatment options considered at a societal level may not reflect preferences within subgroups or for specific individuals [25].

Approaches to circumvent some of these issues include segmentation analysis, pretest-posttest assessment, and multitrait multimethod analysis. These approaches, although time consuming, will provide a foundation from which patient-level data can be translated and used more accurately by health care decision makers and other stakeholders for policy analysis. Fortunately, SP approaches will continue to advance as commercial software has removed some of the challenges associated with study design [26-28].

How Will CA Be Used In The Near Future?

Preference data can substantially alter the relative weight and importance of the patient-relevant endpoints used in the HTA. A given clinical measure or endpoint may only capture one aspect of the illness and be only partially related to other significant facets. Mortality and morbidity are frequently claimed to be the most decisive endpoints in clinical trials. With CA there is also the possibility of presenting new insights into patient-centered outcomes through patient preference data. Future studies are needed to support the role of decision-makers, especially as their role becomes more intertwined with global markets and decision-making processes that have implications of international significance regarding insurance coverage, reimbursement, and payment. Results from these studies are also important because they will provide information for government agencies and administrators that ultimately determine the allocation of health care resources.

Acknowledgement

This work was completed by the ISPOR Preference-based Methods in Health Care Special Interest Group (SIG) Conjoint Analysis Working Group. Additional activities from this Working Group can be accessed at the ISPOR website at: <http://www.ispor.org/sigs/PreferenceBasedMethodsConjointAnalysisWG.asp>.

For more information on this topic, see, "Conjoint Analysis Applications in Health – A Checklist: A Report of the ISPOR

Good Research Practices for Conjoint Analysis task Force," at: <http://www.ispor.org/TaskForces/ConjointAnalysisGRP.asp>, or attend the ISPOR Short Course, Conjoint Analysis—Theory & Methods, held prior to the ISPOR 16th Annual International Meeting, Baltimore, MD, on May 22, 2011, or held prior to the ISPOR 14th Annual European Congress, Madrid, Spain, 6 November 2011.

Appendix: Key Terms Used In Conjoint Analysis

Attributes: Product-specific features that are evaluated in the CA. Attributes vary over levels, (e.g., low, medium, high). These are the possible alternatives of that attribute to be considered in the profiles that will be valued in the analysis.

Adaptive conjoint analysis: An interactive CA approach used for preference estimation where the scenarios presented to the respondent are dependent upon the respondent's previous answers. Traditionally, adaptive methods have combined both rating and choice based tasks [29].

Attribute importance: A context-dependent measure related to the degree (weight) to which an individual attribute influences patient values or choices in the CA.

Completeness: A key axiom in economics that states any individual will have a strict preference for any two options presented to them or be indifferent between them.

Best-worst scaling: A preference elicitation technique for a set of items in the choice set that may be objects, attributes, or profiles. Respondents are asked to choose the pair of items that maximizes the difference in the part-worth utilities within a given scenario. The options of preference between the most and least preferred are modeled as a difference model [30], also called "maximum difference" (Max-diff) conjoint [31].

Compensatory: A decision-making approach for item evaluation in a given choice set. Consumers give equal consideration to gains and losses associated with each attribute, allowing for favorable features to compensate for unfavorable features in the conjoint exercise [32].

Compositional approach: The use of attributes and their respective scores usually obtained from a summated or composite scaling measure. These resulting independent measures are used to predict the behavior or variance in the dependent variable or outcome measure.

Conjoint analysis: An evaluation approach that entails trade-offs among attributes. Attribute-levels are decomposed to determine respondent preferences or values for goods or services.

Contingent valuation: An elicitation technique usually consisting of survey techniques. Information on individual preferences regarding and outcome such as preference or welfare change is collected in response to questions related to willingness-to-pay (accept) [33].

Discrete choice or choice-based: A preference elicitation method where respondents make explicit choices among a set of hypothetical choices. Usually respondents choose from a set of two or more options.

Numeric (metric) rating scale: A type of response where the dependent variable is provided in the form of a rating scale. The participant selects a value on the scale (i.e., on the scale 0 to 100), representing the likelihood of acceptance, preference, or risk for the attributes appearing in each scenario or profile.

Fractional-factorial design (Partial fractional design): An experimental design that generates a subset of profiles from all the possible profiles available from the total combination of attributes and attribute levels. This design reduces the number of scenarios that are considered for inclusion in the study by 'aliasing' (deliberately confounding) estimates of higher order interaction terms with the ones (typically main effects and possibly two-way interactions) of interest.

Full-profile approach: A design approach that utilizes the complete array of profiles generated for the conjoint exercise.

Independence of irrelevant alternatives (IIA): An assumption stating that the ratio of the probabilities of choosing one alternative over another (given that both alternatives have a non-zero probability of choice) in the conjoint exercise remains unchanged when additional alternatives are added to the choice set.

Orthogonal: Conditions in the design of conjoint studies where the part-worth estimates are independent of each other so that changes measured with respect to each attribute level are separate from the effects of changes in the other attribute levels.

Pair-wise comparison (or paired comparison): A method for eliciting preferences through the comparison of pairs of choices in order to judge which of each pair has a greater amount of some quantitative property. This method can be used to elicit ordinal preferences or values for subjective phenomena.

Part-worth: The estimate obtained from CA, which represents the preference or utility associated with each attribute and attribute level in the choice set.

Part-worth utility: In a conjoint-based preference model the part-worth is the marginal utility of a given attribute or the additional utility gained from a unit increase in an attribute level. The contribution of an attribute to an individual's level of satisfaction is the part-worth multiplied by the level of the attribute.

Preference: A general concept that assumes when individuals are presented with a range of alternatives within a choice set, they can arrange the alternatives in order from most to least liked.

Profiles: The individual examples that represent the hypothetical group of attributes and attribute levels (i.e., choice set) under consideration by participants for CA.

Profile case: A type of best-worst scaling in which profiles containing the attributes under consideration are presented one at a time. Respondents choose best and worst attributes within each profile according to the levels presented.

Random utility theory: Stated preference methods are based on random utility theory (RUT). RUT assumes all utilities estimated from the attributes and attribute levels have a random (unpredictable) component, but participants use a deterministic decision rule ("pick the most valuable") when selecting among profile options [34, 35]. Also consistent with RUT, the estimates of systematic components should be constant to ensure that the measurement processes under different settings, manipulations, and elicitation are consistent [36]. This broader conceptualization of the RUT framework applies to parameter estimates across different sources of preference data (e.g., some, but not all, types of conjoint studies or other types of stated and revealed preference models, and DC experiments), types of decision tasks, various manipulations of attributes and profile orderings, groups of people, times periods, and geographical locations [37].

Rank: To order choices, representing various attributes and attribute-levels, according to an internally consistent rule.

Rate: To order profiles usually for the dependent variable using some type of standard metric scale containing equal intervals from either 1 or 0 to 100.

Revealed preference: A method of determining preferences through an examination of real world data to determine actual behavior in market-based or economic-based choices.

Stated preference: A method of eliciting preferences through the use of a hypothetical environment (e.g., survey, audio, or interviews) where individuals say what they will do as opposed to what they actually do, as elicited in revealed preference studies.

Willingness-to-accept: A measure of the individual's valuation of and the amount necessary to compensate for the price that an individual is willing-to-accept in compensation for the loss or the reduction of a good or service.

Willingness-to-pay: A measure of the individual's valuation for a benefit (typically a risk reduction) associated with a good or service. Willingness-to-pay can be estimated directly in CA studies by including the cost of the good or service as an explicit attribute, usually within the context of budget constraints [38].

References

1. Luce RD, Tukey JW. Simultaneous conjoint measurement: A new type of fundamental measurement. *J Math Psychol* 1964;1:1-27.
2. Johnson RM. Trade-off analysis of consumer values. *J Mark Res* 1974;11:121-27.
3. Green PE, Srinivasan V. CA in consumer research: Issues and outlook. *J Consum Res* 1978;5:103-23.
4. Green PE, Srinivasan V. CA in marketing: New developments with implications for research and practice. *J Mark* 1990;54:3-19.
5. Fishbein M. An investigation of the relationships between beliefs about an object and the attitude toward that object. *Hum Relat* 1963;16:233-40.
6. McFadden D. Conditional logit analysis of qualitative choice behavior. In P. Zarembka Ed., *Frontiers of Econometrics*. New York: Academic Press, 1974.
7. Street D, Burgess L. *The Construction of Optimal Stated Choice Experiments, Theory and Methods*. New York: John Wiley & Sons, Inc., 2007.
8. Kenney RL, Raiffa H. *Decisions With Multiple Objectives: Preferences And Value Trade-Offs*. New York: John Wiley & Sons, Inc., 1976.

9. Bridges J, Kinter E, Kidane L, et al. Things are looking up since we started listening to patients: Recent trends in the application of CA in health 1970-2007. *Patient* 2008;1:273-82.
10. Ryan M, Gerard K. Using DC experiments to value health care programmes: current practice and future research reflections. *Appl Health Econ Health Policy* 2003;2:55-64.
11. Szeinbach SL, Mason HL, Schondelmeyer SW, Collins PD. Assessing pharmacists' willingness to accept third party prescription contracts using CA. *Health Care Mark* 1990;10:45-50.
12. O'Brien BJ, Goeree R, Gafni A, et al. Assessing the value of a new pharmaceutical: A feasibility study of contingent valuation in managed care. *Med Care* 1998;3:370-84.
13. Johnson RF, Özdemir S, Hauber B, Kauf TL. Women's willingness to accept perceived risks for vasomotor symptom relief. *J Womens Health* 2007;16:1028-40.
14. McIntosh E. Using DC experiments within a cost-benefit analysis framework. *Pharmacoeconomics* 2006;24:855-68.
15. Gyrd-Hansen D, Slothuus U. The citizen's preferences for financing public health care: A Danish survey. *Int J Health Care Finance Econ* 2002;2:25-36.
16. Green C, Gerard K. Exploring the social value of health-care interventions: A stated preference DC experiment. *Health Econ* 2009;18:951-76.
17. Devlin N, Parkin D. Does NICE have a cost effectiveness threshold and what other factors influence its decision? A binary choice analysis. *Health Econ* 2004;13:437-52.
18. Johnson FR, Backhouse M. Eliciting stated preferences for health-technology adoption criteria using paired comparisons and recommendation judgments. *Value Health* 2006; 9:303-11.
19. Grutters JP, Kessels AGH, Dirksen CD, et al. Willingness to accept versus willingness to pay in a DC experiment. *Value Health* 2008;11:1110-9.
20. O'Brien BJ, Gertsen K, Willan AR, Faulkner LA. Is there a kink in consumers' threshold value for cost-effectiveness in health care? *Health Econ* 2002;11:175-80.
21. Redelmeier DA, Rozin P, Kahneman D. Understanding patients' decisions: Cognitive and emotional perspectives. *JAMA* 1993;270:72-6.
22. Mühlbacher A, Nübling M, Rudolph I, Linke HJ. Analysis of patient preferences in the drug treatment of attention-deficit hyperactivity disorder (ADHD): A DC experiment. *BMC Health Serv Res* 2009;9:149.
23. Mühlbacher A, Nübling M. Analysis of physicians' perspective versus patients' preferences: direct assessment and DC experiments in therapy of multiple myeloma. *Eur J Health Econ Epub* January 28, 2010.
24. Mühlbacher A, Lincke HJ, Nübling M. Evaluating patients' preferences for multiple myeloma therapy, a Discrete-Choice-Experiment. *Psychosoc Med* published online December 19, 2008.
25. Brazier JE, Dixon S, Ratcliffe J. The role of patient preferences in cost-effectiveness analysis. *Pharmacoeconomics* 2009;27:705-12.
26. Hensher D, Louviere J, Swait J. Combining sources of preference data. *J Econ* 1999; 89:197-221.
27. Magidson J, Vermunt JK. Removing the scale factor confound in multinomial logit choice models to obtain better estimates of preference. Sawtooth Software Conference, Santa Rosa. Available from: <http://www.sawtoothsoftware.com/download/techpap/2007Proceedings.pdf>. [Assessed March 10, 2009].
28. Louviere JJ, Street D, Burgess L, et al. Modeling the choices of individual decision-makers by combing efficient choice experiment designs with extra preference information. *Journal of Choice Modelling* 2008;1:128-63.
29. Fraenkel L, Bodardus S, Wittink DR. Understanding patient preferences for the treatment of lupus nephritis with adaptive CA. *Med Care* 2001;39:1203-16.
30. Flynn TN, Louviere JJ, Peters TJ, Coast J. Best-worst scaling: What it can do for health care research and how to do it. *J Health Econ* 2007;26:171-89.
31. Szeinbach SL, Barnes JH, McGhan WF, et al. Using CA to evaluate health state preferences. *Drug Inf J* 1999;33:849-58.
32. Johnson EJ, Meyer RJ, Ghose S. When choice models fail: compensatory models in negatively correlated environments. *J Mark* 1989;26:255-70.
33. Nas TF. *Cost-Benefit Analysis: Theory and Application*. Sage Publications, Inc., Thousand Oaks, CA, 1996.
34. Luce RD, Suppes P. Preference utility and subjective probability. In: Luce RD, Bush RR, & Galanter E. Eds., *Handbook Of Mathematical Psychology, Volume III*. New York: Wiley, 1965.
35. Rieskamp J, Busemeyer JR, & Mellers BA. Extending the bounds of rationality: evidence and theories of preferential choice. *J Econ Lit* 2006;44:631-61.
36. Finn A, Louviere JJ. Determining the appropriate response to evidence of public concern: The case of food safety. *Journal of Public Policy & Marketing* 1992;11:12-25.
37. Coast J, Horrocks S. Developing attributes and levels for DC experiments using qualitative methods. *J Health Serv Res Policy* 2007;12:25-30.
38. Horowitz JK, McConnell KE. Review of WTA/WTP studies. *J Environ Econ Manage* 2002; 44:426-47.