doi: 10.1080/23311908.2018.1446254

https://www.cogentoa.com/article/10.1080/23311908.2018.1446254.pdf

Heinonen, *Cogent Psychology* (2018), 5: 1446254
https://doi.org/10.1080/23311908.2018.1446254

cogent psychology

COGNITIVE SCIENCE & NEUROSCIENCE | NEW PERSPECTIVE

Conjoint fMRI method for shortening analysis time

Jarmo Heinonen[1,2*]

Received: 09 November 2016
Accepted: 20 February 2018
First Published: 01 March 2018

*Corresponding author: Jarmo Heinonen, NeuroLab, Laurea University of Applied Sciences, Espoo 02650, Finland; Advanced Magnetic Imaging Centre, Aalto University School of Science, 00076 AALTO, Finland
E-mail: jarmo.heinonen@laurea.fi

Reviewing editor:
Benny Briesemeister, Neurospective GmbH, Germany

Additional information is available at the end of the article

Abstract: Neuromarketing objective is to understand the functioning of the human decision-making of the brain. The first neuromarketing research was performed by Read Montague in 2003 and Harper Collins added the word neuromarketing to its dictionary in 2005. The most promising way to perform neuromarketing studies are based on fMRI. The fMRI modality is based on using an MRI scanner to image the change of blood flow in the brain. However, participants cannot stay for long inside the fMRI tube and thus it is necessary to improve on the methodology to shorten the research time. One answer to the problem is the conjoint analysis, that short the time and resulting more attributes to analyze products and services. Conjoint tasks may be viewed as multiattribute decision problems, and conjoint analysis is partly a multiattribute model for measuring consumer attitudes and preferences. Connected conjoint fMRI is very efficient way to analyze neuromarketing studies.

Subjects: Neuroscience; Mathematics & Statistics; Behavioral Sciences; Economics, Finance, Business & Industry

Keywords: fMRI; conjoint; neuromarketing; consumer Neuroscience and Neuromarketing

1. Introduction

The term “neuromarketing” was coined in 2002 by Smidts (2002) but it was a Coca Cola vs. Pepsi study (McClure et al., 2004) that attracted the attention of marketers around the world. Most decision alternatives consist of multiple reward-related attributes and to make an optimal choice the reward predictions of all attributes need to be integrated into a combined value (Kahnt, Heinzle, Park, & Haynes, 2011). Marketing researchers often characterize brands by a set of concrete features and attributes (Al-Kwifi, 2016). However, the brain is overwhelmed by processing information when

ABOUT THE AUTHOR

Jarmo Heinonen, principal lecturer, PhD (Education), Lic Sc (Marketing) specializes in food economy, marketing and methodology related to human choice and decision-making. He is involved in the projects as a methodological expert. Heinonen has been helping over than 250 companies with their problems for several years and managed projects and research endeavors.

PUBLIC INTEREST STATEMENT

Functional Magnetic Resonance Imaging (fMRI) is a very effective tool in neuromarketing. However, time limits, subject fatigue, fMRI costs, and participants' concentration are problematic. Conjoint analysis and its cards enable shortening the time and providing more attributes for evaluation. Conjoint analysis models of orthogonal matrices keep the amount of conjoint cards to a minimum which shortens the time spent in the fMRI machine and thus lowering costs. All conjoint cards are different and keep subjects concentrated during the test. fMRI is an efficient analyzing method of neuronal architecture and functions for the identification of the brain areas and networks. Conjoint analysis and fMRI are strong, combined methods to analyze customer needs and desires.

comparing the usefulness of a product relative to another one. Thus, an analysis to shorten acquisition time in fMRI experiments is needed.

The most promising way to perform neuromarketing studies is based on fMRI because of its capacity for localization in the brain. While EEG, MEG, and other research methods reveal information on how brains are functioning as measured outside the skull, fMRi reflects processes inside the skull. MEG has excellent temporal resolution, and a better spatial resolution than EEG. Like EEG, however, MEG is somewhat limited to picking up activities on the surface of the brain, and it is not an appropriate method for imaging subcortical areas. The fMRI modality is based on using an MRI scanner to image the change of blood flow in the brain. The key element is the blood oxygen level-Dependent (BOLD) contrast as measured by the fMRI. When experiencing a particular stimulus, areas of the subject's brain receive more oxygenated blood flow compared to during resting time. This change creates distortions in the magnetic field emitted by protons in the water molecules of our blood. The basis for all fMRI studies is to maintain that the change in the BOLD signal is an accurate measure of neuronal activity. fMRI has the major advantage of being able to image deep brain structures, especially those involved in emotional responses (Morin, 2011).

A disadvantage of the fMRI measurement procedure is that participants cannot stay for long inside the fMRI tube and thus it is necessary to improve on the methodology to shorten the research time. One answer to the problem is conjoint analysis, which both shortens the time needed for the test and allows more attributes to analyze regarding products and services. Conjoint analysis provides a methodology for operationalizing the conceptual basis in a conjoint measurement framework (DeSarbo, Huff, Rolandelli, & Choi, 1994). Conjoint tasks may be viewed as multiattribute decision-making problems (Krantz & Tversky, 1971), and conjoint analysis is partly a multiattribute model for measuring consumer attitudes and preferences. The conjoint model is decompositional; it measures overall preference and decomposes this into inferred subcomponents (Novak, 1996). Conversely, a pure multiattribute model is compositional; it builds up an inferred overall attitude as the sum of measured subcomponents. There are computer programs which are easy to use in fMRI with conjoint cards. In full factorial designs, all possible attribute combinations can be found in the attribute profiles. By contrast, in fractional factorial designs, only a fraction of the master design is reflected in the attribute profiles (Bont, 1992, p. 30).

As Finn (1985) explains, benefit refers to an individual's estimation of the amount of utility which will be supplied by a particular product. The product's whole utility can be seen as a bundle of attributes (Lancaster, 1966). Emphasis on attributes can be understood against the fact that most of the research has concentrated on measuring beliefs and attitudes related to different brands and it is the differences between brands that can be analyzed at the level of attributes. It has even been suggested that salient beliefs tend to take the form of the perceived consequences of using that brand (Lutz, 1975). These consequences give meaning to the attributes. Besides the benefits derived from the use and consumption of a product, the possessing and collecting of this product can also serve as a source of benefits (Belk, 1982). Beliefs about brand attributes are directed by the assumed consequences gained from consuming that product. The attributes do not have a meaning in themselves but only to the degree that they serve as a means for achieving the desired consequences (Rajaniemi, 1992, p. 145). Taylor found that involvement is anchored not to a product itself, but to purchasing or using the product (Taylor, 1981).

At the lowest level of abstraction, Rajaniemi (1992, p. 138) finds the concrete attributes of the product. Concrete attributes are cognitive representations that reflect the physical features of the product relatively directly. Abstract attributes are more subjective representations of product or brand characteristics, which stand for several more concrete attributes. Product attributes have no relevance in themselves, but they receive their meanings from their ability to provide favorable consequences and values to avoid negative ones.

2. Conjoint analysis

In conjoint analysis studies, respondents are invited to evaluate stimuli consisting of sets of attribute levels or attribute-level combinations. Conjoint measurement has primarily been concerned with the conditions under which there exist measurement scales for both the dependent and independent variables, given the order of the joint effects of the independent variables and a prespecified composition rule (Green & Srinivasan, 1978), as practiced by mathematical psychologists. According to Lancaster (1966), goods are treated as tied packages of characteristics or attributes.

Sets of attribute levels may be based more strongly on direct consumer input. Thus, the attributes should include those most relevant to potential customers and those which satisfy the managerial constraint (Cattin & Wittink, 1982). In contrast Olshavsky and Granbois (1979) mention that consumers do not generally seem to seek and process large amounts of information when dealing with problems related to consumption and purchasing, and that an extensive problem-solving process is quite unusual even in connection with major durable appliances (Rajaniemi, 1992, p. 7). According to Munson (1984, p. 16) values have sometimes been defined as being equivalent to and/or synonymous with needs, beliefs or motives.

When inviting participants to evaluate attribute-profiles in the fMRI, it is better to restrict the attribute-level information to a maximum of 5 to 6 attributes (Green & Srinivasan, 1978). Conjoint cards decrease the time spent in fMRI with subjects evaluating the attributes, because of the orthogonal matrix. Attributes in the conjoint cards can be figures, words, pictures, or any kind of material subjects that can be evaluated in the fMRI.

The most important goal of a conjoint-analysis study is to determine individual preference structures. The decision can be taken to develop a particular concept i.e. a combination of attributes. Implicitly, these decisions are based on the assumption that a product which consists of the optimal combination of attributes for a particular group of respondents is introduced into the market and then it will be preferred to all other alternatives on the market.

There are quite many conjoint analysis tools in the market, such as ACA (Adaptive Conjoint Analysis), SPSS Categories, Survey Analytics Conjoint Module, QPR Market Maker, XLSTAT full profile conjoint analysis, and 1000 Minds Conjoint analysis.

3. The role of conjoint analysis

Conjoint analysis has often been identified as a relevant method in the new product development process (Vriens, 1995). Conjoint analysis is also well suited to the implementation of selected types of market segmentation and conjoint analysis has been used in the statistics and machine learning literature for model selection (Evgeniou, Boussios, & Zacharia, 2005; Evgeniou, Pontil, & Toubia, 2007) and multipart pricing (Iyengar, Jedidi, & Kohli, 2008). Conjoint analysis is a stated-preference survey method that can be used to elicit responses that reveal preferences, priorities, and the relative importance of individual features (Hauber et al., 2016). An effective model of consumer preference needs to take into account both form and function and the fact that emotion can be a factor in the way consumers prioritize esthetics against performance (Sylcott, Cagan, & Tabibnia, 2013) The focus of a conjoint analysis (Green & Srinivasan, 1978) is squarely on the measurement of buyer preferences for product attribute levels, including price, and the buyer benefits that may flow from the product attributes.

The conjoint analysis is a micro-based measurement technique. Part-worth functions (preferences for attribute levels) are measured at the individual level. Hence, if preference heterogeneity is present, the researcher will identify it. The conjoint studies typically entail the collection of respondent background information (demographic data, psychographic data). One should bear in mind, however, that buyer background variables, particularly demographic ones, do not necessarily correlate well with attribute preferences (Moore, 1980). Increasingly, background data include information collected on the perceived importance for respondents of purchase or use occasions.

Even rudimentary conjoint studies usually include a buyer choice simulation stage in which the researcher can enter new or modified product profiles and find out who chooses them versus those of competitors. Wind (1978) calls this approach flexible segmentation.

Gabor and Granger (1966) successfully tested several hypotheses about customer behavior in markets where a product's quality was inferred from its price. Gabor and Granger found that any given customer has a price range within which he or she will consider purchasing a product. A brand's prices below that acceptance range will be rejected by the consumer as being too shoddy. Similarly, brands priced above the range will be rejected as being too expensive. The minimum and maximum price acceptable differs from person to person. However, for a homogenous group of customers, the minimum or the maximum price that the customer is willing to pay for the product is a normally distributed random variable. Further, the standard deviations of the log distributions for the minimum and maximum prices are the same.

4. Orthogonality

An orthogonal array is a subset of all of the possible combinations that still allows estimation of the part-worths for all main effects. In virtually all conjoint applications reported in the literature, orthogonal arrays are used to implement full profile presentations (Green, Helsen, & Shandler, 1988; Green & Srinivasan, 1978, p. 392). Huber (1987) has suggested that the use of orthogonal designs may provide a higher degree of robustness over various task simplifications, e.g. ignoring levels and/or entire attributes that subjects may employ in coping with the job of profile evaluation. The orthogonal contrasts define effects and interactions that can be readily determined from a table of orthogonal polynomials. The use of orthogonal contrasts arises from the fact that orthogonal polynomials are so constructed that any term of the polynomial is independent of any other term. This independence permits one to compute each regression coefficient independently of the others and also facilitates testing the significance of each coefficient (Green & Rao, 1971; Green & Srinivasan, 1978). Importantly, the combined value and the variability are orthogonal and thus both variables can be decoded independently of each other (Kahnt et al., 2011) enabling analysis of multiple-attribute character and also single-attribute decisions from the brain simultaneously.

For example, if we have three main attributes and they all have five attribute levels, 243 combinations would result (=3^5). The problem of ranking or otherwise evaluating 243 objects is by no means easily resolved. In a factorial design 3^5 would still require 81 combinations. On the other hand, an orthogonal array of only 27 combinations could test the main effects for even a 3^{13} factorial design (Green, 1984). Orthogonality helps to decrease the number of questionnaire cards. The use of fractional factorial designs is a very common way to avoid respondent fatigue. Since the number of profiles presented increases multiplicatively with the number of attributes and levels, an approach that reduces the task for respondents seems attractive (Reibstein, Bateson, & Boulding, 1988). As respondents may experience fatigue in the fMRI tube, because they do not want to lie too long in a noisy and closed environment, orthogonality in conjoint cards helps shorten the time spent in the fMRI tube.

5. fMRI and the brain

Bechara and Damasio (2005) and Hsu, Bhatt, Adolphs, Tranel, and Camerer (2005) show that the evaluation of ambiguous as opposed to risky choices involves different areas of the brain. Among the regions more active under conditions of ambiguity as opposed to risk are the amygdala, the OFC and the dorsomedial PFC. The dorsolateral striatum is preferentially activated during the risky condition. As the dorsal striatum is implicated in reward prediction, the result indicates that ambiguity reduces the anticipated reward for decisions. According to Overskeid (2000), people opt for the solution which feels the best and reduces the fear of the unknown when facing doubt, which lies at the root of intuitive decision-making. However, even if people pride themselves on being rational and logical, they cannot defuse their emotions.

An experiment confirmed that just increasing all the catalog prices and the spending allowance by the same high proportion correlated with greater activation in the VMOFC – the brains' reward processor (Weber, Rangel, Wibral, & Falk, 2009, pp. 145–146). Coricelli et al. (2005) point to the role of the OFC which is strongly involved in both the experience and the anticipation of regret – an affective response upon learning what would have happened if a different decision was made.

Structures like the NAcc and the anterior regions of the ventral striatum excite correspondingly with the anticipation of pleasant events, whereas simulation of painful future events distinctively activates the amygdala and/or the posterior ventral striatum (Yacubian et al., 2006). However, Engelmann, Capra, Noussair, and Berns (2009) noticed in a laboratory experiment that the subjects demonstrated lesser activity in the areas involved in calculating the effects of the probability on the expected pay-off. The affected network comprised the ACC, DLOFC, thalamus, medial occipital gyrus, and the anterior insula. Also Seymour and McClure (2008) argue that there is a connection in that people tend to value options and prices in relative rather than absolute terms and display strong sensitivity to exemplar and price anchors on the one hand and the functioning of the reward processing in the brain on the other. The relative valuation method may be necessary to represent values accurately, given the limits of neuronal coding. The fluctuating perceptions of value may reflect the role of expectations in determining value based upon all the available information as confirmed by recent findings. The relevant studies point to the PFC, striatum, and VMPFC when it comes to scaling of value (Seymour & McClure, 2008).

Kahnt et al. (2011) used Multi-Attribute Utility Theory (MAUT) and fMRI in their study and found that multi-attribute objects are encoded in different brain regions the vmPFC and the dlPFC whereas the combined value is represented in the vmPFC the variability of the reward predicting of the individual attributes is encoded in the dlPFC. A previous study identified a network of brain regions including the medial PFC, and the dlPFC which was involved in multi-attribute decision-making (Zysset et al., 2006). There is an important difference between conjoint analysis and the multi-attribute model. The multi-attribute model is compositional; it builds up an inferred overall attitude as the sum of measured subcomponents. The conjoint model is decompositional; it measures the overall performance and decompose this into inferred subcomponents (Novak, 1996). However, using conjoint analysis, the findings by Kahnt et al. (2011) might lead to similar results. Goucher-Lambert and Cagan (2015), Goucher-Lambert, Moss, and Cagan (2017) and Chen, Iyengar, and Iyengar (2017) have used the same kind of conjoint analysis fMRI model in researches.

The mechanism of self-regulation in the human brain has only begun to be understood. It is normally implemented by a neural circuit comprising various prefrontal regions, including the VLPFC, and the subcortical limbic structures including the amygdala and striatum. Based on an extensive literature review, Cohen and Lieberman (2010) concluded that the VLPFC is engaged when a person attempts self-control regardless of whether it comes to motor response inhibition, dominating one's risky behavior, delaying gratification, regulating emotion, inhibiting memory, or suppressing thoughts.

6. How can conjoint fMRI be of advantage?

Certainly, avoiding intellectual exhaustion or reducing its scope is crucial for decision-makers regardless of the context. Intriguing for our purpose are the consequences of consumer decision-making while in the depleted state. It has been argued that in such a case, consumers have a tendency to conserve effort and are less inclined to compromise. They concentrate on just one attribute (e.g. the lowest price), use only partial information, succumb to the dominance effect, or simply preserve the status quo and do not make a selection (Masicampo & Baumeister, 2008). The exhaustion may be avoided in fMRI with conjoint analysis and its orthogonality in cards. The salient attribute can be identified from all attributes, such as, for example, price.

By investigating market structures and wider external opportunities, management can become aware of the necessity to adapt its current product policy (Box & van Eyk, 1983). Johne (1985) states that it would be particularly advantageous to explore as many viable new-product concepts as possible, as a safeguard against expensive and embarrassing mistakes. Petty, Cacioppo, and Schumann (1983) discuss the effects of lack of ability and/or lack of motivation on the processing of product information. In psychological approaches, the perception of the attributes, not the attributes themselves, is seen to be of prime importance (Anderson, 1981; Holbrook, 1994).

In fMRI BOLD cluster size may indicate high utility scores in conjoint cards' full factorial model attribute levels, meaning that we can hypothesize a connection between cluster size and the summarized attribute utility scores. This means that more could be seen than the reaction to stimulus from the screen in the fMRI tube. There are different kinds of stimulus from picture, attribute, a word, video clip, song, something to taste or something to smell and all these stimuli show different kinds of markers in the brain. That is why utility scores from conjoint cards could be from different kinds of sources, as mentioned above.

We can separate all the attributes from conjoint cards into different kinds of pieces and particles. According to Lancaster (1966), things are bundles of attributes and at the same time these attributes can be evaluated separately. We can evaluate how these attributes give meanings for the whole product. However, we cannot find out from the study of brain activity how intensively these products and their attributes affect. We might simultaneously hate (amygdala) a product we would like to have (striatum). For example, a child might be afraid of Darth Vader (the villain in the Star Wars film) and the activity is registered in the amygdala, but would like to have Darth Vader costume at the same time (striatum activity). Together conjoint and fMRI can reveal how much the customer likes the product and if changes should be made to the marketing strategy.

A value of central importance or with many connecting linkages to an individual's knowledge base is likely to be definable only in very broad, global terms. Consequently, measurement of such a variable and its influence is likely to be difficult to operationalize for a study in a specific situation. The level of specificity designed into a value measurement instrument is a critical component. Measures that are too general may not indicate a strong relationship to behaviors of interest. Conversely, measures that are too specific may be measuring some other psychological construct besides values (Sherrell, 1984, p. 171). According to Munson (1984, p. 16) values have sometimes been defined as being equivalent to and/or synonymous with needs, beliefs, or motives. However, consumer behavior researchers have quite often interpreted "value" to denote "product attribute," which is clearly too specific to fulfill the definition given to values (Rajaniemi, 1992, p. 141). Because most companies are (as yet) unable to link engineering/operations attributes to customer perceptions of services through statistical models, managers tend to prefer survey items that reflect a compromise between language that is meaningful to customers and language that seems actionable to managers. According to Olson and Reynolds (1983) although people are assumed to acquire different kinds of knowledge about a consumption object, it is general semantic knowledge about the characteristics of an object, i.e. beliefs about product attributes, that has most often been studied in consumer behavior. Beliefs have usually been treated as an evaluation of the attribute possession of an object. This means that the level of abstraction of product knowledge has been low, and is viewed mainly as a direct representation of the object in question. Certainly, avoiding intellectual exhaustion or reducing its scope is very crucial for the decision-makers regardless of the context (Heinonen, 2016). Using conjoint fMRi will be of assistance in identifying those attributes that are relevant for selling the product.

Funding
The author received no direct funding for this research.

Competing interests
The authors declare no competing interest.

Key terms and definitions
In conjoint analysis **conjoint cards** have been used to collect material from participants. These cards have **attributes,** or characteristics from service, gadget, or marketing target. **Conjoint analysis** means different kind of mathematical methods to evaluate attributes utility for participants. **Utility scores** are summarized from conjoint cards and are estimations of their values.

Author details
Jarmo Heinonen[1,2]
E-mail: jarmo.heinonen@laurea.fi
[1] NeuroLab, Laurea University of Applied Sciences, Espoo 02650, Finland.
[2] Advanced Magnetic Imaging Centre, Aalto University School of Science, 00076 AALTO, Finland.

Citation information
Cite this article as: Conjoint fMRI method for shortening analysis time, Jarmo Heinonen, *Cogent Psychology* (2018), 5: 1446254.

References

Al-Kwifi, S. O. (2016). The role of fMRI in detecting attitude toward brand switching: An exploratory study using high technology products. *Journal of Product & Brand Management, 25*(2), 208–218. doi:10.1108/JPBM-12-2014-0774

Anderson, N. H. (1981). *Foundations of information integration theory*. New York, NY: Academic Press.

Bechara, A., & Damasio, A. R. (2005). The somatic marker hypothesis: A neural theory of economic decision. *Games and Economic Behavior, 52*, 336–372. https://doi.org/10.1016/j.geb.2004.06.010

Belk, R. W. (1982). Acquiring, possessing, and collecting: Fundamental processes in consumer behavior. In *Marketing theory: Philosophy of science perspectives* (pp. 185–190). Chicago, IL: American Marketing Association.

Bont, C. J. P. M. (1992). *Consumer evaluations of early product-concepts*. Delft: Delft University Press.

Box, J. M., & van Eyk, G. H. (1983). Industriele produktontwikkeling en marktonderzoek. In *Handboek Marketing* (pp. 13–34). Kluwer.

Cattin, P., & Wittink, D. R. (1982). Commercial use of conjoint analysis: A survey. *Journal of Marketing, 46*(3), 44. doi:10.2307/1251701

Chen, Y., Iyengar, R., & Iyengar, G. (2017). Modeling multimodal continuous heterogeneity in conjoint analysis? A sparse learning approach. *Marketing Science, 36*(1), 140–156. doi:10.1287/mksc.2016.0992

Cohen, J. R., & Lieberman, M. D. (2010). The common neural basis of exerting self-control in multiple domains. *Society to Brain: The New Sciences of Self-Control* (pp. 141–162). New York, NY: Oxford University Press.

Coricelli, G., Critchley, H. D., Joffily, M., O'Doherty, J. P., Sirigu, A., & Dolan, R. J. (2005). Regret and its avoidance: A neuroimaging study of choice behavior. *Nature Neuroscience, 8*(9), 1255–1262. doi:10.1038/nn1514

DeSarbo, W. S., Huff, L., Rolandelli, M. M., & Choi, J. (1994). Service quality: New directions in theory and practice. In *On the measurement of perceived service quality: A conjoint analysis approach* (pp. 201–223). Thousand Oaks, CA: SAGE Publications. Retrieved from http://knowledge.sagepub.com/view/service-quality/n9.xml

Engelmann, J. B., Capra, C. M., Noussair, C., & Berns, G. S. (2009). Expert financial advice neurobiologically "offloads" financial decision-making under risk. *PLoS One, 4*(3). doi:10.1371/journal.pone.0004957

Evgeniou, T., Boussios, C., & Zacharia, G. (2005). Generalized robust conjoint estimation. *Marketing Science, 24*(3), 415–429. doi:10.1287/mksc.1040.0100

Evgeniou, T., Pontil, M., & Toubia, O. (2007). A convex optimization approach to modeling consumer heterogeneity in conjoint estimation. *Marketing Science, 26*(6), 805–818. doi:10.1287/mksc.1070.0291

Finn. (1985). A theory of the consumer evaluation process for new product concepts. In *Research in Consumer Behavior* (1st ed., Vol. 1985, pp. 35–65). JAI Press.

Gabor, A., & Grange, C. W. J. (1966). Price as an indicator of quality: Report on an inquiry. *Economica, 46*(2), 141–150.

Goucher-Lambert, K., & Cagan, J. (2015). The impact of sustainability on consumer preference judgments of product attributes. *Journal of Mechanical Design, 137*(8), 081401. doi:10.1115/1.4030271

Goucher-Lambert, K., Moss, J., & Cagan, J. (2017). A meta-analytic approach for uncovering neural activation patterns of sustainable product preference decisions. In J. S. Gero (Ed.), *Design computing and cognition '16* (pp. 173–191). Cham: Springer International Publishing. Retrieved from http://link.springer.com/10.1007/978-3-319-44989-0_10 https://doi.org/10.1007/978-3-319-44989-0

Green, P. E. (1984). Hybrid models for conjoint analysis: An expository review. *Journal of Marketing Research, 21*(2), 155. doi:10.2307/3151698

Green, P. E., Helsen, K., & Shandler, B. (1988). Conjoint internal validity under alternative profile presentations. *Journal of Consumer Research, 15*(3), 392–397. https://doi.org/10.1086/jcr.1988.15.issue-3

Green, P. E., & Rao, V. R. (1971). Conjoint measurement for quantifying judgmental data. *Journal of Marketing Research, 8*(3), 355. doi:10.2307/3149575

Green, P. E., & Srinivasan, V. (1978). Conjoint analysis in consumer research: Issues and outlook. *Journal of Consumer Research, 5*(2), 103–123. https://doi.org/10.1086/jcr.1978.5.issue-2

Hauber, A. B., González, J. M., Groothuis-Oudshoorn, C. G. M., Prior, T., Marshall, D. A., Cunningham, C., … Bridges, J. F. P. (2016). Statistical methods for the analysis of discrete choice experiments: A report of the ISPOR conjoint analysis good research practices task force. *Value in Health, 19*(4), 300–315. doi:10.1016/j.jval.2016.04.004

Heinonen, J. (2016). Conjoint analysis with fMRI: A novel analytical approach to neuromarketing. *Neuroeconomics and the Decision-Making Process, 2016*, 16. https://doi.org/10 4018/978-1-4666-9989-2 ch009

Holbrook, M. B. (1994). The nature of customer value: An axiology of services in the consumption experience. In R. T. Rust & R. L. Oliver (Eds.), *Service quality* (pp. 21–71). Thousand Oaks, CA: SAGE Publications.

Hsu, M., Bhatt, M., Adolphs, R., Tranel, D., & Camerer, C. F. (2005). Neural systems responding to degrees of uncertainty in human decision-making. *Science, 310*(5754), 1680–1683. doi:10.1126/science.1115327

Huber, J. (1987). Conjoint analysis: How we got here and where we are. In *Proceedings of the Sawtooth Software Conference on Perpetual Mapping, Conjoint Analysis, and Computer Interviewing* (pp. 237–252). Ketchum, ID: Sawtooth Software.

Iyengar, R., Jedidi, K., & Kohli, R. (2008). A conjoint approach to multipart pricing. *Journal of Marketing Research, 45*(2), 195–210. doi:10.1509/jmkr.45.2.195

Johne, F. A. (1985). *Industrial product innovation, organization and management*. London: Groom Helm.

Kahnt, T., Heinzle, J., Park, S. Q., & Haynes, J.-D. (2011). Decoding different roles for vmPFC and dlPFC in multi-attribute decision making. *NeuroImage, 56*(2), 709–715. doi:10.1016/j.neuroimage.2010.05.058

Krantz, D. H., & Tversky, A. (1971). Conjoint-measurement analysis of composition rules in psychology. *Psychological Review, 78*(2), 151–169. doi:10.1037/h0030637
Lancaster, K. J. (1966). A new approach to consumer theory. *Journal of Political Economy, 74*. Retrieved from http://econpapers.repec.org/article/ucpjpolec/v_3a74_3ay_3a1966_3ap_3a132.htm
Lutz, R. J. (1975). Changing brand attitudes through modification of cognitive structure. *Journal of Consumer Research, 1*(4), 49–59. doi:10.1086/208607
Masicampo, E. J., & Baumeister, R. F. (2008). Toward a physiology of dual-process reasoning and judgment: Lemonade, willpower, and expensive rule-based analysis. *Psychological Science, 19*(3), 255–260. doi:10.1111/j.1467-9280.2008.02077.x
McClure, S. M., Li, J., Tomlin, D., Cypert, K. S., Montague, L. M., & Montague, P. R. (2004). Neural correlates of behavioral preference for culturally familiar drinks. *Neuron, 44*(2), 379–387. doi:10.1016/j.neuron.2004.09.019
Morin, C. (2011). Neuromarketing: The new science of consumer behavior. *Society, 48*(2), 131–135. https://doi.org/10.1007/s12115-010-9408-1
Moore, W. L. (1980). Levels of aggregation in conjoint analysis: An empirical comparison. *Journal of Marketing Research, 17*(12), 516–523.
Munson, J. M. (1984). Personal values: Considerations on theri measurement and application to five areas of research inquiry. In A. G. Woodside & R. E. Pitts (Eds.), *Personal Values & Consumer Psychology* (pp. 12–33). Lexinton, MA: Lexinton Books.
Novak, T. P. (1996). Conjoint analysis. *461 OGSM, Lecture Notes, Marketing Research*.
Olshavsky, R. W., & Granbois, D. H. (1979). Consumer decision making-fact or fiction? *Journal of Consumer Research, 6*(2), 93–100. https://doi.org/10.1086/jcr.1979.6.issue-2
Olson, J. C., & Reynolds, T. J. (1983). Understanding consumers' cognitive structures: Implications for marketing strategy. *Advertising and Consumer Psychology* (pp. 77–90). Lexinton, MA: Lexinton Books.
Overskeid, G. (2000). The slave of the passions: Experiencing problems and selecting solutions. *Review of General Psychology, 4*(3), 284–309. doi:10.1037/1089-2680.4.3.284
Petty, R. E., Cacioppo, J. T., & Schumann, D. (1983). Central and peripheral routes to advertising effectiveness: The moderating role of involvement. *Journal of Consumer Research,* 135–146. https://doi.org/10.1086/jcr.1983.10.issue-2
Rajaniemi, P. (1992). *Conceptualization of product involvement as a property of a cognitive structure*. Vaasa: Acta Wasaensia.
Reibstein, D., Bateson, J. E. G., & Boulding, W. (1988). Conjoint analysis reliability: Empirical findings. *Marketing Science, 7*(3), 271–286. doi:10.1287/mksc.7.3.271
Seymour, B., & McClure, S. M. (2008). Anchors, scales and the relative coding of value in the brain. *Current Opinion in Neurobiology, 18*(2), 173–178. doi:10.1016/j.conb.2008.07.010
Sherrell, D. L., Hair, J. F. Jr., & Bush, R. P. (1984). The influence of personal values on measures of advertising effectiveness : Interactions with audience involvement. In R. E. Jr. Pitts & A. G. Woodside (Eds.), *Personal values & consumer psychology* (pp. 169–185). Lexinton, MA: Lexinton Books.
Smidts, A. (2002). *Kijken in het brein: Over de mogelijkheden van neuromarketing. ERIM Inaugural Address Series Research in Management*. Retrieved form http://hdl.handle.net/1765/308
Sylcott, B., Cagan, J., & Tabibnia, G. (2013). Understanding consumer tradeoffs between form and function through metaconjoint and cognitive neuroscience analyses. *Journal of Mechanical Design, 135*(10), 101002. doi:10.1115/1.4024975
Taylor, M. B. (1981). Product involvement and brand commitment. *Journal of Advertising Research, 21*, 51–56.
Vriens, M. (1995). *Conjoint analysis in marketing*. Capelle a/d Ijssel: Labyrint Publication.
Weber, B., Rangel, A., Wibral, M., & Falk, A. (2009). The medial prefrontal cortex exhibits money illusion. *Proceedings of the National Academy of Sciences*, pnas.0901490106. https://doi.org/10.1073/pnas.0901490106
Wind, Y. (1978). Issues and advances in segmentation research. *Journal of Marketing Research, 15*, 317–338.
Yacubian, J., Gläscher, J., Schroeder, K., Sommer, T., Braus, D. F., & Büchel, C. (2006). Dissociable systems for gain- and loss-related value predictions and errors of prediction in the human brain. *The Journal of Neuroscience: The Official Journal of the Society for Neuroscience, 26*(37), 9530–9537. doi:10.1523/JNEUROSCI.2915-06.2006
Zysset, S., Wendt, C. S., Volz, K. G., Neumann, J., Huber, O., & von Cramon, D. Y. (2006). The neural implementation of multi-attribute decision making: A parametric fMRI study with human subjects. *NeuroImage, 31*(3), 1380–1388. doi:10.1016/j.neuroimage.2006.01.017