Adaptive CBC: Are the Benefits Justifying its Additional Efforts Compared to CBC?

Benedikt M. Brand and Daniel Baier

Abstract Currently, there is a big discussion ongoing among both practitioners and scientists whether the benefits of the Adaptive Choice-Based Conjoint (ACBC) analysis in comparison to (standard) Choice-Based Conjoint (CBC) analysis are justifying the additional costs and efforts of ACBC. To answer this question, recent studies in literature are reviewed and a conducted ACBC (n=205) about e-commerce in an international context is analyzed with regards to several aspects, e.g. excluded attribute levels and stimuli used for the Choice Tasks section. The results indicate that CBC is generally able to provide the main information about the most preferred attribute levels with less effort compared to ACBC. However, ACBC is very suitable for more complex products or services and for gaining deeper insights, such as information about the second-best options or completely unacceptable features. Furthermore, CBC requires a bigger sample size and is often less precise. Still, the related context will remain the main factor for or against the usage of one or the other method.

Benedikt M. Brand*
✉ benedikt.brand@uni-bayreuth.de
Daniel Baier*
✉ daniel.baier@uni-bayreuth.de

* University of Bayreuth, Chair of Marketing & Innovation, Universitätsstraße 30, 95447 Bayreuth, Germany

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1 Introduction

Choice-Based Conjoint analysis (CBC) has been the most frequently used form of conjoint analysis amongst all existing ones in the last decades (Ku et al, 2017; Voleti et al, 2017). Originally developed by Louviere and Woodworth (1983) and made easily applicable by Sawtooth Software's CBC system in 1993, CBC nowadays is the standard method to analyze discrete choices among multi-attributed stimuli. (Standard) CBC not only outperforms traditional conjoint analysis (TCA) – even if hierarchical Bayes estimation is used in the latter one (Baier et al, 2016) – but CBC is also able to illustrate the decision making process more realistically, especially if extended by incentive alignment (Ding, 2007) or dual-response procedures (Wlömert and Eggers, 2016). However, the latest report of conjoint analysis usage (Sawtooth Software, 2019) states that the percentage of Adaptive Choice-Based Conjoint analysis[1] (ACBC) projects increased in recent years, while the percentage of CBC projects slightly declined. The ACBC invented in 2007 (Johnson and Orme) comes at certain costs, but it also provides many benefits for researchers and practitioners likewise. Accordingly, there is an ongoing major debate about whether the benefits of ACBC are justifying its additional efforts compared to CBC. To cover all relevant aspects, the paper at hand is structured as follows: First, the theoretical disadvantages of CBC investigations are presented (Section 1). Founded on these shortcomings, the ACBC and its theoretical advantages are illuminated in Section 3. Afterwards, a review of recent studies dealing with the comparison of CBC to ACBC is given (Section 4), before an own empirical study (Section 5) is used for examining the diverse trade-off aspects (Section 6). In Section 7, a conclusion is drawn based on this concrete investigation.

2 Theoretical Disadvantages of CBC

The development of ACBC was propelled by shortcomings performing a CBC investigation. Major issues with CBC investigations are illustrated in Table 1. Even though research proposed optimized types of CBC, where choice tasks are adapted depending on previous decisions (Gensler et al, 2012; Toubia

[1] referring to the composition of Sawtooth Software.

et al, 2004), the overall layout of the survey remains identical. The findings (Table 1) go in line with recently conducted research showing that the validity of commercially fielded CBC investigations slightly went down (Selka and Baier, 2014).

Table 1: Theoretical Disadvantages with CBC investigations.

Theoretical Disadvantage	**Source(s)**
Answering the same question multiple times across varying choice tasks is often experienced as very monotonous and boring	Bauer et al (2015), Lines and Denstadli (2004)
Respondents are often facing stimuli that are irrelevant to them	Garver et al (2012)
$\Longrightarrow$ If respondents focus on certain key features not contained within the stimuli, they may only choose the none-option	Steiner and Meißner (2018)
(When applying more than just a limited amount of the most important attributes) respondents tend to not carefully weigh up the trade-off of different choices (anymore) $\Longrightarrow$ Instead, they use fast-feasible simplification strategies	Gilbride and Allenby (2004), Ryan et al (2009), Scholz et al (2010),
$\Longrightarrow$ Respondents' choices could better be captured by non-compensatory models where only a few attribute levels are considered	Yee et al (2007)
Still, CBC assumes a compensatory model with respondents carefully weighing up different choice options using compensatory decision heuristics	Garver et al (2012) Scholz et al (2010)

Apparently, the assumption of a compensatory model with compensatory decision heuristics does neither go in line with the observed quick answering behavior, nor with detected simplified respondents heuristics, which led to the development of ACBC in 2007 by Johnson and Orme.

3 ACBC and Its Theoretical Advantages

The process of ACBC contains three to four sections: In the first section (“Build-Your-Own”, abbr.: BYO) respondents are asked to create their ideal product selecting the best attribute levels. Similar to the incentive-aligned upgrading method from Park et al (2008), it is possible to extend the BYO by a "summed price"-setup allowing to determine a base price and/or component prices for all attribute levels. The researcher may further specify which attributes should be included in the BYO-section and whether conditional attributes exist or whether a conditional display should be part of the BYO. The latter one illustrates the current BYO-selection based on what respondents are indicating. Based on this ideal product, a screening section is pursued. Here, respondents are exposed to similar stimuli (as full-profile stimuli), asking whether presented stimuli are taken into consideration or not (binary choice: “a possibility” vs. “not a possibility”). Depending on which attribute levels of a stimulus are chosen very frequently, respondents are asked whether the related attribute level is representing a “must-have”-level to them. In parallel to this, respondents will be asked whether an attribute level is considered as an unacceptable attribute level, when the same attribute levels of a stimulus are always rejected. When respondents are thereby asked to select the most unacceptable (or most important) level out of the detected attribute levels proposed, respondents still could select that none of these presents an unacceptable (or must-have) level. Here, researchers may specify how many unacceptable and must-have levels could potentially be detected. It is recommended to use the *#Unacceptables* = *#ScreeningTasks* - 3 and *#MustHaves* = *#ScreeningTasks* - 4 (Sawtooth Software, 2014). Based on the results of the selected must-have and unacceptable levels, a regular CBC is performed. Here, unacceptable attribute levels will not appear at all, while must-have levels kept constant for all stimuli in each choice set (highlighted in gray) to ensure that the proposed stimuli are really part of the respondents’ evoked set and to allow respondents to focus on their relevant trade-off attribute levels. Again, the researcher may specify how many stimuli (out of the stimuli selected as a possibility in the screening section) should be part of this choice tournament section. The chosen "winning" stimulus of each choice set will be compared with other winning stimuli in subsequent choice tasks, until the most preferred stimulus is identified. With k stimuli marked as a possibility in the screening section, the final winning stimulus will be yielded after $k/2$ choice tasks when

using three stimuli per choice task (Sawtooth Software, 2014). Additionally, a fourth section can be included asking for buying probabilities ("calibration section") for the BYO-option, winning concept of the CBC tournament and further stimuli. These buying probabilities are enquired by a scale ranging from a minimum of two to a maximum of nine scale points (by default, a 5-point Likert scale is used).

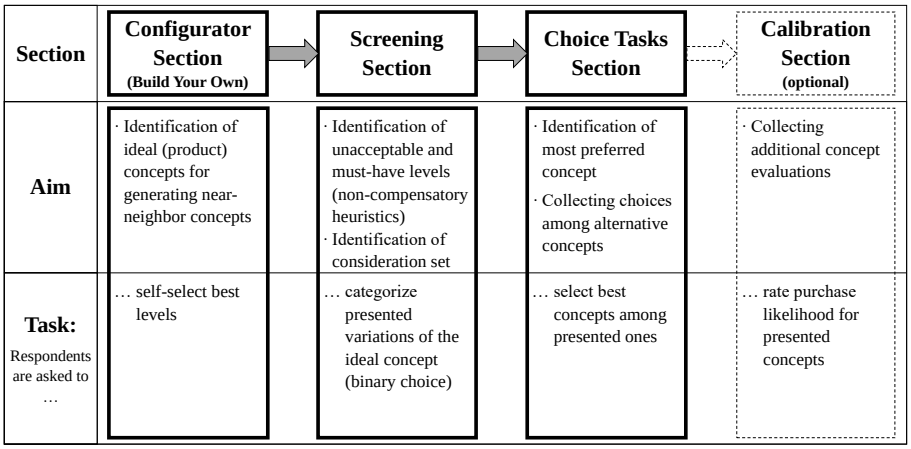

Figure 1: Procedure of an Adaptive Choice-Based Conjoint analysis (based on Sawtooth Software 2014).

Critically reflecting this procedure, one might argue that the eligibility of ACBC for simplifying the trade-off decisions compared to CBC is not sufficiently given when also using full-profile stimuli. However, in contrast to the CBC design, the screening section is not asking about the best choice, but whether the presented stimuli are generally taken into consideration allowing to simplify the decision. This approach aims to mimic a more realistic choice behavior by deploying a two-step decision making process: first, consumers will form an evoked set (screening section), before choosing the best option within that evoked set (CBC section) subsequently (Shocker et al, 1991; Turley and LeBlanc, 1995). This kind of procedure is similar to dual-response types of CBC that have proven to outperform CBC in several regards (Schlereth and Skiera, 2016; Wlömert and Eggers, 2016). Apart from that, the implementation of both types of choice tasks (taking stimuli into consideration or not, as well as choosing the best stimulus)

allows to combine the benefits of applying rejectable choice sets (with more evaluative judgments) and forced choice sets (with more comparative judgments) and thereby highlight how respondents process and recall information from choice tasks (Parker and Schrift, 2011).

Furthermore, it should be noticed that the choice tournament section resembles the CBC procedure resulting in the same monotonous patterns. However, the previous two sections enable respondents to focus on far less stimuli in this section and the ones presented are even closer to the individual, ideal configuration. Additionally, specifying an ideal BYO-stimulus and include/exclude concepts into one's consideration set is loosening the rigid procedure of sole CBC procedures and could be considered to require less cognitive effort than choosing the best option. Moreover, this adaptive approach could handle extreme response behavior (frequently occurring with CBC investigations (Gensler et al, 2012)) better by applying the previous two sections.

The designs created for the screening section are based on the selection in the BYO-section. In line with the traditional orthogonal array, each attribute should vary in order to accomplish maximum statistical efficiency. If only a certain amount of attributes varies, this will result in lower statistical efficiency. Therefore, the design creation using ACBC tries to antagonize these issues by focusing on "near-neighbor"-stimuli that are more relevant to respondents (Sawtooth Software, 2014). Apart from that, usual design efficiency criteria employed for CBC investigations (such as high D-efficiency and orthogonality) are based on the assumption of respondents using compensatory decision heuristics. Hence, the design of ACBC experiments should take into account the before-mentioned non-compensatory screening rules most respondents are applying. Additionally, varying only a subset of all attributes within each stimulus will lead to less noise in the data. Consequently, the designs could not be considered as perfectly orthogonal, though they have proven to function very well and a feature was implemented into the software to check the design created regarding orthogonality (Sawtooth Software, 2014).

These near-orthogonal designs follow a five-step algorithm (Sawtooth Software, 2014): Depending on the BYO-selection by respondents, a vector S_0 with as many elements as attributes contained in the BYO-section explains which attribute levels have been chosen for the ideal BYO-option. On the researchers' side, one could determine the total number of stimuli that should be created (T), as well as the minimum amount of attributes varying from the BYO-selection

(A_{min}) and the maximum amount of attributes varying from the BYO-selection (A_{max}). For the latter one, half of all attributes in the BYO could be varied at maximum.

Step 1: In order to generate a new near-neighbor stimulus S_i, the algorithm randomly chooses an integer (A_i) ranging from A_{min} to A_{max} specifying how many attributes within S_0 will be modified.

Step 2: A_i elements within S_0 are randomly selected to be modified.

Step 3: New levels for the attributes selected from the previous step are randomly chosen varying from the BYO-selection. All other attribute levels from the BYO-selection are kept constant.

Step 4: It is checked whether the concept selected is not a duplicate to another stimulus previously chosen for this respondent and is not at odds with any prohibited pairs. In case the chosen stimulus is prohibited or a duplicate, the stimulus will be rejected and the first step starts again.

Step 5: It is tested whether relabeling non-BYO selected attribute levels to a different non-BYO selected attribute level within the same attribute improves the relative D-efficiency of the design for this respondent. In parallel to this, it is checked whether swapping non-BYO selected attribute levels between two stimuli improves the relative D-efficiency. In case swapping or relabeling increases efficiency while the target level count balance is not deteriorating, adaptions are accepted.

4 Results from Empirical Comparisons of CBC and ACBC

Before evaluating ACBC's benefits and additional efforts compared with CBC based on an empirical study in the context of international e-commerce, recent studies comparing the two methods in other environments are presented in chronological order in Table 2.

Table 2: Review of Recent Studies Comparing (HIT-)CBC to ACBC.

Source	Sample	Application Example	Results
Johnson and Orme (2007)	n_{CBC}=277, n_{ACBC}=282	Laptops	Median time to complete ACBC (11.6 minutes) more than twice the time for a CBC (5.4 minutes) ACBC is experienced as more interesting & more realistic Both methods produced similar results in terms of Mean Absolute Errors (abbr.: MAE) for predicting holdout shares Hit rate for the last holdout used was significantly higher for the ACBC.
	$n_{CBC}\approx500$ $n_{ACBC}\approx400$	Recreational Equipment	ACBC's hit rate was higher than CBC's, albeit not significantly.
Orme and Johnson (2008)	$n_{ACBC\ I}$=299, $n_{ACBC\ II}$=303, $n_{ACBC\ III}$=295, n_{CBC}=314	Home Purchases	ACBC outperformed CBC in terms of MAE, market share predictions & hit rates, albeit not significantly regarding hit rates.
Chapman et al (2009)	n_{CBC}=201, n_{ACBC}=199	Computer Accessory	ACBC's estimates were closer to actual market data, generating smaller standard deviations of respondents' utilities & yielding 15-25% lower error proportion than CBC ACBC showed to estimate greater price sensitivity.
Cunningham et al (2010)	Review of Various Articles	–	ACBC simulates the decision-making process more realistically & respondents evaluated this method as more engaging than traditional conjoint approaches ACBC shows improved prediction of holdout tasks, more precise estimations of product decisions & lower standard errors ACBC requires more time for completion.
Jervis et al (2012)	n_{CBC}=777, n_{ACBC}=250	Sour Cream	ACBC performs better in estimating the perception of brands & price compared to CBC, with smaller standard deviations at the estimated individual utilities Confirmed earlier proposition that ACBC leads to similar results even if smaller samples are used.
Bauer et al (2015)	n=423 for both methods, $n_{holdout}$=66	Cars	ACBC significantly outperforms even HIT-CBC regarding hit rates & qualitative criteria, such as overall pleasure, task simplicity, closeness to reality & enjoyment; Internal (using holdout tasks) & external (using a separate holdout sample) MAEs have been smaller using ACBC

Similarily to Chapman et al (2009), more precise estimations about the willingness-to-pay were also confirmed by Gensler et al (2012), who adapted price levels based on previous choice decisions and implemented conjunctive

and disjunctive decision heuristics for price. Moreover, findings on higher external validity when using adaptive designs based on previous choices (Bauer et al, 2015) could also be confirmed by Gensler et al (2012).

Summarizing all studies, one can observe that ACBC prevails in most cases compared to CBC. Only the longer interview time appears to represent a major drawback. However, respondents prefer ACBC over CBC due to its more encouraging and less monotonous procedure. Moreover, it is recommended to use ACBC in rather complex decision environments with about more than six attributes, whereas CBC should be used for choice designs with just a few attributes (Eggers and Sattler, 2011). Besides the fact that the number of attributes intended always depends on the number of levels applied, literature emphasizes that respondents are cognitively overstrained when facing a wide range of attributes (Green and Srinivasan, 1990; Lines and Denstadli, 2004; Netzer and Srinivasan, 2011; Scholz et al, 2010) in full-profile designs. Apart from that, it becomes clear that ACBC is still a rather nascent phenomenon in literature with only a few applications existing (e.g. Garver et al 2012; Hinnen et al 2017; Wuebker et al 2015), while most experiments are conducted by researchers affiliated with the software provider Sawtooth Software.

5 Research Methodology and Data Collection

To examine whether ACBC's benefits are justifying its additional effort concerning time and cost compared to the predominantly used CBC, an own empirical study has been conducted. This empirical study applying an ACBC serves exemplarily for deriving advantages and disadvantages with ACBC and will be compared to hypothetical CBC investigations. Here, ACBC was applied in the context of e-commerce configurations for Chinese and German consumers. As ACBC is more appropriate for complex decision environments with more than five (Garver et al, 2012) or six attributes (Eggers and Sattler, 2011), the eight most important attributes for e-commerce were used illustrating a more holistic perspective on the ideal configuration. Furthermore, all eight attributes contained four attribute levels preventing the number-of-levels effect (Steenkamp and Wittink, 1994; Verlegh et al, 2002). In addition, the order of the attributes shown to each respondent was randomized in order to prevent the position effect. The investigation was exemplified by sport compression shorts in the considered online shop to provide a more descriptive scenario for

Table 3: Attributes and Attribute Levels used.

Attribute	Attribute level 1	Attribute level 2	Attribute level 3	Attribute level 4
Method of payment	PayPal	Credit card	AliPay	WeChat Pay
Country of production	Germany	Europe (except Germany)	China	USA
Time for delivery	3 days	5 days	7 days	9 days
Product references	3/5 stars	4/5 stars	5/5 stars	References unknown
Website design				
Warranty options	No redemption	Return shipment at additional costs	Free return shipment	Free return shipment & extended conversion period
Contact possibilities	Via e-mail	Via phone	Via live-chat	No contact possibilities
Price	70€	80€	90€	100€

respondents. The ACBC itself included all four before-mentioned sections. Furthermore, seven screening tasks were implemented and four times it was asked for any unacceptable attribute levels, three times for any must-have attribute levels – as recommended by the software provider for the number of attributes utilized. Still, some adjustments were made to shorten the already longer survey procedure. The ACBC consisted of only three concepts per screening task (plus additional none-option). Besides, the number of calibration stimuli shown was reduced to four instead of six, the minimum number of attributes to vary from BYO-selection was scaled down to one and the maximum number of attributes to vary from BYO-selection was cut down to two. Generally speaking, the total number of potential stimuli would be 8^4 resulting in 4,096 stimuli. Using the ACBC approach with the BYO-selection as starting point, this number can be broken down to the number of screening tasks (7) times the number of stimuli per screening task (3) leading to 21 stimuli each respondent will be evaluating. Out of these 21 stimuli from the respondents' evoked set, 16 will be used in the third section (choice tournament) at maximum.

Holdout tasks, which are commonly used in CBC investigations for measuring hit rates and MAE, are not planned to be implemented in ACBC surveys due to the adaptive design of ACBC investigations (Sawtooth Software, 2014). As

ACBC's choice design is created "on-the-fly", it is basically not possible to generate an experimental design prior to the launch. Furthermore, holdout tasks determined a priori might display respondents stimuli including attribute levels that they have already assigned as unacceptable attribute levels, potentially leading to confusion and higher dropout rates. However, implementing holdout tasks is not mandatory, because prognostic validity can be tested through diverse testing methods: Actual market data or information about consumers' real buying probabilities should be preferred (Steiner and Meißner, 2018), as recommended by developers of the ACBC (Sawtooth Software, 2014). Ultimately, both approaches, hit rates and real-world buying probabilities, should serve as reference for judging whether estimated utilities provide predictive validity, which can be checked using the separately determined buying probabilities accessed in the calibration section.
In order to make sure that the design created will show each attribute level at least two times (generating enough near-neighbor stimuli), the design was tested with five dummy respondents answering randomly. Results strongly suggested the implementation of the BYO-section to increase the D-efficiency of the chosen design (see Table 4). Apart from that, it was ensured that each attribute level occurred at least two times (85% of the time even more than two times).

Table 4: D-efficiency with and without BYO-section.

Respondent Number	D-Efficiency w/ BYO	D-Efficiency w/o BYO
1	0,8176	0,0019
2	0,8919	0,0022
3	0,8346	0,0000
4	0,8305	0,0018
5	0,8769	0,0022

Focusing on German and Chinese consumers with sport affinity and online shopping experience, a very large target group could be considered. Therefore, a two-step clustered sample approach has been conducted allowing to survey a widespread sample. Considering the subject of this investigation, respondents should be both experienced in online shopping and also demonstrate some affinity

to sports. As more than two-thirds of the German population shopped online at least once, data collection has been focusing on the second segmentation criterion of exercising on a regular basis. Therefore, all German sport associations of the 16 federal states in Germany were contacted and asked to randomly select a certain number of sport clubs out of their lists to answer the survey. The number of randomly selected sport clubs varies by the number of members of the corresponding federal sport association, taking into account the varying number of sport clubs per federal sport association. Consequently, 51 randomly selected sport clubs distributed all over Germany should ask 260 members (average number of members per sport club), leading to 1,326 potential respondents assuming a response rate of 10%.

For generating a comparable sample in China, same criteria should be applied. However, internet penetration in China varies enormously by region, where the majority of internet non-users is much higher in rural areas (Tan and Ludwig, 2016). This is the reason why contacting all 22 Chinese provinces with their sport associations would lead to a sample of regularly exercising participants, but it would neglect the prerequisite of having access to internet equally distributed among their members. Therefore, focus shifted to inhabitants of the largest cities in China, ensuring that all respondents have access to internet. As students are representing the most sportive group in China, sports universities of the five biggest cities have been contacted requesting them to forward the survey to students. Those are the sports universities of Shanghai (approx. 6,000 students), of Beijing (approx. 14,000 students), of Guangzhou (approx. 5,000 students), of Tianjin (approx. 6,000 students) and the sports faculty of Shenzhen University (approx. 5,000 students). Paying attention to the different amount of inhabitants in the selected cities, the number of students asked needed to be adapted accordingly: Beijing and Shanghai are accounting for approximately twice the number of inhabitants as in the other three cities, which is why in these cases it has been asked for 4,000 students each. In the other three universities, it was asked for only 2,000 students each, as the related cities account for a similar number of inhabitants. As a result, there were 14,000 potential respondents. Assuming the same response rate as in Germany (10%), it was expected to reach 1,400 Chinese online shoppers exercising regularly compared to 1,326 potential respondents in Germany.

6 Empirical Study: Results

The ACBC study resulted in N=346 respondents, where 141 out of these skipped the survey prematurely (61 Chinese and 80 Germans). Here, most respondents stopped answering the survey, when ACBC part started (6%). The remaining n=205 complete surveys were answered by 54 Chinese and 151 German respondents. The standard Hierarchical Bayes (abbr.: HB) estimation exhibited a root likelihood (abbr.: RLH) of .710 and a pseudo R^2 of .593. However, using the conventional HB calculation might result in misleading estimations, because the level of errors varies by section: Distinguishing between stimuli considered as a possibility and not a possibility (binary) will result in smaller error levels than choosing the best option out of a choice task (Allenby et al, 2005). Therefore, the "Task-Specific Scale Factors Hierarchical Bayes" estimation was used taking this bias into account (Sawtooth Software, 2014). Apart from that, the highly significant interaction effect between country of production and method of payment was implemented (2-log likelihood p<.00). Additionally, irrational behavioral structures were detected for the attribute levels of time of delivery, which is why a constraint was used for this attribute. These structures could be a by-product of the lowest average important of time of delivery out of all eight attributes. With the three adjustments described, the new model resulted in an improved RLH=.738 with a pseudo R^2=.639. The before-mentioned validity check with separately investigated buying probabilities (derived from calibration section) indicates that highest estimated part-worth utilities match the stimuli with the highest buying probabilities attesting a high prognostic validity. Furthermore, the most frequently configured BYO-selection from the first section coincides with the winning concept of the choice tournament (at the third section) verifying a high internal consistency. Regarding the effect on the decision of all eight attributes used (Figure 2), the three factors of method of payment, warranty options, and contact possibilities are the most important ones by far.

In order to find out how valuable the additional information of the performed ACBC are and how precise ACBC is in estimating the most relevant configuration in comparison to CBC, a closer look is taken to the stimuli in the screening section. Here, the sample is analyzed separated by nationality in case any cultural influence might bias the overall consideration. In the German sample, only five out of the total 21 stimuli were assigned as "not a possibility". However, the five

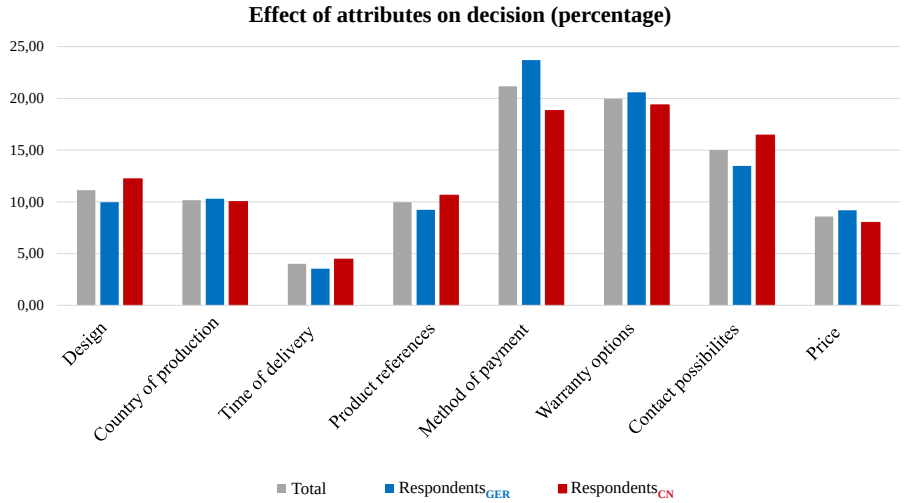

Figure 2: Effect of attributes on decision.

most frequently considered stimuli out of the remaining 16 ones account for 64.24% of all stimuli used. In the Chinese sample, six out of the 21 stimuli were considered as "not a possibility". Here, the seven most frequently considered ones out of the remaining 16 stimuli account for 64.91% of all stimuli used.

Another important benefit of ACBC that needs to be highlighted comparing the results to CBC investigations is the frequency of attribute levels marked as unacceptable or must-have features. Among German respondents, potentially 453 times attribute levels could be assigned as must-haves, as must-have questions have been asked three times for all 151 Germans. Out of these, respondents determined 128 times (28.26%) attribute levels as must-haves. To be precise, the most frequently chosen must-have attribute levels (> 10%) revealed minimum requirements such as at least return options at additional costs (34.44%) and at least a three star customer reference (10.60%) should be provided. On the other hand, potentially 604 times unacceptable attribute levels could be detected. Out of these, unacceptable features were chosen 449 times (73.40%). Here, many attribute levels were assigned as unacceptable more than 10% of the time: AliPay (59.60%) and WeChat Pay (50.33%) are most frequently assigned unacceptable, but also having no return options at all (45.03%), no contact possibilities (31.13%), no customer references available (13.25%), the yellow

navigation bar on the right-hand side (11.26%), return option at additional costs (10.60%), and contact via live-chat (10.60%).

Similar results were identified in the Chinese sample: 42 times out of 162 related questions (25.90%), must-have attribute levels were examined. Especially, at least return options at additional costs (24.07%), a three-star customer reference (14.81%) or at least free return (12.96%) were required as must-haves. Analogous to the German sample, more unacceptable features than must-have attribute levels were identified (65.70%). Among these, the most frequently chosen unacceptable attribute levels were no return of the product possible (37.04%), payment via PayPal (25.93%), no contact possibilities available (24.07%), yellow navigation bar on the right-hand side (22.22%), contact option via phone (20.37%), payment via Mastercard (20.37%), no available customer references (16.67%), return at additional costs (12.96%), and contact via email (12.96%).

As one of the major disadvantages mentioned by literature, the time of the interview needs to be analyzed as well. In this investigation, the total survey time was eleven minutes on average among Chinese and twelve minutes among German respondents. Here, up to six question (depending on answers of the previous three questions) were asked before the actual ACBC took place and afterwards, another three questions about demographical information were included. Summarizing the results of this investigation in consideration of CBC's problems and ACBC approaches to solve these issues, the Table 5 captures the main aspects on the next page.

7 Conclusion and Outlook

Starting with the disadvantages of ACBC, the longer interview time amounts to eleven to twelve minutes. This duration of the interview confirming earlier findings about ACBC investigations (Johnson and Orme, 2007) still seems to be positioned in a reasonable range of time. One could argue that respondents refuse to spend that much time answering a survey, but as demonstrated earlier (see chapter 3), survey participants report higher overall pleasure and enjoyment performing ACBC studies compared to monotonous CBC investigations. However, especially if panels are used for acquiring respondents, this downside will result in additional costs. Even though it is possible to shorten the interview time by removing the BYO-section from the ACBC survey (Orme and Johnson, 2008),

Table 5: Problems with CBC and its solution using ACBC exemplified by study.

(Identified) problems of CBC	ACBC's problem solving	Presented investigation
Answering CBC is experienced as monotonous and boring leading to higher termination rates and	Non-compensatory procedure implemented making surveys more realistic and engaging (including BYO-section; selection of unacceptable and must-have attribute levels)	Only 21 respondents (6 %) stopped answering the survey when ACBC started (comparable number of Chinese and Germans)
Respondents rushing through the survey		Interview length between 11 (Chinese) and 12 (Germans) minutes
Respondents are exposed to irrelevant stimuli (may only choose none-option)	ACBC starts with their personal ideal stimulus configuration (BYO), followed by near-neighbor stimuli that are adjusted with unacceptable and must-have features	High rate of stimuli considered as a possibility (CN: 71%; GER: 76%), whereas already a few represent the majority of all stimuli used
Respondents are focusing on certain key features often neglected at CBC analysis	Respondents are asked about unacceptable and must-have attribute levels. Selections influence composition of upcoming stimuli (excluding unacceptable ones, keeping must-have ones constant)	Most respondents focused on excluding unacceptable features (CN: 66%; GER: 73%), rather than determining must-have features (CN: 26%; GER: 29%)
Restricted to very few attributes (not able to illustrate complex decision environments)	ACBC usage recommended for more than six up to twelve attributes (unacceptable and must-have attribute levels help focusing on relevant trade-off aspects)	Three attributes identified (out of eight) representing the most important factors by far

one of its biggest advantages will be removed as well. Apart from that, holdout tasks are not planned to be implemented in ACBC. Focusing on this aspect, this is not a disadvantage per se, as holdout tasks are just used as a surrogate and it is questioned to what extent they are able to actually predict choices (Steiner and Meißner, 2018), rather than just testing the reliability (Leigh et al, 1984; Louviere, 1988). Another downside of ACBC compared to CBC investigations can be found in the higher price for the software to perform one or the other. For instance, the market leader for conjoint analysis software "Sawtooth Software" is charging an additional annual fee of 2,000$ for accessing the ACBC package. Besides, the dropout rate for the study conducted had its peak (6%) at the start of ACBC in the survey. On the other hand, it was proven that ACBC works well even with smaller samples (Garver et al, 2012). Confirming the literature presented, a high consistency was found even within the small German sample of 151 respondents. Apart from that, additional respondents canceling the survey prematurely at the beginning of the ACBC part would account for 21 potential participants only.

In this rather complex decision environment of an e-commerce configuration in a cross-cultural comparison, ACBC proofs to be a very beneficial tool allowing to include more attributes than in CBC investigations. Furthermore, the procedure of ACBC surveys allows focusing straight on the evoked set or the most relevant stimuli – even if preferences are completely unknown in the first place. Additionally, by using non-compensatory heuristics in the screening section (with unacceptable and must-have features), it facilitates to concentrate on the most relevant trade-offs in the CBC-like part (choice tournament) of the questionnaire. These decision heuristics (especially the disjunctive ones) seem to be closer to approaches used by consumers in real life (Liu and Arora, 2011; Steiner et al, 2016) and, therefore, speak in favor for the procedure of ACBC. In particular, information generated about unacceptable attribute levels (chosen two-thirds of the time) provide valuable insights about which features need to be rejected by companies. Apart from that, ACBC allows to focus on the evoked set of each respondent with very precise estimations based on the BYO-section. Even simulations using synthetic data with respondents answering randomly resulted in better RLH values for ACBC. Using the same number of respondents as in the investigation presented (n=205) and the same eight attributes with its four attribute levels each, the CBC simulation with 50,000 iterations (including 25,000 burn-in iterations) leads to a RLH=.407 while the ACBC simulation

shows a RLH=.574 (compared to the actual investigation RLH=.738). Moreover, ACBC studies reveal information about the ideal configuration of a product or concept (BYO-section) and - if a calibration section is included - also buying probabilities for the individual stimuli could be presented. While CBC mainly focuses on finding the most preferred option, ACBC provides more detailed information, e.g. using the second most frequently chosen BYO-selection of attribute levels besides the results of the HB estimation.

Especially in the complex context of e-commerce configuration in a cross-cultural comparison, ACBC has shown its benefits. Summing up this comparison, the selection of one method over the other will always depend on the budget available, the planned maximum of time for the survey, the amount of information needed, and the complexity of the decision environment.

References

Allenby G, Fennell G, Huber J, Eagle T, Gilbride T, Horsky D, Kim J, Lenk P, Johnson R, Ofek E (2005) Adjusting choice models to better predict market behavior. Marketing Letters 16(3-4):197–208. DOI: 10.1007/s11002-005-5885-1.

Baier D, Pełka M, Rybicka A, Schreiber S (2016) TCA/HB Compared to CBC/HB for Predicting Choices Among Multi-Attributed Products. Archives of Data Science, Series A 1(1):77–87. DOI: 10.5445/KSP/1000058747/05.

Bauer R, Menrad K, Decker T (2015) Adaptive Hybrid Methods for Choice-Based Conjoint Analysis: A Comparative Study. International Journal of Marketing Studies 7(1). DOI: 10.5539/ijms.v7n1p1.

Chapman CN, Alford JL, Johnson C, Lahav M, R. Weidemann (2009) Comparing results of CBC and ACBC with real product selection. Proceedings of the 2009 Sawtooth Software Conference, pp. 199–206.

Cunningham CE, Deal K, Chen Y (2010) Adaptive choice-based conjoint analysis: a new patient-centered approach to the assessment of health service preferences. The patient 3(4):257–273. DOI: 10.2165/11537870-000000000-00000.

Ding M (2007) An incentive-aligned mechanism for conjoint analysis. Journal of Marketing Research 44(2):214–223. DOI: 10.1509/jmkr.44.2.214.

Eggers F, Sattler H (2011) Preference measurement with conjoint analysis. Overview of state-of-the-art approaches and recent developments. GfK Marketing Intelligence Review 3(1):36–47. DOI: 10.2478/gfkmir-2014-0054.

Garver MS, Williams Z, Stephen Taylor G, Wynne WR (2012) Modelling choice in logistics: A managerial guide and application. International Journal of Physical Distribution & Logistics Management 42(2):128–151. DOI: 10.1108/09600031211219654.

Gensler S, Hinz O, Skiera B, Theysohn S (2012) Willingness-to-pay estimation with choice-based conjoint analysis: Addressing extreme response behavior with individually adapted designs. European Journal of Operational Research 219(2):368–378. DOI: 10.1016/j.ejor.2012.01.002.

Gilbride TJ, Allenby GM (2004) A Choice Model with Conjunctive, Disjunctive, and Compensatory Screening Rules. Marketing Science 23(3):391–406. DOI: 10.1287/mksc.1030.0032.

Green PE, Srinivasan V (1990) Conjoint analysis in marketing: New developments with implications for research and practice. Journal of marketing 54(4):3–19. DOI: 10.2307/1251756.

Hinnen G, Hille SL, Wittmer A (2017) Willingness to pay for green products in air travel: Ready for take–off? Business Strategy and the Environment 26(2):197–208. DOI: 10.1002/bse.1909.

Jervis SM, Ennis JM, Drake MA (2012) A Comparison of Adaptive Choice-Based Conjoint and Choice-Based Conjoint to Determine Key Choice Attributes of Sour Cream with Limited Sample Size. Journal of Sensory Studies 27(6):451–462. DOI: 10.

1111/joss.12009.
Johnson RM, Orme BK (eds) (2007) A new approach to adaptive CBC, Johnson RM, Orme BK (eds), Sequim (WA).
Ku YC, Chiang TF, Chang SM (2017) Is what you choose what you want?—Outlier detection in choice-based conjoint analysis. Marketing Letters 28(1):29–42. DOI: 10.1007/s11002-015-9389-3.
Leigh TW, MacKay DB, Summers JO (1984) Reliability and validity of conjoint analysis and self-explicated weights: A comparison. Journal of Marketing Research 21(4):456–462. DOI: 10.2307/3151471.
Lines R, Denstadli JM (2004) Information overload in conjoint experiments. International Journal of Market Research 46(3):297–310. DOI: 10.1177/147078530404600305.
Liu Q, Arora N (2011) Efficient choice designs for a consider-then-choose model. Marketing Science 30(2):321–338. DOI: 10.1287/mksc.1100.0629.
Louviere JJ (1988) Conjoint analysis modelling of stated preferences. Journal of Transport Economics and Policy 22(1):93–119. URL: http://www.jstor.org/stable/20052837.
Louviere JJ, Woodworth G (1983) Design and analysis of simulated consumer choice or allocation experiments: an approach based on aggregate data. Journal of Marketing Research 20(4):350–367. DOI: 10.2307/3151440.
Netzer O, Srinivasan V (2011) Adaptive self-explication of multiattribute preferences. Journal of Marketing Research 48(1):140–156. DOI: 10.2139/ssrn.1077434.
Orme BK, Johnson RM (2008) Testing adaptive CBC: Shorter questionnaires and BYO vs.'most likelies'. Research paper, Sawtooth Software Series, Sequim, WA. URL: https://www.sawtoothsoftware.com/support/technical-papers/adaptive-cbc-papers/testing-adaptive-cbc-shorter-questionnaires-and-byo-vs-most-likelies-2008.
Park YH, Ding M, Rao VR (2008) Eliciting preference for complex products: A web-based upgrading method. Journal of Marketing Research 45(5):562–574.
Parker JR, Schrift RY (2011) Rejectable choice sets: How seemingly irrelevant no-choice options affect consumer decision processes. Journal of Marketing Research 48(5):840–854. DOI: 10.2307/23033523.
Ryan M, Watson V, Entwistle V (2009) Rationalising the 'irrational': A think aloud study of discrete choice experiment responses. Health economics 18(3):321–336. DOI: 10.1002/hec.1369.
Sawtooth Software (2014) ACBC Technical Paper. Orem, Utah, USA. URL: https://www.sawtoothsoftware.com/download/techpap/acbctech2014.pdf.
Sawtooth Software (2019) Report on Conjoint Analysis Usage among Sawtooth Software Customers. URL: https://www.sawtoothsoftware.com/about-us/news-and-events/news/1693-results-of-2016-sawtooth-

software-user-survey.

Schlereth C, Skiera B (2016) Two new features in discrete choice experiments to improve willingness-to-pay estimation that result in SDR and SADR: Separated (adaptive) dual response. Management Science 63(3):829–842. DOI: 10.1287/mnsc.2015.2367.

Scholz SW, Meissner M, Decker R (2010) Measuring Consumer Preferences for Complex Products: A Compositional Approach Based on Paired Comparisons. Journal of Marketing Research 47(4):685–698. DOI: 10.1509/jmkr.47.4.685.

Selka S, Baier D (2014) Kommerzielle Anwendung auswahlbasierter Verfahren der Conjointanalyse: Eine empirische Untersuchung zur Validitätsentwicklung. Marketing ZFP 36(1):54–66. DOI: 10.15358/0344-1369_2014_1_54.

Shocker AD, Ben-Akiva M, Boccara B, Nedungadi P (1991) Consideration set influences on consumer decision-making and choice: Issues, models, and suggestions. Marketing Letters 2(3):181–197.

Steenkamp JBE, Wittink DR (1994) The metric quality of full-profile judgments and the number-of-attribute-levels effect in conjoint analysis. International Journal of Research in Marketing 11(3):275–286. DOI: 10.1016/0167-8116(94)90006-X.

Steiner M, Meißner M (2018) A User's Guide to the Galaxy of Conjoint Analysis and Compositional Preference Measurement. Marketing ZFP 40(2):3–25. DOI: 10.15358/0344-1369-2018-2-3.

Steiner M, Helm R, Hüttl-Maack V (2016) A customer-based approach for selecting attributes and levels for preference measurement and new product development. International Journal of Product Development 21(4):233–266. DOI: 10.1504/IJPD.2016.080308.

Tan J, Ludwig S (2016) Regional Adoption of Business-to-Business Electronic Commerce in China. International Journal of Electronic Commerce 20(3):408–439. DOI: 10.1080/10864415.2016.1122438.

Toubia O, Hauser JR, Simester DI (2004) Polyhedral Methods for Adaptive Choice-Based Conjoint Analysis. Journal of Marketing Research 41(1):116–131. DOI: 10.1509/jmkr.41.1.116.25082.

Turley LW, LeBlanc RP (1995) Evoked Sets: A Dynamic Process Model. Journal of Marketing Theory and Practice 3(2):28–36. DOI: 10.1080/10696679.1995.11501682.

Verlegh PW, Schifferstein HN, Wittink DR (2002) Range and Number-of-Levels Effects in Derived and Stated Measures of Attribute Importance. Marketing Letters 13(1):41–52. DOI: 10.1023/A:1015063125062.

Voleti S, Srinivasan V, Ghosh P (2017) An approach to improve the predictive power of choice-based conjoint analysis. International Journal of Research in Marketing 34(2):325–335. DOI: 10.1016/j.ijresmar.2016.08.007.

Wlömert N, Eggers F (2016) Predicting new service adoption with conjoint analysis: External validity of BDM-based incentive-aligned and dual-response choice designs. Marketing Letters 27(1):195–210. DOI: 10.1007/s11002-014-9326-x.

Wuebker R, Hampl N, Wuestenhagen R (2015) The strength of strong ties in an emerging industry: Experimental evidence of the effects of status hierarchies and personal ties in venture capitalist decision making. Strategic Entrepreneurship Journal 9(2):167–187. DOI: 10.1002/sej.1188.

Yee M, Dahan E, Hauser JR, Orlin J (2007) Greedoid-Based Noncompensatory Inference. Marketing Science 26(4):532–549. DOI: 10.1287/mksc.1060.0213.