Necessary condition analysis in marketing research

Jan Dul, Sven Hauff, Zsófia Tóth

Chapter for the Handbook of Research Methods for Marketing Management

Edited by Robin Nunkoo, Viraiyan Teeroovengadum, and Christian Ringle

SUMMARY

This chapter introduces necessary condition analysis (NCA), which represents a new and promising approach for identifying necessary conditions in empirical data. The reader will be familiarized with the basic logic and steps to conduct an NCA. We will also discuss the opportunities of using NCA in marketing research.

INTRODUCTION

Necessary condition analysis (NCA) (Dul, 2016; Dul, van der Laan, & Kuik, 2020) is a new approach and analysis technique for identifying necessary conditions. Necessary conditions represent constraints, bottlenecks, or critical factors that must be present for a desired outcome. They cannot be compensated by other factors and will lead to guaranteed failure if absent. For example, the assumption that reciprocity is necessary for cooperative outcomes (Jap & Ganesan, 2000) implies that cooperative outcomes cannot be achieved without reciprocity. Similar, if researchers state that research and development are necessary for innovativeness (Rubera & Kirca, 2012), they assume that there will be not innovativeness if there are no research and development activities.

The logic of NCA differs from additive logic implied in conventional methods (e.g. correlation, regression, or structural equation modelling) where contributing factors add up to produce an outcome and can compensate for each other. In contrast to these methods, NCA does not try to predict the presence of an outcome when the condition is present, but the absence of an outcome when the condition is absent instead. Therewith, NCA provides a different view on theory, methodology and practical relevance. With this different view, NCA can enrich marketing research by exploring (levels of) conditions without which (levels of) desired outcomes of marketing strategies, planning, advertising etc. cannot occur.

In this chapter, we introduce NCA and discuss its applications into marketing management. First, we will familiarize with the underlying logic of necessary conditions. Building on that, we describe the basics of NCA (for a more thorough introduction see Dul, 2020) and show how NCA can be applied to identify necessary conditions of relevant marketing phenomena. Finally, we will discuss the advantages of using NCA in marketing research.

NECESSITY LOGIC

Necessity statements are very common in any research discipline. Researchers use different words to express that a condition X is a necessary cause for an outcome Y. Common expression are, for example, *"X is needed for Y*", *"X is critical for Y*", *"X must be there for Y to succeed*", *"X is a pre-condition for Y*", or *"Y requires X"*. All these expressions refer to a necessity logic implying that an outcome Y can only be achieved if a specific condition X is present. This is different from sufficiency logic. Sufficiency logic implies that a change in X is sufficient for a change in Y, whereby X is not automatically necessary for Y since Y may also be achieved if X is not present.

Figure 1 exemplifies the difference between necessity and sufficiency logic by illustrating three types of causes. On the left we see possible combinations of values of X and Y when X is a sufficient but not necessary cause for Y. When X is present (value 1) also Y is present: X produces Y. However, when X is absent (value 0) Y can be absent or present. For example, when relationship between customers is not very strong (high tie-strength is absent), word-of-mouth (WOM) between them may still be present or absent (Groeger & Buttle, 2014). In the middle of Figure 1 we see possible combinations of values of X and Y when X is a necessary but not sufficient cause for Y. In this situation Y is absent when X is absent (value 0). Thus the absence of X produces the absence of Y. However, when X is present (value 1) Y can be absent or present.[1] For example, customer participation is necessary for collaborative marketing relationships (Lacey, 2009). If customer participation is absent, collaborative marketing relationships cannot be built. On the right we see the possible combination of values of X and Y when X is a necessary and sufficient cause for Y. When X is present (value 1) also Y is present and when X is absent also Y is absent. The presence of X produces the presence of Y and the absence of Y produces the absence of Y. For example, paying the fee to access

[1] Necessary conditions can be formulated in different ways, depending on the presence or absence of X and Y. Thus different combinations of the presence or absence of X and Y allow different formulations of necessary causes. For example, researchers can assume that absence of X is necessary for the presence of Y or that presence of X is necessary for the absence of Y. In this chapter we only focus on necessary conditions in that the presence of X is necessary for the presence of Y since this is the standard case in most situations.

a market research database will result in being able to access the database and not paying the fee produces the inability to access it for the individual or company.

Insert Figure 1 near here

Notably, causal statements do not need to be universally true; they usually refer to a specific context. For example, building guanxi is necessary for the success of small- and medium-sized enterprises in China (Hu & Stanton, 2011) but not necessary in some other international business contexts.

So far, we have discussed necessary conditions in terms of "X is necessary for Y". However, the idea of necessity is not limited to the dichotomous case but can also refer to discrete or continuous variables. With discrete and continuous variables, necessary conditions can be formulated in degree, i.e. in terms of "A certain level of X is necessary for certain level of Y". Figure 2 provides several examples of discrete necessary conditions. In contrast to the dichotomous case, discrete variables allow more precise statements on necessity. For example, Figure 2 left shows a case in that a medium level of X (X = 1) is necessary for a superior level of Y (Y = 2). In contrast, the second one from the left shows a case in that a high level of X (X =2) is necessary for a superior level of Y (Y = 2).

The example in Figure 2 shows a discrete situation with three levels. This can be extended to more levels (four, five, etc.) up to the continuous situation where the condition and the outcome can have an infinite number of levels (Figure 3). In this situation level X = Xc is necessary or level Y = Yc, where c is a point on the 'ceiling line' that separates the dark area with observations from the light area without observations.[2]

[2] Notably, the ceiling line can be linear and non-linear.

Insert Figure 2 and 3 near here

In sum, necessary conditions can be formulated in different ways. This can be in terms of "X is necessary for Y" in the dichotomous case or in terms of "A certain level of X is necessary for a certain level of Y" for discrete or continuous variables. This gives countless options for marketing research. In the next section, we introduce necessary condition analysis as a methodology for analysing necessary conditions empirically.

BASICS OF NCA

Necessary condition analysis (NCA) (Dul, 2016; Dul et al., 2020) is a novel approach and data analysis method that is based on the logic that certain conditions are necessary (but not sufficient) to achieve a specific outcome. By applying necessity logic, NCA differs fundamentally from conventional methods like correlation, regression, or structural equation modelling. In contrast to these methods, NCA does not try to predict the presence of an outcome, but to predict the absence of an outcome instead.

In order to identify necessary conditions, NCA looks for an empty space in the upper left-hand corner of a scatter plot.[3] Therefore, instead of drawing a regression line "through the middle" of the data in a scatter plot, NCA draws a ceiling line "on top" of the data. Several techniques can be used to draw ceiling lines. Two currently recommended techniques are Ceiling Envelopment - Free Disposal Hull (CE-FDH) and Ceiling Regression - Free Disposal Hull (CR-FDH). The *ceiling envelope* (CE) technique puts a piecewise linear envelope along the upper left observations. Ceiling envelopment with free disposal hull (CE-FDH) assumes that the ceiling is non-decreasing, resulting in a non-decreasing step function. *Ceiling regression* (CR)

[3] Again, necessary conditions can refer to the presence and/or absence of the condition and/or the outcome. This implies to look for empty spaces in different corners of a scatter plot. By default, the NCA software identifies empty spaces in the upper-left hand corner thus we focus on this case here. However, if researchers want to analyse necessary conditions that do not follow the standard logic implied here, they just need to choose another corner, which is facilitated in the NCA software.

smooths the piecewise linear function obtained by the CE techniques by using OLS regression through the upper left corners of the piecewise linear functions. Thus, CR-FDH draws a line through CE-FDH corners. The percentage of cases that are on or below the ceiling line defines the *accuracy* of a ceiling line (c-accuracy). The c-accuracy of CE-FDH is by definition 100%. The c-accuracy of the CR-FDH line is below 100%. CE-FDH is recommended for dichotomous and discrete (with few levels) necessary conditions, or when the ceiling pattern is irregular. CR-FDH is recommended for discrete (with many levels) and continuous necessary conditions or when the ceiling is assumed to be linear.

Figure 4 illustrates the CE-FDH and the CR-FDH ceiling line in an example where Sociability is assumed to be a necessary condition for the Sales ability of salesman (for more details on this example see below). The figure also shows the OLS regression line. While the OLS line addresses the average trend within the data, the ceiling line separates the zones with and without observations. Therewith, the ceiling line indicates which maximum Y (Sales ability) can be achieved for a given value of X (Sociability) or, in other words, which value of X is necessary for which level of Y.

Insert Figure 4 near here

The ceiling line(s) can also be displayed in a tabular form, which is called the *bottleneck table*. The first column in the bottleneck table is the outcome, the next column(s) is (are) the condition(s). Outcome and conditions can be expressed as a percentage of the range, actual values or as percentiles. Table 1 shows the bottleneck table for the previous example. The bottleneck indicates the necessary levels (minimum required levels) of the condition for a given value of outcome Y. For example, when an outcome level of only Y = 50% is desired, the condition (Sociability) is not necessary to achieve that outcome (NN = Not Necessary). However, when the desired Y is 80%, the condition must have a level of at least 23%. For 100% Sales ability, the bottleneck table predicts that Sociability must be also close to 100%.

Insert Table 1 near here

The size of the empty space above the ceiling line ('ceiling zone') relative to the size of the entire area that can have observations ('scope') defines the strength of the necessary condition. This can be expressed as d = C/S with d being the *effect size*, C the ceiling zone, and S the scope. The scope is defined by the minimum and maximum values of X and Y. This can either be the empirically observed minimum and maximum values ('empirical scope') or the theoretically possible minimum and maximum values ('theoretical scope'). The theoretical scope and the corresponding empty space are larger than the empirical scope and the corresponding empty space, and the effect size calculated with the theoretical scope is usually larger than the effect size calculated with the empirical scope. Thus, the empirical scope should be preferred in order to avoid over-estimation.

The range of d can be from 0 to 1 ($0 \leq d \leq 1$). In order to establish whether the effect size is practical meaningful, Dul (2016) suggested the following thresholds:

$0 < d < 0.1$ "small effect"

$0.1 \leq d < 0.3$ "medium effect"

$0.3 \leq d < 0.5$ "large effect'"

$d \geq 0.5$ "very large effect".

Since the observed effect size may the result of random chance, NCA also allows to evaluate the statistical significance of the effect (Dul et al., 2020). NCA uses an approximate permutation test that estimates the probability p that the data is the result of random chance when X is unrelated to Y. If this probability is very small (e.g., $p < 0.05$) it can be concluded that the observed sample is not the result of a random process of unrelated variables (the null hypothesis is rejected). Subsequently, the researcher may conclude that the hypothesis of interest (the alternative hypothesis) is supported.

Notably, NCA is fundamentally a bivariate analysis: only two variables are analysed at a time (one X and one Y). When more variables are potential necessary conditions (multiple NCA), the analysis is done for these conditions separately. This is possible because a necessary condition operates in isolation from the rest of the causal structure: The necessity of X_1 on Y does not depend on the necessity of X_2 on Y. A multivariate analysis that includes "all" variables plus "control factors" (e.g., as in multiple regression) is thus not needed.

When performing an NCA, researchers should perform an *outlier* analysis since NCA is very sensitive to some outliers. Indeed, the cases around the ceiling line are particularly important for two reasons. First, these cases determine the ceiling line. These cases may have sampling error or measurement error or may be an outlier (very high value of Y compared to other cases with similar X-values). When there is only one case in the "empty space" due to measurement error or sample error (e.g., the case does not belong to the population of interest), a wrong conclusion can be made. Thus NCA researchers must give particular attention to avoid measurement error and sample error. Second, cases around the ceiling line are "best cases" in the situation that X is a scarce resource, and Y is a desired output. These cases are apparently able to have relatively high desired outcome with relatively low resources. The question how to deal with few "outliers" that are not caused by measurement or sample error is not an easy one. In a *deterministic view* on necessity, every single case can falsify a necessity theory. Thus, if there is one single case in the upper left corner, the necessity hypotheses should be rejected. However, researchers could also opt for a more *probabilistic few* on necessity in that a few cases above the ceiling line are acceptable. Therewith, necessity statements are more flexible in terms like "practically", "virtually", or "almost always" necessary.

NCA can be performed with a free software package for R. The NCA software's main functions are to draw scatter plots with ceiling lines, calculate NCA parameters (e.g. ceiling zone, scope, effect size), and the bottleneck tables, and perform the significance test. In the next section, we will illustrate its application and main functions (for a quick guide on how to apply NCA with R, see also Dul, 2019).

APPLICATION AND MAIN FUNCTIONS OF THE NCA SOFTWARE

Data and model

In order to illustrate the application and the main functions of the NCA software, we use data from the Hogan Personality Inventory (Hogan & Hogan, 2007). This data contains information on personality traits and the sales ability of 108 sales representatives of a large US food manufacturer. 81.7% of the respondents are male and average age is 36.7 years (SD = 10.7 years).

The dependent variable in our example is *Sales ability* measured as the degree to which a person has effective demonstration, promotion, and selling of products and services. This was measured through supervisor rating of employee's performance bases on a seven items scale (alpha = 0.83). The independent variables are four personality traits of the Hogan Personality Inventory, namely *Ambition* (the degree to which a person seems leader like, status seeking, and achievement-oriented), *Sociability* (the degree to which a person needs and/or enjoys social interaction), *Interpersonal sensitivity* (the degree to which a person has social sensitivity, tact, and perceptiveness), and *Learning approach* (the degree to which a person enjoys academic activities and values education as an end in itself). Our guiding assumption is that these four personality traits are necessary conditions for the sales ability of sales representatives (see Figure 5).

Insert Figure 5 near here

How to conduct an NCA

In order to perform an NCA you first need to install and load the NCA R package in R. You can use the following commands:

```
install.packages("NCA")

library(NCA)
```

The first command downloads the NCA R package, which needs to be done if you use NCA for the first time. For an update to the latest NCA version you can use the `update.packages()` function. After the NCA package is installed, the `library()` function runs the NCA software. This needs to be done in every new R session.

In the next step you need to import the data you want to analyse. To do this, you can use the `read.csv()` function (or another data import function, depending on the format – SPSS, Stata, Excel etc. – you are using).

Once your data is loaded you can run a basic NCA with the `nca()` function. Thereby, you need to specify your data, the independent and the dependent variable. In our example, this looks as follows:

```
nca(Hogan, "Ambition", "Sales ability")
```

Our data set is called *Hogan*, the independent variable is *Ambition* and the dependent variable is *Sales ability*. By default, the `nca()` function provides the CE-FDH and the CR-FDH effect sizes as well as a scatter plot with the OLS, CE-FDH and CR-FDH lines. For our example, the following output is provided:

```
------------------------------------------------------------------
Effect size(s):
ce_fdh cr_fdh
 0.204  0.179
------------------------------------------------------------------
```

Insert Figure 6 near here

The scatter plot (Figure 6) shows an empty space in the upper left corner which is an indication of a necessary condition. This is also supported through the effect size. Since independent and dependent variables are continuous, we focus on the CR-FDH effect size which is *d* = 0.18 and can be characterized as “medium effect”.

You can also integrate multiple necessary conditions in the `nca()` function to analyse different necessary condition (multiple NCA) together:

```
nca(Hogan, c("Ambition",  "Sociability", "Interpersonal
   sensitivity", "Learning approach"), "Sales ability")
```

This provides the following outputs:

```
---------------------------------------------------------------------
Effect size(s):
                          ce_fdh cr_fdh
Ambition                  0.204  0.179
Sociability               0.221  0.193
Interpersonal sensitivity 0.113  0.108
Learning approach         0.129  0.139
---------------------------------------------------------------------
```

Insert Figure 7 near here

All scatter plots (Figure 7) show an empty space in the upper left corner and the CR-FDH effect sizes are all above 0.1. Thus according to the thresholds for a practical meaningful effect (Dul, 2016), Ambition (*d* = 0.18), Sociability (*d* = 0.19), Interpersonal sensitivity (*d* = 0.11), and Learning approach (*d* = 0.14) represent a medium necessary condition.

For a more detailed output you can use the `nca_analysis()` function followed by the `nca_output()` instruction. Thereby, the analysis can be given a specific name, like “model”. The command structure is as follows:

```
model <- nca_analysis (Hogan, c("Ambition",  "Sociability",
   "Interpersonal sensitivity", "Learning approach"),
   "Sales ability")

nca_output(model)
```

This provides you with a summary of key NCA parameters for all integrated necessary conditions. For the relationship between Ambition and Sales ability, this looks as follows:

```
---------------------------------------------------------------------
NCA Parameters : Ambition - Sales ability
---------------------------------------------------------------------

Number of observations 108
Scope                  549.224
Xmin                     1.000
Xmax                   100.000
Ymin                     0.000
Ymax                     5.548

                   ce_fdh  cr_fdh
Ceiling zone      112.011  98.246
Effect size         0.204   0.179
# above             0       4
c-accuracy        100%     96.3%
Fit               100%     87.7%

Slope                       0.045
Intercept                   2.530
Abs. ineff.       279.235 352.732
Rel. ineff.        50.842  64.224
Condition ineff.   26.263  33.230
Outcome ineff.     33.333  46.418
---------------------------------------------------------------------
```

The `nca_output` instruction can also be modified in order to also provide a bottleneck table for all necessary conditions:

```
nca_output(model, bottlenecks=TRUE)
```

This respective output looks like this:

```
---------------------------------------------------------------------
Bottleneck CR-FDH (cutoff = 0)
Y Sales ability             (percentage.range)
1 Ambition                  (percentage.range)
2 Sociability               (percentage.range)
3 Interpersonal sensitivity (percentage.range)
4 Learning approach         (percentage.range)
---------------------------------------------------------------------
Y         1    2    3    4
0        NN   NN   NN   NN
10       NN   NN   NN   NN
20       NN   NN   NN   NN
30       NN   NN   NN   NN
40       NN   NN   NN   NN
50       4.5  NN   NN   NN
60       16.9 NN   2.7  0.8
70       29.4 23.2 14.8 17.7
80       41.8 48.3 27.0 34.6
90       54.3 73.3 39.1 51.5
100      66.8 98.4 51.2 68.4
---------------------------------------------------------------------
```

Furthermore, the `nca_analysis()` function can be used to test the statistical significance of the effects. Therefore, you need to integrate the "test.rep" argument into the `nca_analysis()` function and to specify a large number of random samples (e.g., 10,000) which are created to obtain a distribution of effect sizes when the null-hypothesis is true (X and Y are not related). This distribution is used for comparison with the observed effect size and for calculating the *p* value. If the p value is small enough (e.g. $p < 0.05$), it is unlikely that the observers effect size is caused by random chance (for more details see Dul et al., 2020). The command structure looks as follows:

```
model<-nca_analysis(Hogan, c("Ambition",  "Sociability",
   "Interpersonal sensitivity", "Learning approach"),
   "Sales ability", test.rep=10000)

model
```

The respective output is:

```
---------------------------------------------------------------------
Effect size(s):
                          ce_fdh p     cr_fdh p
Ambition                  0.204  0.040 0.179  0.044
Sociability               0.221  0.003 0.193  0.004
Interpersonal sensitivity 0.113  0.315 0.108  0.380
Learning approach         0.129  0.190 0.139  0.165
---------------------------------------------------------------------
```

Thus, we find that the effects of Ambition and Sociability are statistically significant, while the effects of Interpersonal sensitivity and Learning approach are not statistically significant.

NCA vs. regression analysis

The results of the NCA have shown that Ambition and Sociability are meaningful and statistically significant necessary conditions for Sales ability. How do this results compare to traditional regression based analysis? – Table 2 shows both the results of OLS regression analysis and NCA. For each method we provide the results of a full model (i.e. a model where all independent variables were considered) and a reduced model (i.e. a model where Sociability is not considered as an independent variable).

The OLS results from the full model show that Sociability is the only personality trait that has a significant relationship with Sales ability. Based on this results researchers might conclude that Sociability is the only personality trade that is relevant for the selection of sales people. This stands, however, in contrast to the NCA results where Ambition and Sociability are both statistically significant necessary conditions for Sales ability. Both analysis refer to a different logic and provide different implications. The results of the OLS analysis points out that Sales ability can be increased (on average) if sales people show a higher score on the Sociability index. In contrast, the results of the NCA imply that a high levels of Sales ability cannot be achieved without a certain level of Ambition and Sociability.

Insert Table 2 near here

The comparison between the full and the reduced model highlights another feature of NCA: while results of the OLS regression become biased through the omitted variable, because Sociability correlates with the other independent variables and the depended variable, the results of the NCA are stable. The reason is that each necessary condition is analysed separately, thus omitting a variable does not have an effect on the results of the other variables.

APPLYING NCA IN MARKETING RESEARCH

First of all, NCA can be applied as a novel method in various marketing research frameworks and domains. It can add value with new insights as well as shed light on long-lasting dilemmas of what conditions are necessary for an outcome and which ones are only nice to have. Domains may include but are not restricted to the study of consumer markets, strategic marketing and marketing planning, marketing communications, personal selling and sales, and business to business marketing.

Consumer markets is an exciting field to study necessary conditions as it can inform ongoing academic discussion on understanding the necessary but not sufficient conditions of purchase decisions. Research shows that being isolated in terms of lack of seeking and giving advice about brand appears to be a necessary condition for pamper buying that refers to the purchase of products and services that the customer would normally be able to achieve without the purchase and are used for pleasure (Rauch, Deker, & Woodside, 2015). The evaluations of alternatives and motivational factors of customer needs such as the need for recognition (Lambert & Desmond, 2013) also have the potential for the exploration of new necessary conditions. There are remarks, for example, about the necessary nature of transparency for effective market functioning (Simintiras, Dwivedi, Kaushik, & Rana, 2015) that could be further investigated.

Strategic marketing plays a key role in the creation of vision, mission, and effective strategic marketing campaigns as part of a comprehensive system, aligned with the organisation's corporate identity (Peloza & Shang, 2011). Among other NCA applications, this domain would benefit from studying the necessary conditions of ensuring a good fit between strategic

marketing campaigns and corporate identity. Marketing planning (Madhavaram & Hunt, 2008) is the next level towards implementing strategic marketing principles: this systematic process involves the assessment of marketing opportunities, setting up objectives and scheduling steps to achieve the planned objectives. Applying NCA in this context could result in a better understanding on which steps are necessary for achieving certain objectives, where the bottlenecks are.

The *marketing mix* is a set of controllable tactical marketing tools that the firm combines to achieve the desired response from their target audience (Kotler & Armstrong, 2010) which tools are necessary within the marketing mix to effectively reach customers. While the emphasis is on the combination of different tools, there might be certain tools without which a desired outcome (for example, purchase or reputational benefits) cannot occur.

Necessary conditions are widely discussed but not always empirically investigated (or at least not from a necessity perspective) in the *marketing communications* domain. For example, consumer learning is posited as a necessary but not sufficient condition of persuasion (Yeh, Jewell, & Hu, 2013). Also, lobbying appears being a necessary but not sufficient condition for obtaining preferential treatment (Anderson, Martin, & Lee, 2018) or maintaining communication is necessary for firms to articulate and transfer knowledge (Park, Vertinsky, & Lee, 2012). NCA could be applied for theory testing in the mentioned marketing communication contexts.

The same applies to research on *personal selling and sales* – some examples of the discussed sales issues are the necessity of perceived organisational justice for the effective functioning of a sales organisation (Miao, Evans, & Li, 2017) and certain personal traits of salespeople being necessary for high performance (Rubel & Prasad, 2016). Further characteristics of salespeople that appear as potential necessary conditions of high performance include customer orientation (Homburg, Müller, & Klarmann, 2011), opportunity recognition ability (Leff Bonney & Williams, 2009) and competitive intelligence (Mariadoss, Milewicz, Lee, & Sahaym, 2014).

In *business-to-business marketing* trust is discussed as a necessary condition for continued inter-organisational interactions (Laaksonen, Pajunen, & Kulmala, 2008), customer involvement for efficient solution provision (Haas, Snehota, & Corsaro, 2012) and familiarity for attraction to occur (Hüttinger, Schiele, & Veldman, 2012). Furthermore, healthy financial situation appears as necessary but not sufficient condition of successful service provision in business-to-business contexts (Kowalkowski, Gebauer, & Oliva, 2017) and reciprocity as a criteria of maintaining effective supplier-buyer relationships (Blonska, Storey, Rozemeijer, Wetzels, & Ruyter, 2013). International marketing embraces various contextual factors inherent to international markets such as market size (Bausch & Krist, 2007), the economic growth (Sun, Peng, Ren, & Yan, 2012) of the country and political stability (Rosado-Serrano, Paul, & Dikova, 2018) as potential necessary conditions for successful internationalization. Further potential necessary conditions are discussed in relation to different modes of market entry, such as finding the right timing (Makadok, 1998) and possessing locally-specific skills (Anand & Delios, 2002).

The reviewed necessary conditions in marketing research can be grouped into three distinct categories: they are either actor-specific (for example, specific salesperson personality traits as necessary conditions for high sales performance), relationship-specific (for example, reciprocity to maintain business relationships) or contextual factors (such as political stability for successful internationalization). Future research should identify and empirically investigate more necessary conditions in marketing research – several of which are already discussed in literature but not tested yet. Illustrative cases for remarks on specific necessary conditions in marketing research are demonstrated in Table 3 – the list is far from extensive but should offer some starting points for future research investigations.

Insert Table 3 near here

CONCLUSION

NCA has been welcomed in a steady increasing number of research fields such as psychology (Karwowski et al., 2016), human resource management (Hauff, Guerci, Dul, & Rhee, 2021), hospitality and tourism management (Lee & Jeong, 2021), education (Tynan, Credé, & Harms, 2020) and international business (Aguinis, Ramani, & Cascio, 2020). The method has also recently entered the marketing field when Shahjehan and Qureshi (2019) studied the necessary personality characteristics for impulse buying. In our perspective, NCA is very promising for marketing research. This assessment is based on two reasons. First, the method sharpens theoretical thinking and engenders new theoretical insights. In every research field we find assumptions on necessity (Goertz, 2003) and researchers use various expression that refer (explicitly or implicitly) to necessity logic. However, necessity logic differs from sufficiency logic and researchers should be aware of the differences. Second, the results of NCA are highly relevant for marketing practice. If a necessary condition is identified, the condition must be in place in virtually every single case to reach the outcome. If the condition is not in place, the outcome will not occur and it makes no sense to focus on other causes to influence the outcome.

NCA can be applied either alone or in combination with other methodologies (e.g. Richter, Schubring, Hauff, Ringle, & Sarstedt, 2020). For example, when NCA is combined with regression analysis, the insights about the necessary of the variable for the outcome (evaluated with NCA), can be combined with the insights about the average contribution of the variable to the outcome (evaluated with regression analysis). Therewith, NCA provides different and additional insights.

ACKNOWLEDGEMENT

We are grateful to Karen Fuhrmeister of Hogan Assessments for providing the data of the illustrative example.

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ANNOTATED FURTHER READING

Dul, J. (2016). Necessary Condition Analysis (NCA): Logic and Methodology of "Necessary but Not Sufficient" Causality. *Organizational Research Methods*, 19(1), 10–52.

This is the core paper that introduces NCA. It discusses necessity logic compared to conventional average effect additive logic. The paper shows that traditional regression-based methods cannot be used for testing necessary condition hypotheses. The paper distinguishes between dichotomous, discrete, and continuous necessary conditions and provides a step-wise approach for testing necessary conditions with data.

Dul, J. (2020). *Conducting Necessary Condition Analysis*. London: Sage Publications.

This book provides a hands-on primer for conducting NCA in qualitative and quantitative research. It provides backgrounds of NCA, the main components of NCA, data analysis with NCA, examples of NCA applications, and discusses the strengths and weaknesses of NCA.

Dul, J., van der Laan, E., & Kuik, R. (2020). A statistical significance test for Necessary Condition Analysis. *Organizational Research Methods*, 23, 385–395.

This paper provides a statistical significance test of NCA to test whether or not the data are compatible with the null hypothesis that the (assumed) necessary condition is unrelated to Y. This test helps researchers to prevent false positive conclusions:

concluding that the condition is necessary when it actually is a random result of unrelated variables.

Karwowski, M., Dul, J., Gralewski, J., Jauk, E., Jankowska, D. M., Gajda, A.,. . . Benedek, M. (2016). Is creativity without intelligence possible?: A Necessary Condition Analysis. *Intelligence*, 57, 105–117.

This paper is one of the first applications of NCA that properly tests the long existing theory in psychology that intelligence is necessary for creativity. This much cited paper re-analyses nine existing datasets to conclude that high levels of intelligence are indeed necessary for high levels of creativity.

Figure 1. Types of causes

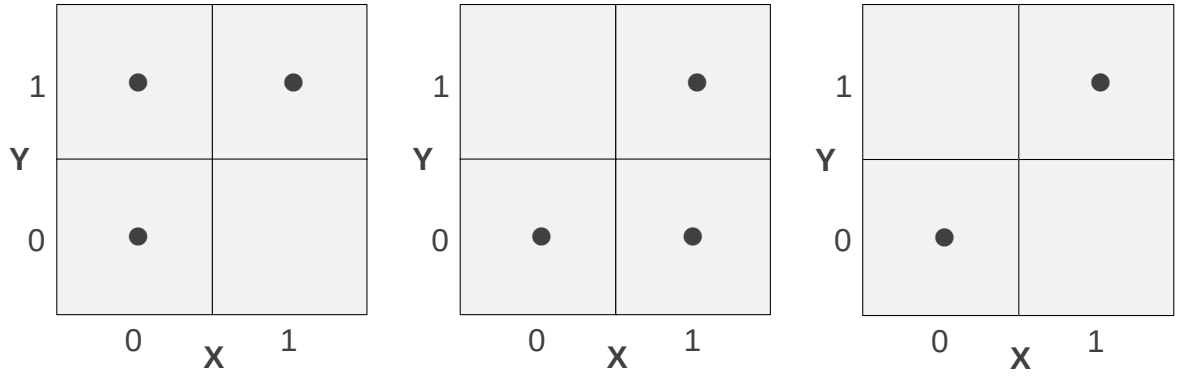


Figure 2. Discrete necessary conditions

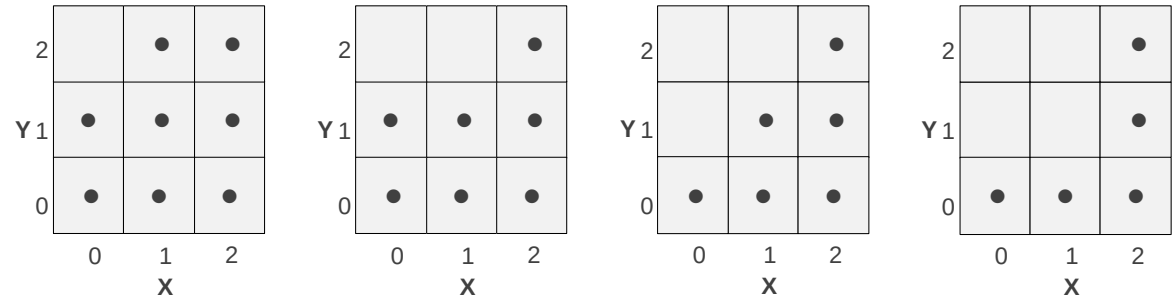
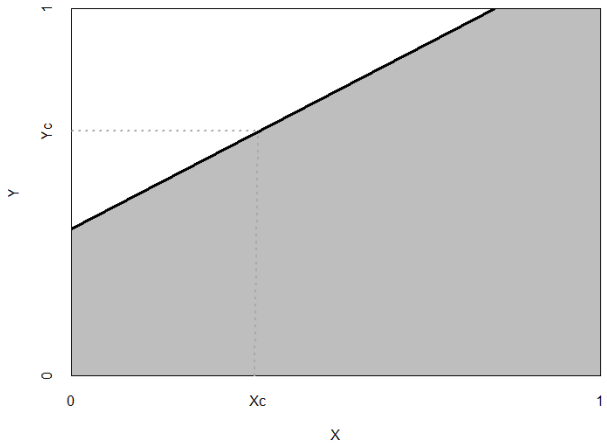


Figure 3. Basic continuous necessary condition



Xc is necessary for Yc

Figure 4. Ceiling Lines

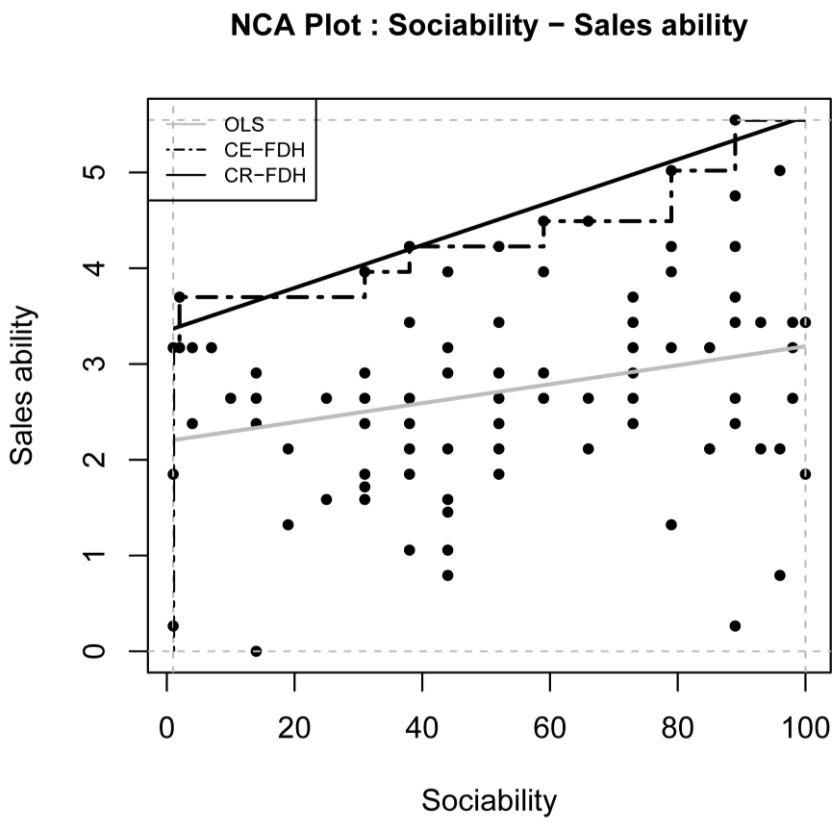


Figure 5. Personality traits as necessary conditions of sales ability

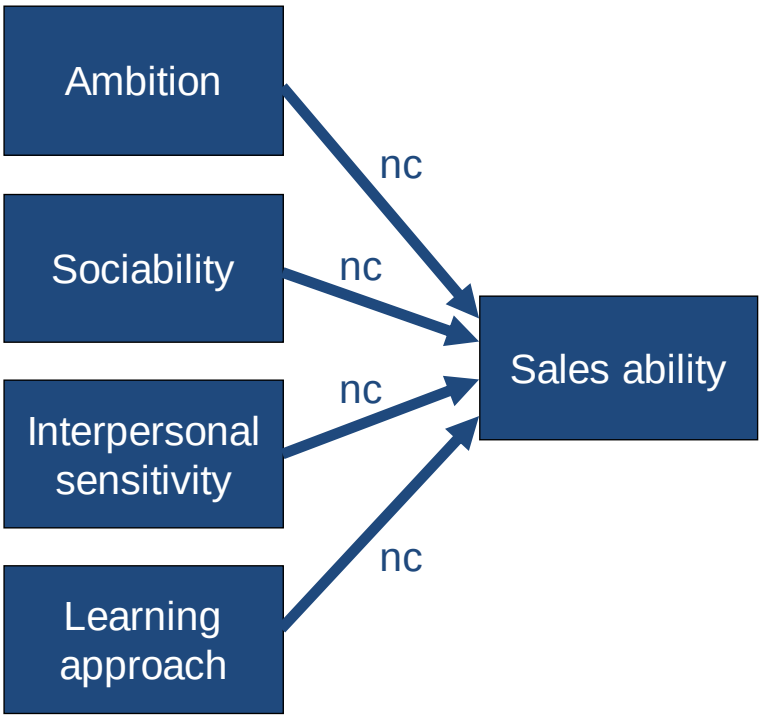


Figure 6: R plot for Ambition and Sales ability

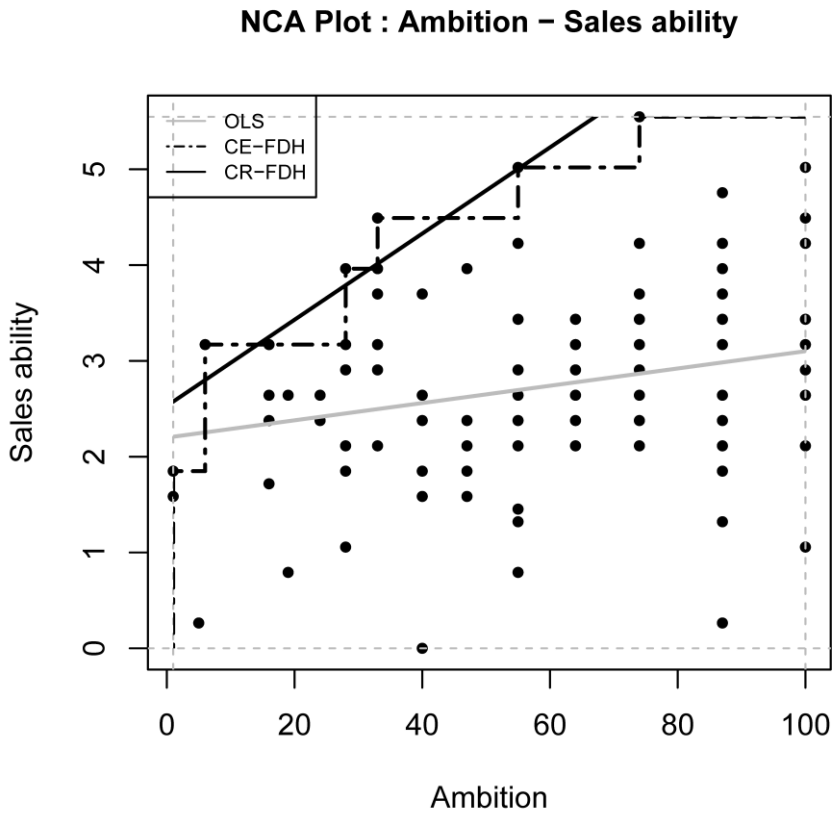


Figure 7: R plots for the multiple NCA

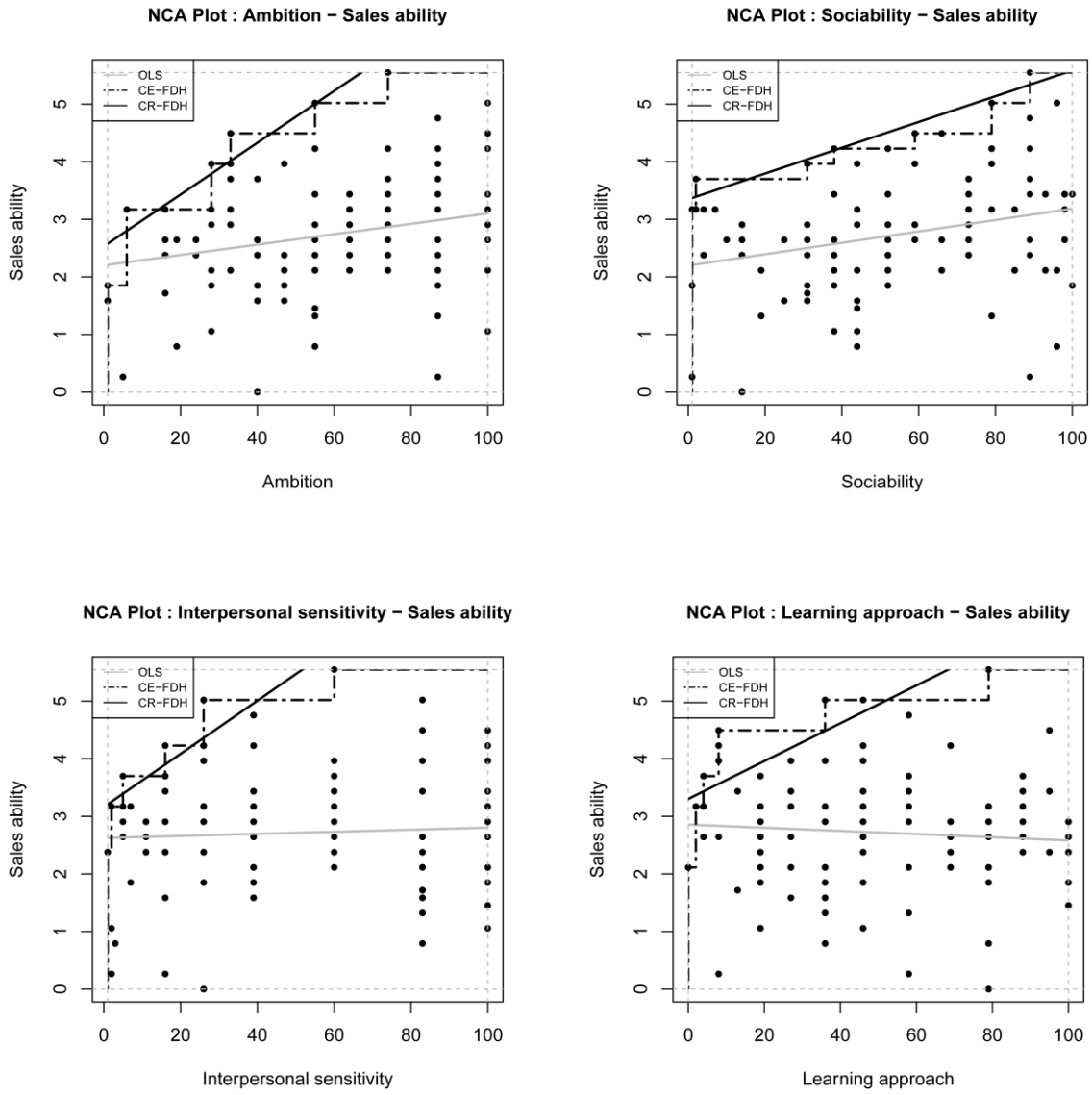


Table 1. Bottleneck table

Y Sales ability (%)	X Sociability (%)
0	NN
10	NN
20	NN
30	NN
40	NN
50	NN
60	NN
70	23
80	48
90	73
100	98

Table 2: OLS vs. NCA results

	OLS full model		**NCA full model**		**OLS reduced model**		**NCA reduced model**	
	B	p value	D	p value	B	p value	d	p value
(Constant)	2.115	0.000			2.363	0.000		
Ambition	0.007	0.059	0.179	0.044	0.010	0.006	0.179	0.044
Sociability	0.009	0.012	0.193	0.004	-	-	-	-
Interpersonal sensitivity	0.000	0.883	0.108	0.380	0.000	0.952	0.108	0.380
Learning approach	-0.006	0.055	0.139	0.165	-0.005	0.135	0.139	0.165
Adjusted R squared	0.101				0.053			

Table 3: Illustrative cases for remarks on specific necessary conditions in marketing research

Source	Research Design and Sample	Necessary but not Sufficient Statement
Augustin and Singh (2005)	1230 randomly selected individual consumers	"Satisfaction is a *necessary but not sufficient* component of loyalty" (p.96)
Bhattacharya and Sen (2003)	Theoretical review	"identity attractiveness in the customer-company context is likely to be a *necessary but not sufficient condition* for identification" (p.81)
Ellis and Pecotich (2001)	Theoretical review	"exports cannot be initiated without the coexistence of three *necessary but not sufficient conditions:* (1) the capability to go abroad, (2) the motive to go abroad, and (3) the awareness of a particular market opportunity" (p.119)
Gebhardt, Carpenter, and Sherry Jr. (2006)	Theoretical review	"These cultural values, however, appear to be *necessary, but not sufficient*, for the presence of market-oriented behaviors" (p.52)
Kennedy, Goolsby, and Arnould (2003)	Observations, in-depth interviews, focus groups, documentation	"if senior leadership is *necessary but not sufficient*, what are the key factor that differentiate successful from unsuccessful implementation?" (p.71)
Lilien (2004)	Theoretical review	"A problem focus and an insights-actions correspondence are *necessary but not sufficient* conditions for success" (p.190)
Noble, Sinha, and Kumar (2002)	Case studies	"In this view, market orientation is described as a *necessary, but not sufficient*, factor in the creation of a learning organization" (p.30)
Im and Workman Jr. (2004)	1080 project managers drawn from the CorpTech Directory of Techonology Companies. Field Survey	"All innovation begins with creative ideas.… [C]reativity by individuals and teams is a starting point for innovation; the first is a *necessary but not sufficient condition* for the second" (p.114)
Ulaga and Eggert (2006)	Theoretical review, with a qualitative study	"cost competitiveness emerges as a *necessary but not sufficient* condition to gain key supplier status" (p.131)