

Editorial

Death to Dichotomizing

Why call for a death to dichotomizing? The *Journal of Consumer Research* receives manuscripts on an almost daily basis in which researchers have dichotomized (often referred to as median splitting) a continuous independent variable. There are two principal problems with this approach to data analysis, each of which is very well documented in the literature. The first is that by dichotomizing continuous independent variables researchers are quite likely reducing the statistical power available to test their hypotheses (Irwin and McClelland 2003). The second, potentially more troubling, problem is that inappropriate dichotomizing of continuous data can at times create spurious significant results if the independent variables are correlated (Maxwell and Delaney 1993). And yet, despite these well-known problems, dichotomizing is an extremely frequent activity for experimental consumer researchers. The goal of this editorial is not to write an in-depth methodological piece on this subject but rather to briefly outline why all consumer researchers should be concerned about this topic. I also hope to illustrate how we can easily write up appropriately conducted analyses when our research designs include continuous independent variables. (For more thorough, methodological pieces on this topic I suggest an excellent and concise article in the *Journal of Marketing Research* [Irwin and McClelland 2001] or a truly comprehensive guide to performing analysis including continuous independent variables and interactions [Aiken and West 1991].)

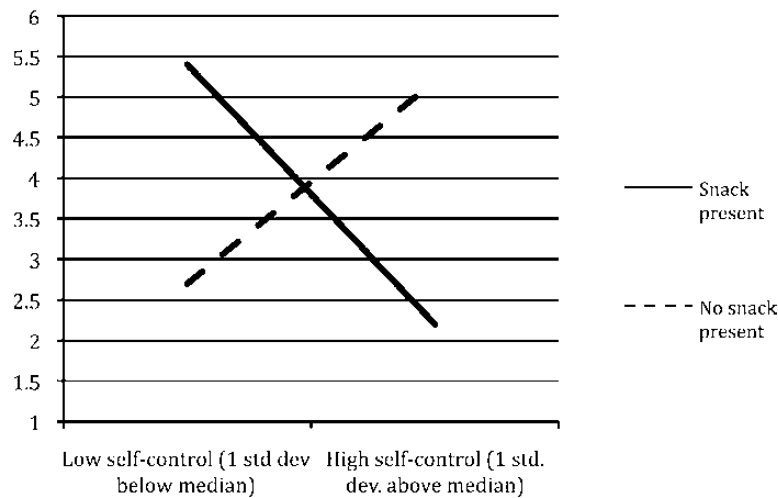
Likely the most common research design utilized by experimental consumer researchers is a very straightforward manipulation of one or more independent variables that the researcher believes will affect a dependent variable. Virtually all consumer researchers learn at one point how to describe and analyze such designs and are typically quite adept at it. For example, a researcher manipulates two independent variables between subjects and performs a two-by-two ANOVA examining their impact on a dependent variable measured on a simple 1–10 scale. Such designs are so easy to analyze and describe that many consumer researchers are reluctant ever to deviate from this approach to research.

The problem arises when a simple ANOVA framework does not map onto the actual research design the researcher has implemented. One of the most common deviations from the standard research design described above is to measure, rather than manipulate, one of the key independent variables. For example, a researcher might design a study in which he or she is interested in the interaction between consumer self-control and the presence of a tempting snack on consumer happiness. As self-control is difficult to manipulate at the individual consumer level, the researcher decides to use a multi-item measure to capture differences in self-control among participants. This measure consists of three 1–7 items that are averaged to create an individual self-control score. Now the research design has one manipulated variable (e.g., presence or absence of a tempting snack) and one measured variable (e.g., the individual measure of self-control), and the researcher seeks to understand how these two variables interact to affect a consumer's happiness.

After running their studies, many consumer researchers continue to perform the inappropriate action that is the subject of this editorial: they dichotomize their measured independent variable. In the example above, many researchers would perform a median split on their self-control data and create a new variable that is coded as "high" when the participant's self-control score is above the median and "low" when that score is below the median. The researcher would then run a two-by-two between-subjects ANOVA with snack presence and self-control as independent variables and consumer happiness as the dependent variable. Conducting and explicating such an analysis is very familiar to most researchers. Unfortu-

FIGURE 1

HYPOTHETICAL EFFECT OF CONSUMER SELF-CONTROL AND SNACK PRESENCE ON CONSUMER HAPPINESS



nately it is also inappropriate and could potentially lead to misleading interpretations of the researcher’s hypothesized relationship.

The most typical explanation or justification for dichotomizing and reducing to an ANOVA framework is that it is easier and more parsimonious to present to the reader. I would like to suggest that, with only limited effort, data analyzed appropriately can be just as clearly presented to the reader and will not fall prey to the potential problems associated with dichotomizing. Irwin and McClelland (2001) nicely lay out an example of how to perform the analysis correctly, so I will only briefly summarize the correct approach: the researcher should regress the dependent variable on the continuous independent variable, the manipulated independent variable, and their interaction (note that logistic regression can be trivially substituted if the dependent variable is binary in nature). This is very easy for most researchers—the challenge for many comes in describing the results in a clear manner.

To illustrate how easy it can be to describe the appropriately performed analyses, I will use the hypothetical research design described above and compare descriptions of hypothetical data analyzed inappropriately (using the dichotomized independent variable in an ANOVA) and appropriately (using the continuous independent variable in a regression). Imagine that the results obtained by the researcher were as shown in figure 1.

A researcher who inappropriately performed an ANOVA would report “a significant two-way interaction between snack presence and self-control” with the corresponding *F*-test statistics. A researcher who appropriately performed the corresponding test in a regression would use the exact same language. To decompose the interaction, a researcher inappropriately using ANOVA would perform planned comparisons. Let us imagine that they wanted to determine if the decrease in happiness when a snack was present was significant between the dichotomized “low” and “high” self-control levels. They would report that “a planned comparison between low and high levels of self-control when snack was present was significant.” When doing the appropriate regression analyses, this statistical test is simply the slope of self-control at the “snack present” level of the manipulated independent variable (the solid line in fig. 1). This slope is easily found by examining the parameter and significance for self-control when the dummy variable for the manipulated variable is set to zero if a snack is not present. The language to report it is straightforward: “the slope of self-control is significant and negative when a snack was present.” Similar language would be used to report the positive slope when a snack was not present (the dashed line in fig. 1); the statistical

test for this slope is obtained by reversing the coding of the independent manipulated variable so the dummy variable is set to zero when a snack was present.

If the researcher's hypotheses had focused on consumer happiness at, for example, high levels of self-control, in the inappropriately performed ANOVA the researcher would report that "a planned comparison at high levels of self-control between participants in the snack present versus snack not present conditions was significant." To perform a similar analysis in the appropriately performed regression utilizing the continuous self-control data, the researcher performs a "spotlight" analysis at one or more standard deviations above the mean level of self-control. By mean-shifting the self-control data up or down (i.e., adding a constant to all self-control responses, thus "shifting" the mean higher or lower) the researcher can focus the "spotlight" on the region of self-control in which the researcher would like to test for differences across snack present or not conditions. At, for example, one standard deviation above the mean level of self-control, the statistical test for differences across snack present or not is given by the parameter and significance of the snack present dummy variable in the regression equation. The researcher would report that "a spotlight analysis at one standard deviation above mean self-control showed a significant difference such that high self-control consumers were happier when no snack was present versus when a snack was present."

Pulling together the elements of the appropriately conducted regression model description above, researchers could describe their results as follows (statistics omitted for simplicity):

A regression was performed on consumer happiness with independent variables (i) self-control, (ii) a dummy variable for whether or not a snack was present, and (iii) their interaction. The results showed a significant two-way interaction between self-control and whether a snack was present or not. To explore the interaction, we examined the slopes of self-control at each level of snack presence. The slope of self-control was significant and negative when a snack was present, while the slope of self-control was significant and positive when a snack was not present. In addition, a spotlight analysis at one standard deviation above the mean of self-control showed a significant difference such that high self-control consumers were happier when no snack was present versus when a snack was present. A similar spotlight analysis at one standard deviation below the mean of self-control showed a significant difference such that low self-control consumers were happier when a snack was present versus when it was not.

This very brief description is based on appropriately performed regression analyses that utilize the continuous nature of the independent variable that the researcher measured. It is clear what the statistical tests mean, and this approach is no longer than an analogous description based on the inappropriate approach utilizing an ANOVA framework. From the *Journal of Consumer Research's* perspective, the relatively small investment in appropriately analyzing and presenting data involving a continuous independent variable is certainly justified compared to the costs of not doing so (e.g., sacrificing statistical power in our hypotheses tests, potentially spurious significant results). I hope this editorial illustrates how easy it can be to present analyses that are performed appropriately. While I have illustrated this perspective using an example of a design with one two-level manipulated variable and one continuous variable, similar approaches can be taken when research designs include variables with more than two manipulations or more than one continuous variable and so on (see Aiken and West [1991] for details). I hope that this editorial will help hasten a death to dichotomizing continuous independent variables—its day, I hope, is behind us.

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