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A simulator of the degree to which random responding leads to biases in the correlations between two individual differences

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ABSTRACT

Random responding can inflate Type I and Type II error rates (Huang, Liu, & Bowling, 2015b, *Journal of Applied Psychology*, *100*). Type II error inflation often involves certain variables having Invalid Centered Responses And Valid Uncentered Responses (ICRAVUR; pronunciation: /aikreɪvər/). Although Huang et al. (2015b) offer a set of formulas for calculating the expected bias in a correlation when such variables are present, they do not offer a way to simulate the effects. We offer two sets of Monte Carlo simulations of ICRAVUR variables. Study 1 examines the correlation between narcissism and psychopathy—thought to be a large effect. The effect was inflated (by $r = 0.16$), comparable to what the Huang formulas forecast. Study 2 examines the correlation between secure attachment and self-esteem—thought to be a large effect. The effect was inflated (by $r = 0.26$), but this time the simulation result was larger than the forecast from the Huang formulas. Thus, our simulator offers a way to test tailored hypotheses about specific variables—sometimes yielding effects more extreme than the Huang formulas. We guide the readers through software, available at the first author's website, allowing for estimating the impact of ICRAVUR variables on any Pearson correlation.

1. Introduction

Random responding can inflate correlations under certain empirical conditions (Huang et al., 2015b). This may seem counterintuitive, as classic texts argue that random responding attenuates relationships (Nunnally & Bernstein, 1994). After all, random responding adds noise to a given variable and this will decrease reliability thereby presumably attenuating associations with external correlates. Thus, the traditional logic is that random responding is little more than a nuisance that ultimately reduces statistical power (i.e., the ability to detect a true effect that exists in nature). Random responding can make correlations more extreme (Huang et al., 2015b) under the following three conditions: (a) There are participants who respond in a valid way in which the mean response falls away from the midpoint of the scale—these are valid uncentered responses; (b) there are participants who respond in a random way thereby yielding averages in the middle of the scale—these are invalid centered responses; and (c) the first two conditions are met for both variables that enter into the correlation. Because the variables involve Invalid Centered Responses And Valid Uncentered Responses, we call these ICRAVUR variables (pronunciation: /aikreɪvər/, like the word "eye", the word "crave", and the suffix "er").

We aim to do several things in this paper. First, we reiterate the point made by Huang and colleagues: Random responding is a serious threat to making valid conclusions in research on individual differences. Accordingly, we encourage readers to first consult the work of Huang and colleagues before reading this paper. Second, we demonstrate that ICRAVUR variables may be even more detrimental than Huang and colleagues show. Third, we guide the reader through an easy-to-use Excel spreadsheet that facilitates estimating the impact of ICRAVUR variables. Fourth, we apply this research to two specific widely researched correlations in social-personality psychology—namely, the association between narcissism and psychopathy and the association between self-esteem and secure attachment. This will provide some concrete implications of ICRAVUR variables. Last, in the General Discussion, we provide guidance about how to reduce random responding, given the emerging consensus that it is so insidious (Huang et al., 2015b).

To begin, we will walk the reader through an illustrative case of how ICRAVUR variables manifest in a biased correlation, shown in Fig. 1. The two ICRAVUR variables are measured on Likert-type scales that range from one to five. In this particular situation, there are fourteen total respondents; half are random respondents and half respond in a valid way. The seven respondents who respond in a valid way yield scores clustered around the bottom left part of the figure (near x = 1.5, y = 1.5). This is the type of scenario one might expect on some measures of psychopathology—most people score low; these are the valid

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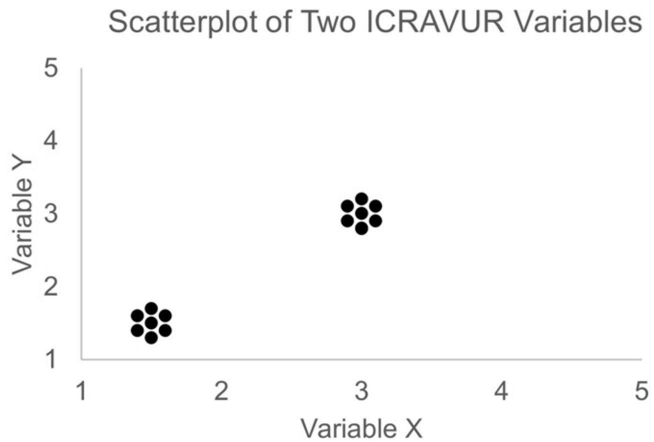

Fig. 1. Scatterplot of two ICRAVUR variables. The correlation between them produces a large positive correlation, despite the fact that in reality there is no correlation between the two variables within valid respondents.

uncentered responses. In addition, there are seven respondents who respond in an invalid (and, in this case, random) way, yielding scores clustered around the middle part of the figure (x = 3.0, y = 3.0); these are the invalid centered responses. This clustering in the middle is to be expected when participants are responding randomly. For instance, a random respondent may select a "1", a "3", and a "5" on a three item scale—thus averaging to 3.00 overall. The reader will note that each of the variables (X and Y) can be considered an ICRAVUR variable, as each variable has invalid centered responses and valid uncentered responses. It is the process of correlating two ICRAVUR variables that ultimately leads to more extreme correlation magnitudes. In this case, the correlation among only valid responses is essentially 0.00 (and the correlation among only invalid responses is likewise 0.00), but the correlation among all responses is virtually 1.00. This is an extreme case, but it illustrates how much of an impact two ICRAVUR variables might have on one's research conclusions. One must consider the invalid centered responses (ICR) in conjunction with the valid uncentered responses (VUR) in order to see the impact ICRAVUR variables can have on correlation magnitudes.

Thus far, in this paper, we have reiterated arguments by Huang and colleagues (2015b); indeed our research would be impossible without theirs. However, we take their arguments further. In particular, the process outlined in their paper does not capture item-level responses, nor does it capture within-person variation on a particular measure (see their Formula 13). So, although Huang can indeed approximate the bias, confidence in that estimate is lacking. The bias in the correlation could be smaller or larger than what the Huang paper and formulas imply. Thus, it is necessary to create a simulation that takes into account both the item-level responses and the within-person variation on a particular measure (in addition to all of the factors Huang and colleagues account for). Thus, we aim to extend the utility of Huang's argument by using a Monte Carlo simulator for the same purpose (i.e., estimating the magnitude of the bias in r). This will allow us to determine if there are cases in which the inflation of Type I errors might be even more likely than Huang and colleagues suggested (Indeed, we will show that this is true).

In the cases we present in this paper, we will show how ICRAVUR inflates the key correlations toward +1.00, although it is possible that a correlation may be biased toward −1.00 under different circumstances. We examine two different, yet widely discussed associations in the social-personality psychology literature: the association between narcissism and psychopathy (Study 1) and the association between secure attachment and self-esteem (Study 2). The first study has implications for the literature on the debate about the extent to which narcissism and psychopathy are separate constructs (Jones & Paulhus, 2011; Muris, Merckelbach, Otgaar, & Meijer, 2017; Vize, Lynam, Collison, & Miller, 2016) and the second study has implications for the literature on the correlates of attachment security and how attachment is related to self-esteem and possibly depression (Hart, Shaver, & Goldenberg, 2005; Roberts, Gotlib, & Kassel, 1996).

1.1. Software

We present two simulation studies using a Microsoft Excel file that could generate output given certain input specifications (available at https://nickholtzman.com/publications/). First, the file has in it an option for including up to 1000 participants. It also has an option for the fraction of valid participants. For each survey, the user must specify: (1) the number of items up to 100, (2) the lowest Likert scale response option (e.g., 1 on a 5-point Likert-type scale), (3) the highest Likert scale response option (e.g., 5 on a 5-point Likert-type scale), (4) the mean of valid responses based on prior research, (5) the standard deviation of valid responses across participants from prior research, (6) the within-person standard deviation of responses from prior research, and (7) the mean of invalid responses, which is the center point on the scale (e.g., 3 on a 1-to-5 Likert-type scale). Based on the number of participants specified and the fraction of valid participants, the program creates a list of the participants who are providing valid, non-random data.

If a participant is providing non-random data, then their true score is the mean of valid responses plus some random normal deviate; the standard deviation for the non-random data is the standard deviation of valid responses across participants. If the participant is providing random data, then their theoretical true score is the scale midpoint. The program simply generates a random number given the endpoints of the scale (e.g., 1 to 5 using a 5-point scale). For the non-random data, the program cuts off the scores at the lower limit and upper limit; that is, if a random normal deviate pushes a score outside of the range of possible values on the scale, then the program pulls the score back within range. The true score—definitely within range after applying the algorithm—is provided. Next, the program generates a score for the first item, with the normal deviate, where the deviate is generated based on the within-person standard deviation of responses that the researcher specifies. The same upper limits and lower limits are applied in order to adjust data that is out of the Likert range, and then the final score for that particular item is generated. This process is repeated for all items, up to the number of items specified by the user. The final item scores are averaged for the survey. This process is repeated for the second survey.

The program returns the expected correlation when the correlation in the population is actually zero (it calculates the expected correlation 50 times, simultaneously, labeled "Trials"). This provides 50 estimates of the bias in the observed correlation. Negative expected correlations indicate that the correlation estimate in empirical work is biased toward −1.00. Positive expected correlations indicate that the correlation estimate in empirical work is biased toward +1.00. Finally, the program is also designed to calculate Cronbach's alpha for an estimate of internal consistency; it is currently programmed to calculate alpha only on the data shown (i.e., not 50 times over).

2. Study 1

2.1. Introduction to Study 1

In the first study, we estimate the relationship between narcissism and psychopathy. Narcissism involves traits such as arrogance, entitlement, and vanity (Raskin & Terry, 1988); psychopathy involves traits such as callousness, recklessness and antisocial behavior (Neumann & Hare, 2008). Recently, researchers have highlighted the finding that these traits are "substantially intercorrelated" (Muris et al., 2017, p. 183). Indeed, the correlation between narcissism and psychopathy is estimated to be 0.42, with a 95% CI of 0.39 to 0.45 (O'Boyle, Forsyth, Banks,