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Forced Choice for Response Style Bias

Forced Choice to Overcome the Cross-Cultural Response Style Bias Problem

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Abstract

Two formats, traditional Likert scale single statements and two-alternative forced choice statements, were administered to samples from the United States and China to examine whether format influences response biases. Examination of response anchor usages and decision making processes from the two samples using an item response tree model yielded conclusions consistent with findings of prior studies--traditional Likert scale single statements exhibited cross-cultural response style differences: Chinese respondents engage in significantly less endpoint endorsement. Such response style differences can produce measurement nonequivalence across cultures. In contrast, a two-alternative forced choice format with Item Response Theory scoring yielded latent trait score estimates substantially correlated with estimates from other measures, demonstrating convergent validity, but with much smaller differences in trait variance across cultural groups. Thus, the two-alternative forced choice format appears to be an effective format for reducing the impact of cross-cultural response style bias. Implications for practice and extensions for further research are discussed.

Keywords: cross-cultural response bias, forced choice, item response theory

Forced Choice to Overcome the Cross-Cultural Response Style Bias Problem

Despite the wide use of various assessment tools in organizational settings, questionnaires and surveys are likely to remain as the the most pervasive data sources. In these questionnaires, item formats have been substantially limited to the Likert rating scale. Here respondents are asked to choose from a series of response options (e.g., a rating scale with 1 = strongly agree, 2 = agree, 3 = neutral, 4 = disagree, and 5 = strongly disagree) to indicate how well the item describes them (Pedhazur & Schmelkin, 2013). It has long been known that a serious concern about Likert scales is their susceptibility to response style effects (Cronbach, 1946). Response styles can be defined as systematic tendencies to respond to questionnaire items on some basis other than what the items were designed specifically to measure (Paulhus, 1991; Rost, 2004). Different types of response styles reflect individual differences in interacting with the response scale. For example, the extreme response style (ERS) describes the tendency to prefer extreme categories. Response styles have been found to be largely stable when responses are given to similar items both within a short time period and across a prolonged duration of time (e.g., Weijters, Geuens, & Schillewaert, 2010; Wetzel, Lüdtke, Zettler, & Böhnke, 2015). When such response styles differ across cultural groups, the dimensionality of the measurement and the validity of survey data may be affected (Baumgartner, 2008; Weijters, Schillewaert, & Geuens, 2008), rendering measurement equivalence degraded, comparisons across cultures problematic, and results possibly distorted (Wetzel, Boehnke, & Brown, 2015). This creates substantial difficulties for cross-cultural research (Beaton, Bombardier, Guillemin, & Ferraz, 2000).

In this article, we address the problem of cross-cultural response style biases in two parts. In Part I, we investigate cross-cultural response style bias in Likert rating scales by comparing United States and Chinese samples. First, we describe the commonly observed cross-cultural

response style bias, which presents itself as a culture-induced tendency for respondents to rate in a way that might not reflect their true level of the construct in question. Second, we summarize existing methods for modeling the aforementioned bias. Lastly, we examine response category usage and endorsement decision making processes from cross-cultural samples to confirm the existence of cross-cultural response style bias. In Part II, rather than further demonstrating the problem, we offer an alternative approach. We first argue that the two-alternative forced choice (2AFC) format may reduce cross-cultural response style bias. Then we present a study that tested this proposition.

PART I

Response Biases in Cross-Cultural Studies

Cross-cultural research, rapidly becoming one of the most important aspects of Psychology, is carried out in two or more cultures (Shirayev & Levy, 2014). For comparisons examining the influences of culture, assessments of psychological variables, such as values, attitudes, beliefs, and personalities, must yield scores with little or no bias. That is, any observed differences between cultures should represent true cultural differences, not test-irrelevant factors, such as response styles. However, it has been found that culture affects the way people respond to rating scales (Chen, Lee, & Stevenson, 1995; Hamamura, Heine, & Paulhaus, 2007). Specifically, individuals from Western cultures tend to use extreme response categories, whereas people from Eastern cultures more often use intermediate categories (Johnson, Kulesa, Cho, & Shavitt, 2005; Dolcinar & Grun, 2007; Harzing, Brown, Koster, & Zhao, 2012). Such discrepancies in response styles may potentially lead to spurious differences in observed

responses, when true cross-cultural differences in the measured traits may be only trivial, and alternatively, observed lack of differences may be found when true differences exist.

Several studies confirm the existence of cultural differences in responses to Likert scales. Dolcinar and Grun (2007) found that it is much less likely for Asian respondents to choose the endpoints of a scale, and Asian respondents' endorsements are more frequent in the middle range. Moreover, response style has been found to be related to the individualism-collectivism dimension (Hofstede, 1980). Later, de Jong, Steenkamp, Fox and Baumgartner (2008) found a positive correlation between ERS and individualism. In addition, Harzing and colleagues (2012) had respondents rate behavior-based statements and examined the inter-cultural and intra-cultural aspects of response style differences with a sophisticated research design, incorporating acculturated groups and scale anchors into their sample and rating scales. Their results showed that culture and individual background differences impact respondents' response styles. These differences in response styles could affect the results of statistical analyses by causing spurious relationships between variables (Moors, 2012) or by misrepresenting relationships (Wetzel, Bohnke, Carstensen, Ziegler, & Ostendorf, 2013), and create a challenge for interpretations of the data, leading to inaccurate conclusions about the constructs measured. Such discrepancies represent a significant source of concern about findings from cross-cultural research using Likert rating scales, underscoring that it is extremely important to take into consideration response style differences when designing a measurement scale and when interpreting data collected across cultures.

Correcting for Response Style Biases

Several methods for dealing with response style biases have been proposed. These methods include operational action such as changing the mode of data collection (e.g. Weijters,

Schillewaert, and Geuens [2008] found that response style differences appeared less often in computerized testing than in traditional paper-and-pencil testing), instrumental action such as switching to another response format (e.g. Weijters, Cabooter, and Schillewaert [2010] found that the number of categories and labeling of response options influenced response biases), and post-hoc analytical action such as employing different statistical procedures (e.g. within-individual score standardization).

Webster (1958) suggested an analytical correction method based on linear regression, calculating frequency indices to quantify respondents' response styles and regressing trait scores on those indices to get regression residuals. Baumgartner and Steenkamp (2001) as well as Weijters and colleagues (2008) extended the regression method by regressing trait scores on multiple response style indices concurrently and by using non-trait-overlapping items to compute the response style indices. Though it is simple to implement the regression-based approaches, the method requires the assumption of a linear relationship between traits and response styles, which may not always be met.

Rost, Carstensen, and von Davier (1997) applied mixed Rasch models to differentiate subgroups of respondents with systematically different response behaviors, so that trait estimates coming separately from within each subgroup are comparable across subgroups. This method uses only the trait items, but it is limited in not showing quantitative differences among different response styles and only working to differentiate between ERS and non-ERS.

Moors (2003) proposed a model based on the Latent Class Factor Analysis (LCFA) approach (Magidson & Vermunt, 2001) to deal specifically with ERS, by defining a latent variable model containing an ERS factor independent from the substantive factors of interest, so that an observed trait estimate can be differentiated from the ERS factor. This model fitted well

and facilitated parameter interpretation (Morren, Gelissen, & Vermunt, 2011). However, it does not disentangle the effects on the item response simultaneously of both the substantive trait and response style and can only accommodate a few response style types (Bolt, Lu, & Kim, 2014).

To complement methods developed for ERS, Maydeu-Olivares and Coffman (2006) proposed a method factor using a random intercept model to account for ARS, with the assumption that endorsements for both positively and negatively worded items are positive and equal indicators of acquiescence, but this method requires a balanced scale.

Bolt and Johnson (2009) proposed a method to correct for response styles utilizing multidimensional item response theory. Trait estimation for these models takes into consideration information from both the response style and trait dimensions (Bolt & Newton, 2011). This modeling method can also be extended to multiple response styles and model all characteristics simultaneously. However, this method has limitations that it only captures scale-specific response styles and is blind to dependency relationships between traits and response style dimensions (Wetzel & Carstensen, 2015).

Most of the approaches mentioned above have the disadvantage that they cannot demonstrate that the estimates used for representing response styles really do represent response styles and not—at least in part—something else (Khorramdel & von Davier, 2014). To solve this problem, another approach attempting to address response bias issues is anchoring vignettes—a method using additional hypothetical portrayals to identify and quantify differences in the ways people perceive identical scale information and to correct for such differences (King, Murray, Salomon, & Tandon, 2004). However, empirical applications of this approach have found that respondents sometimes fail to provide vignette scores that are strictly ordered (Möttus et al., 2012),

meaning that vignettes are often not perceived in the same way by every respondent, which violates a major assumption of this method.

Lastly, a crude but widely used response style correction method is dichotomization. It attempts to eliminate ERS by converting the originally polytomous item responses to dichotomous scores. However, this way of reducing the effects of ERS involves sacrificing the information in polytomous scores, which seems less than optimal.

Responding Processes and Response Style Biases

Although the consequences are believed to be severe and correction methods have been proposed, there has always been skepticism within the field that observed differences in responses are actually a reflection of response style differences. Without concrete proof of response style differences across cultures, claims about cross-cultural response style bias are just speculation.

To provide evidence based on data, a recently proposed item response theory (IRT) tree model, the Tree Process Model (TPM; Böckenholt, 2012; Böckenholt, 2017), can be used to examine the legitimacy of claims of cross-cultural response style bias from the standpoint of response processes. Böckenholt (2012) suggested that multiple response processes occur when respondents answer rating scale items, and that IRT tree models (De Boeck & Partchev, 2012) can be used to estimate these processes.

Under the TPM, a respondent's decision to choose a specific response option is guided by underlying processes following three distinct sequential decision-making steps: indifference, direction, and intensity. Figure 1 illustrates the three-step tree process model for a 5-point Likert item responding process. In the first step, *indifference*, respondents decide whether they have a clear preference about the item content and, if not, they would endorse the neutral category and

the response process ends. If respondents do not feel indifferent about the item, they move into the second step, *direction*, during which they decide whether they agree or disagree with the item content. In the third step, *intensity*, respondents decide how strong their attitude regarding the item is and choose between the extreme response option and the less extreme one. Therefore, responses are either governed by one decision-making step or three. To adapt the TPM to fit 4-point Likert scales, the indifference step can be eliminated, and a two-step tree process can be used to model responses.

Especially important for modeling response styles, the TPM does not presume that the decision making processes relate to the item content—so if individual differences such as response style biases in any one of the processes exist independently from item content, respondents must show similar tendencies across different items or scales. Among the subprocesses defined by the TPM, the direction and intensity responses have been found to reflect acquiescence and extreme response styles relatively well (Böckenholt, 2017).

The TPM also supports validating a multiple-process structure with covariates that may have subprocess-specific effects. Such covariates can be included for each latent process to test their process-specific influences. To apply TPM to cross-cultural research, the covariate can be a variable indicating the cultural affiliation of the respondent.

The Present Research

For this first part of the present research, we expect to confirm that cross-cultural response style bias will be observed for personality traits assessed with a Likert response scale by finding significantly different response distributions (through frequency analyses) and extreme responding processes (through IRT tree modeling) across cultures, where Easterners endorse endpoints less often than Westerners do. Our first set of hypotheses is therefore:

Hypothesis 1a: When responding to Likert rating scales, respondents from Eastern and Western cultures show different tendencies in endorsing scale categories. Specifically, respondents from Western cultures will endorse more extreme items.

Hypothesis 1b: The covariate, culture, influences the intensity response process. Particularly, respondents from Western cultures will show a stronger intensity process than respondent from Eastern cultures.

Method

Participants

Participants were recruited from three different sources in the United States and China to produce two samples: the American sample and the Chinese sample.

For the American sample, 733 participants were recruited from the Psychology Subject Pool at a large Midwestern university. They were students enrolled in the introductory Psychology course and participated in this study in exchange for course credit. All students had the option of gaining this extra credit in other ways (e.g., writing a term paper), ensuring that participation was voluntary. At the beginning of each research session, participants were further informed that they had the right to withdraw at any time. For recruitment, access into the study was limited, determined through prescreening questions, to students whose first language was English. No one was excluded for any other reason with the exception that individuals were required to be at least 18 years of age. Individuals of all ethnic groups, genders, etc., were welcome to participate in the study.

Another 450 participants were recruited for the American sample from the Amazon Mechanical Turk (MTurk), a large online crowdsourcing platform for individuals to participate in online surveys and receive a monetary reward. Research has shown that MTurk is a relatively inexpensive source of high quality data, with access to more demographically diverse samples than those obtained from college students (Buhrmester, Kwang, & Gosling, 2011; Landers & Behrend, 2015). This sample source was used to increase the generalizability of our results. Internet MTurk users can select to participate in a study via a notice posted on the MTurk website. Our internet posting invited users within the 18-25 age range and whose first language is English to "*answer a survey about personality*", which required them to "*take an online survey*", and showed that they would get one US dollar as compensation for finishing the survey. The survey invitation was only visible to IP addresses within the United States.

For the Chinese pool, a sample of 1654 participants was collected from several undergraduate classes among six departments in two universities in China. All students were given an option of either participating or not participating in this survey to ensure voluntary participation. Access into the study was limited to those students who were of Chinese nationality and were born and raised in China. At the beginning of each research session, participants were informed that they had the right to withdraw at any time. For recruitment, no one was excluded for any reason except being less than 18 years of age. Individuals of all Chinese ethnic groups, genders, etc., were welcome to participate in the study. Since there were no legal online crowdsourcing survey platform like MTurk in China, we weren't able to get working sample data from Chinese sources.

The total American sample representing Western culture consisted of 1183 native English speakers from the Subject Pool and MTurk, while the sample of 1654 Chinese undergraduate

students represented the Eastern culture. All study procedures were administered online via the Qualtrics platform.

We used quality control items to filter out careless responses. Six quality control items, instructing respondents to choose a specific option (e.g. “*Please select ‘disagree’ for this statement*”), were embedded at random places. We excluded anyone who did not answer all six questions correctly. We also removed respondents who had uniform responses. Based on these quality control criteria, the exclusion procedures resulted in final samples of 1021 individuals from the Chinese pool and 858 individuals from the American pool (530 from the Subject Pool; 328 from MTurk), giving retention rates of 61.7% for the Chinese sample and 72.5% for the American sample. Of the Chinese sample, 17.2% were male and the average age was 19.9 ($SD = 1.6$), with predominantly respondents from the majority (Han) ethnicity (95.9%) and a few from the minority groups (4.1%); of the American sample, 33.8% were male and the average age was 22.2 ($SD = 2.5$), with predominantly Caucasian (78.4%), followed by African American (7.8%), Latino/Hispanic (6.4%), Asian (3.8%), and Other (3.6%) groups.

Measures

We selected 100 items based on item extremities from the Comprehensive Personality Scale (CPS; Wang, 2013) that measure five facets underlying the Big Five dimensions (Costa & McCrae, 1992). We chose the CPS over other scales because the development of the CPS followed an ideal-point-based scale development approach. And since we are specifically assessing response style bias, the ideal point model which has a wider range and coverage of item extremities is of more utility. The five chosen facets demonstrated satisfactory model fit to the ideal point model in a previous validation study and each is believed to be an important component of the corresponding dimension of the Big Five (Wang, 2013). Specifically, we

selected Sociability from Extraversion, Cooperation from Agreeableness, Industriousness from Conscientiousness, Well-being from Emotional Stability, and Curiosity from Openness (Goldberg, 1993). Twenty items were selected for each facet, and item extremity was controlled: seven items had positive extremity parameters (e.g., “*I don't argue with others even if I don't agree with them*”), seven had negative extremities (e.g., “*I don't think it is important to consider others' opinions*”), and six had intermediate extremities (e.g., “*I am usually cooperative, but not always*”). Intermediate items were included because an ideal point IRT model was used and such items improve trait estimation (Chernyshenko, Stark, Drasgow, & Roberts, 2007).

Personality items and instructions were translated to Chinese following a translation/back-translation procedure (Brislin, 1980). The translation and back-translation were performed by a group of six Chinese bilingual academics working independently. The American sample received the English language questionnaire, and the Chinese sample received the Chinese version. Study instructions and item content remained the same across the two language versions.

Single statements rating scale. For the section of single statements, we presented items in a 4-point Likert scale single statement format with response options "strongly disagree", "disagree", "agree", and "strongly agree". We opted to use a 4-point scale instead of a 5-point scale because middle response scale options have been found to present difficulties for ideal point scales (Dalal, Carter, & Lake, 2014), and we wanted to rule out neutral options to make these items more similar to 2AFC items. In 2AFC pairs, a statement is considered either a description of the respondent or not. All the items were presented in a random order. Participants followed instructions and rated how much they agreed with each statement as a description for themselves. Some example items are shown in Figure 2(a).

Procedures

All participants in the sample completed the survey online. For the Chinese university undergraduate sample, participants were seated in classrooms with computers connected to the Internet and linked to the survey. For both the subject pool sample and the MTurk sample, the online survey was reached via a link on the subject pool website or MTurk. Participants reviewed the consent information and indicated their consent by clicking to continue the survey before proceeding to the main study. After consenting, participants were given the personality items. The total allotted time to finish the entire study was one hour. Participants could omit any questions if they did not choose to answer. After the blocks of questions, participants were asked several demographic questions.

Analytical Procedures

To investigate *Hypothesis 1a*, we constructed frequency distributions for the Likert scale response categories across the two samples to test our first hypothesis. The distributions show percentage of total endorsements of each point in the Likert scale across all personality dimensions. We then compared the distributions across two samples to see whether response style differences appeared. Pearson's Chi-squared test for count data was performed to test whether the endorsement frequencies of the American and Chinese samples were significantly different.

To investigate *Hypothesis 1b*, we translated participants' responses to the single statements to an IRT tree model as introduced by Böckenholt (2012). Each response process is therefore called a pseudoitem and is modeled by a separate Rasch-type model. Table 1 shows an example of pseudoitems coding for this study: The first pseudoitem (f1) of the two-process

model captures direction, and the second (f2) assesses intensity. Specifically, f1 equals one if the response for the item is positive, zero if negative; f2 equals one if the response involves “strongly”, zero if not. We treated culture as a covariate (cul), and coded as “1” for Americans and “2” for Chinese. The two-process model as described was fit using Mplus 7 (Muthen & Muthen, 2012).

Results

Means, standard deviations, and reliabilities are presented in the Likert columns in Table 3.

Response Style Bias Confirmation

We performed a frequency analysis on the responses to the single statement Likert-scale items, to test *Hypothesis 1a* to confirm the cross-cultural response bias found in prior research. We predicted that response style bias would be found for our single statement personality measures, with the American sample showing more endorsement of endpoints, and respondents from China placing more responses in the middle range of the scale.

The results were consistent with *Hypothesis 1a*: 10.8% of American respondents chose 1-strongly disagree, 34.0% chose 2-disagree, 43.0% chose 3-agree, and 12.2% chose 4-strongly agree; whereas only 6.0% of Chinese respondents endorsed endpoint 1 and 7.7% for 4, yet 40.0% chose the intermediate category of 2 and 46.3% chose 3. Aggregating across personality facets, a Chi-square test confirmed that the frequency distributions between the two samples significantly differ ($\chi^2 = 2855.3, p < 0.05$). The distributions of endorsement are shown in Figure 3.

Tree Process Model Fitting

Table 2 shows the direction and intensity effects under the pseudoitem coding of the Tree-Process Model, as well as cultural influences for the full two-process model for each personality trait across two samples. It also provides information on the similarities and differences of each responding process between cultural groups. As shown therein, across all five personality dimensions, the intensity response process differs significantly between two samples ($ps < 0.05$). The responding process effect estimates show weaker intensity tendencies for Chinese respondents. In sum, these findings support *Hypothesis 1b*.

Discussion

In Part I, we confirmed the often discussed differences in response styles of Easterners and Westerners. Given the recent discussion of failure to replicate (e.g., Open Science Collaboration, 2015; Shrout & Rodgers, 2018), our findings with large sample of Easterners and Westerners demonstrate that the response differences are not a Type I error or artifact of some study idiosyncrasy.

PART II

For the second part of the present research, we sought a response format less susceptible to response style bias. We desired an alternative approach that mitigates this response style bias and provide as much statistical information as possible about the traits of interest. The multidimensional forced-choice format appears to provide such an option. In the forced-choice format, sets of items are presented simultaneously to respondents, with the task of ranking the items with regard to how well they describe the respondent (Wetzel et al., 2015).

Two-alternative Forced Choice (2AFC)

Recently, the two-alternative forced choice (2AFC) format, with Item Response Theory (IRT) scoring, has been proposed as an implementation of this approach (Stark, Chernyshenko, & Drasgow, 2005; Brown & Maydeu-Olivares, 2011, 2013, 2016). In this specific format, respondents are presented with two statements and are asked to choose the one statement that is “more like me”. This format has a long history (Gordon, 1951; Berkshire & Highland, 1953), but the traditional scoring approach yields ipsative scores, where a score on one attribute for an individual is relative to scores on other attributes for this same individual and all individuals therefore have a common total test score and should not be compared to one another (Brown & Maydeu-Olivares, 2011, 2013). As demonstrated by Stark and colleagues, IRT scoring overcomes this limitation of traditional scoring and produces normative scores, which are needed for between-person comparisons (Stark et al., 2005; Chernyshenko, Stark, Prewett, Gray, Stilson & Tuttle, 2009). In the present study, we examined the 2AFC format with IRT scoring for use in cross-cultural research.

The two-alternative forced choice format avoids the traditional rating scale, eliminating the tendency to endorse or avoid endpoints. It presents items in a way that allows respondents to make comparative judgement among statements, which may lead to higher discriminant validity (Bass & Avolio, 1989). In comparison with the traditional Likert scale, it has also been found that other response biases such as leniency and halo effects can be reduced or eliminated by the combination of the 2AFC format and IRT scoring through the forced differentiation between characteristics (Brown & Maydeu-Olivares, 2013; Brown, 2014).

To explore cross-cultural response style bias with 2AFC items, our second hypothesis is:

Hypothesis 2: The two-alternative forced choice format with IRT scoring reduces cross-cultural response style bias.

We expected to see that the 2AFC format successfully reduces cross-cultural response bias in personality measurement compared to Likert-scale formatting. Specifically, the 2AFC format measure should yield smaller differences in trait scores across respondents' cultural groups than single statement Likert rating scales. To this end, we investigate both the traditional Likert format data and the 2AFC format data.

Method

Participants

Participants for this part of the study is the same as in Part I.

Measures

In combination with Part I, we designed a two-part within-subject study to evaluate cross-cultural response style differences in single statements and 2AFC. When collecting data for Part I on the single statements rating scale, we also administered for Part II the two-alternative forced choice pairs. Participants were randomly assigned to receiving the single statements or the forced choice section first.

Two-alternative forced choice pairs. In addition to the section with single statements, participants also receive a section with 2AFC pairs. For this section, participants were presented with 100 forced-choice pairs, each consisting of two personality statements, and they were asked to choose the statement from each pair that they considered a better description of themselves. Ten-percent of the forced-choice pairs were constructed as unidimensional comparisons, where the two statements were selected from the same facet. The other ninety-percent of the forced-choice pairs were multidimensional pairs, where the two statements assessed different personality facets. All pairs of items were presented in a random order for this section. The same

item content was used in the single statement Likert scale and the 2AFC scale so that any observed difference in response styles can be attributed to the difference in response formats.

Some example items are shown in Figure 2(b).

Procedures

Procedures for this part of the study were the same as in Part I.

Analytical Procedures

For scoring the single statements, we first used the traditional summation approach to obtain trait estimates for each individual for each personality dimension. We then moved to the ideal point IRT scoring approach, with the Generalized Graded Unfolding Model (GGUM; Roberts, Donoghue, & Laughlin, 2000). Based on the single statement responses, we calculated item parameters and individual respondents' trait estimates for each dimension. The item parameters were calculated using the combined sample of Chinese and American participants: we wanted to have a consistent standard for computing trait estimates for both samples, so that the differences in respondents' trait estimates would not be due to different item parameters. The GGUM parameters were estimated using the GGUM2004 program (Roberts, Fang, Cui, & Wang, 2006). Both dichotomous and polytomous GGUM analyses were conducted, and two trait scores (one from dichotomous IRT scoring, and the other from polytomous) were obtained for each respondent. For response dichotomization, we followed the practice of previous studies (e.g., Stark, Chernyshenko, Drasgow, & Williams, 2006). Specifically, responses "1" and "2" were recoded as "0", and responses "3" and "4" were recoded as "1". We then calculated the mean and variance of trait scores for each sample across measures for the single statements.

We performed the single statements scoring in several ways (i.e., summation, dichotomous IRT, and polytomous IRT) with the purpose of checking sensitivity. We wanted to

verify that our results did not depend on one special way of analyzing the data. To summarize the differences for *Hypothesis 2*, the ratio of variance of trait estimates from the American sample to the variance of trait estimates from the Chinese sample was computed and its significance was tested with an F-ratio test for equality of variances.

For the 2AFC section, we once again used the item parameters for single statements estimated via GGUM2004 based on the combined sample of American and Chinese respondents, to obtain comparable trait estimates across the two samples. To score the 2AFC items, we adopted the IRT scoring method for the multi-unidimensional pairwise-preference (MUPP) items (Chernyshenko et al., 2009; Stark et al., 2005). Trait scores for each individual respondent were estimated using multidimensional Bayes modal estimation (Stark et al., 2005).

We then correlated the 2AFC trait estimates of individual respondents with estimates from the scoring methods for the single statement section (i.e., summation scoring, dichotomized IRT scoring, and polytomous IRT scoring) to examine the convergent validity of 2AFC scores. In the next stage, we calculated the mean and variance of trait scores of both samples, and compared the variances of 2AFC scores with those of single statement scores. The equality of variance across cultural samples was examined via Levene's test for homogeneity of variance (homoscedasticity). We assessed whether the 2AFC format reduced the variance differences.

Finally, we classified the single statement IRT scores and the 2AFC trait scores into relative extremity categories based on the trait estimate distributions of the two samples, and did frequency analyses to examine ERS across samples. The comparison between these three sets (i.e., dichotomous IRT, polytomous IRT, and 2AFC) of frequency distributions for all five personality dimensions shows the similarity and differences across two samples, and tests

whether the 2AFC format overcomes the response style bias. Chi-square tests were also performed to test for significance.

Results

Table 3 displays descriptive statistics for all the personality facets measured with the two formats and all four scoring methods, including means, standard deviations, reliabilities, and variance ratios. We note that Cronbach's α s (Cronbach, 1951) were obtained from the combined sample of American and Chinese respondents, and intermediate items in CPS scales were excluded from computing these statistics for the traditional Likert scoring, because they do not have a monotonic relationship with the true scores of a scale (Cao, Dragow, & Cho, 2014). Also for the traditional Likert scoring, negatively-worded items were reverse-coded before computing the above statistics. For IRT scores, marginal reliabilities for polytomous GGUM were calculated and reported as suggested by Green and colleagues (Green, Bock, Humpherys, Linn, & Reckase, 1984).

Correlations among Trait Scores across Scoring Methods

To confirm that the 2AFC format yields scores substantially related to the traditional single statement format, we correlated the 2AFC trait estimates with estimates from other scoring methods for the single statements. The correlation matrix among trait score estimates across the four different scoring methods for all five dimensions is shown in Table 4.

Except for Agreeableness, all correlations between trait scores across scoring methods for each dimension were moderate to high (i.e., 0.6 or larger; Brown & Maydeu-Olivares, 2013), indicating differences in measurement formats and scoring had relatively little effect on construct validity. Note that the Likert, dichotomous and polytomous, scores were computed from the

same responses, whereas 2AFC scores were computed from a different set of responses. Thus, it is expected that the 2AFC correlations with single statement scores are somewhat lower.

Variance Ratio Comparisons

Variances provide a measure of extreme category responding: more extreme responses should yield more variance in scores. Larger variances for the American sample were observed for each dimension (shown in Table 3). One-sided F-ratio tests also confirmed that the variances of scores from single statements in the American sample are significantly larger from those in the Chinese sample ($F_A = 1.50$, $F_c = 1.75$, $F_E = 2.70$, $F_N = 1.52$, $F_O = 1.36$, numdf = 859, denomdf = 1022, $ps < 0.05$).

Specifically, we observed the variance ratios of American to Chinese trait scores in Agreeableness measures via Likert scoring, dichotomized GGUM scoring and polytomous GGUM scoring are, accordingly, 1.72, 1.70, and 1.54; for Conscientiousness 1.64, 1.02, and 1.75; for Extraversion 2.71, 1.99, and 2.70; for Emotional Stability 1.56, 1.38, and 1.51; and for Openness 1.53, 1.20, and 1.36. Clearly, all traits show a larger variance in the American sample than in the Chinese sample. Thus the first set of hypotheses were confirmed.

The variance ratios of American to Chinese samples were larger for the single statement scoring methods than the 2AFC format on all dimensions except Openness (shown in Table 3). Levene's Tests also showed that variance differences between the two samples from the 2AFC score estimates are significantly smaller than those resulted from the single statement items across all dimensions except for Openness ($ps < 0.05$ for Agreeableness, Conscientiousness, Extraversion, and Emotional Stability; $p = 0.39$ for Openness). Specifically, the 2AFC trait scores generally showed smaller differences across the two samples than the single statement

scores. The 2AFC scores had variance ratios of 0.56 for Agreeableness, 1.31 for Conscientiousness, 2.13 for Extraversion, 1.14 for Emotional Stability, and 1.56 for Openness.

Figures 4 shows variance ratios of trait scores from all four scoring methods for the American sample to those for the Chinese sample across all five dimensions. These figures provided partial support for *Hypothesis 2* that the 2AFC format would reduce cross-cultural response style bias.

Trait Score Category Comparisons

To make 2AFC trait scores more comparable to the single statement scores, we categorized the single statement IRT scores and the 2AFC trait scores using cut-offs at -1, 0, and 1, and labeled each interval, from small to large, 1, 2, 3 and 4. We then computed the frequency distributions for each sample. Averaging across dimensions, our data analysis revealed that for such relative categorization, (1) under the dichotomous IRT scoring for the Likert format, 15.1% of the American sample fell into Category 1, 32.4% in 2, 37.3% in 3, and 15.2% in 4; whereas 11.6% of the Chinese sample was in Category 1, 36.4% in 2, 44.9% in 3, and 7.1% in 4; (2) under the polytomous IRT scoring for the Likert format, 10.2% of the American sample fell into Category 1, 38.2% in 2, 35.2% in 3, and 16.4% in 4; whereas 7.0% of the Chinese sample was in Category 1, 50.6% in 2, 36.0% in 3, and 6.4% in 4; (3) under the 2AFC format with IRT scoring, 20.6% of the American sample fell into Category 1, 42.1% in 2, 27.8% in 3, and 9.5% in 4; whereas 22.8% of the Chinese sample was in Category 1, 46.3% in 2, 24.6% in 3, and 6.3% in 4. The frequency distributions for the dichotomous and polytomous IRT scores, as well as the 2AFC trait scores are shown in Figures 5. These three sets of frequency distributions differ from each other: The distributions of the 2AFC trait scores showed less differentiation between the two samples than those of the single statement scores. Though under both formats the

distributions of the two samples were significantly different ($\chi^2 = 204.47, p < 0.05$; $\chi^2 = 323.1, p < 0.05$; $\chi^2 = 53.655, p < 0.05$), 2AFC yielded the lowest chi-square statistic. Clearly, the 2AFC scale trait scores do not show as much cross-cultural extremity response style difference as the Likert scale scores. In sum, our results indicate that response style bias has less impact on trait scores under the 2AFC format compared to the traditional Likert scale.

General Discussion

Researchers and practitioners have been concerned that individual differences in the use of response scales can affect estimates of the construct measured and even distort conclusions (e.g., Bolt & Johnson, 2009; Moors, 2012). Although cross-cultural differences in response behavior and their potential negative effects have been investigated for some time (e.g., Chen et al., 1995; Hamamura et al., 2007), previous approaches capturing these differences lack a conceptual understanding of how respondents from different cultures choose differently. Moreover, there was a lack of concrete proof of cross-cultural response style bias going beyond the observed differences in scale endpoint endorsements across cultures.

In this two-part study, we tackled the above issues. Specifically, first we described and applied a recently introduced IRT tree model, the tree-process model, which provides a theoretical framework for describing response processes differences. As an initial application of this model to cross-cultural personality data, our results confirm that the model captures cultural differences in response processes, particularly in intensity, and provides evidence confirming the cross-cultural response style bias. Moreover, we found that response style bias occurs for single statement rating scales across measures of different constructs.

Furthermore, this study also enriches our understanding about the impact of scale formats on the way individuals from different cultures respond. Taking a new perspective, we examined whether changing the measurement format to 2AFC could overcome the response style bias often observed for single statement Likert scales. To varying degrees, the 2AFC format was effective in overcoming response style bias. Recoding the IRT trait estimate to four categories further reduced cross-cultural differences. Additional research in this area, however, is needed to advance our understanding of 2AFC format as a replacement for traditional Likert scales.

The unexpected results for Openness in the variance ratio comparisons might be explained by the fact that the Chinese sample included only young adults. As China is undergoing remarkable changes in modern times, young people in China are exposed to more and more new experiences. Some young Chinese appear to be embracing the new ways, for example, the ones travelling to the US for their college education. Others may not embrace these changes, perhaps youths from traditional families in rural areas. Thus, the Chinese in this research, located in urban campuses, may be characterized by greater variability in openness than youth in the perhaps more stable American context.

Implications

It is an important finding that the forced-choice measurement format can potentially overcome ERS, which opens doors for improved cross-cultural personality research. ERS pose a serious challenge to score comparability for data from different cultures, but by requiring respondents to make direct comparative judgments among alternative options, the forced-choice format appears to at least partially suppress response style bias. The forced-choice design may also enhance validity by reducing rater effects such as halo and leniency/severity (Borman, Buck, Hanson, Motowidlo, Stark, & Drasgow, 2001; Brown, in press). In addition, IRT scoring

yields more accurate trait scores. Together, the 2AFC format and IRT scoring can extend research in workplace, educational, and other settings.

This research also has important implications for practice. As the prevalence of multinational firms increases, there is a need for rationally evaluating individuals to be placed into different positions. Psychological measurement scales will play a growing role in providing information about personnel for these multinational firms. To be fair to all, cross-cultural measurement equivalence is essential. Reducing or eliminating response style differences by use of the 2AFC format should contribute to fairness.

The results of this study suggest directions for future researchers to construct assessment tools with improved cross-cultural comparability. With more cross-culturally robust assessment tools, researchers will be able to study people with different cultural backgrounds, leading to better understandings of people in diverse settings.

Limitations

This study has limitations that should be noted. First, our samples largely consisted of young people preparing to enter, or at the beginning stage of, the workforce of two countries. Further research investigating people at different career stages (e.g., mid-career) and from other cultures is needed. Also, since there were no legal online crowdsourcing survey platform like MTurk in China, we weren't able to get working sample data from Chinese sources.

Second, the study was based on the assumption that the response style differences were not reflective of true cultural variation in personality. Although previous researchers have labeled the observed difference in responses as bias, it is possible that Asian individuals are indeed less extreme on many dimensions (Gelfand et al., 2011), and therefore the response "bias" is at least partially an accurate reflection of reality. Though 2AFC trait score

categorizations significantly reduces the endpoint and midpoint endorsement differences between the two samples, additional research is needed to ascertain whether the response style bias is indeed all bias.

Third, we utilized items from one measurement instrument, the Comprehensive Personality Scale (CPS; Wang, 2013), assessing one category of individual differences-- personality, and we only examined one facet under each personality dimension, which might have lacked representation of the full dimension. Research is needed to determine whether the results found here generalize to items from other personality facets or instruments and other individual differences, such as values and attitudes.

Conclusion

The findings of this study show promise for improved cross-cultural research. The two-alternative forced choice format could be applied as a valid replacement for traditional Likert scales to overcome cross-cultural response style bias. Much additional research is needed, however, to examine other traits and cultures.

References

- Baumgartner, H., & Steenkamp, J.-B. E. M. (2001). Response styles in marketing research: A cross-national investigation. *Journal of Marketing Research*, 28, 143-156.
<http://dx.doi.org/10.1509/jmkr.38.2.143.18840>
- Barrick, M. R., & Mount, M. K. (1991). The Big Five personality dimensions and job performance: A meta-analysis. *Personnel Psychology*, 44, 1-26.
<http://dx.doi.org/10.1111/j.1744-6570.1991.tb00688.x>
- Bass, B. M., & Avolio, B. J. (1989). Potential biases in leadership measures: How prototypes, leniency, and general satisfaction relate to ratings and rankings of transformational and transactional leadership constructs. *Educational and psychological measurement*, 49(3), 509-527. <http://dx.doi.org/10.1177/001316448904900302>
- Beaton, D. E., Bombardier, C., Guillemin, F., & Ferraz, M. B. (2000). Guidelines for the process of cross-cultural adaptation of self-report measures. *Spine*, 25, 3186-3191.
<http://dx.doi.org/10.1097/00007632-200012150-00014>
- Berkshire, J. R., & Highland, R. W. (1953). Forced-choice performance rating—A methodological study. *Personnel Psychology*, 6, 355-378.
<http://dx.doi.org/10.1111/j.1744-6570.1953.tb01503.x>
- Böckenholt, U. (2012). Modeling multiple response processes in judgment and choice. *Psychological Methods*, 17(4), 665-678. <http://dx.doi.org/10.1037/a0028111>
- Böckenholt, U. (2017). Measuring response styles in Likert items. *Psychological Methods*, 22(1), 69-83. <http://dx.doi.org/10.1037/met0000106>

- Bolt, D. M., & Johnson, T. R. (2009). Addressing score bias and differential item functioning due to individual differences in response style. *Applied Psychological Measurement*, 33, 335-352. <http://dx.doi.org/10.1177/0146621608329891>
- Bolt, D. M., Lu, Y., & Kim, J. S. (2014). Measurement and control of response styles using anchoring vignettes: A model-based approach. *Psychological Methods*, 19, 528- 541.
- Bolt, D. M., & Newton, J. R. (2011). Multiscale measurement of extreme response style. *Educational and Psychological Measurement*, 71, 814-833.
<http://dx.doi.org/10.1037/met0000016>
- Borman, W. C., Buck, D. E., Hanson, M. A., Motowidlo, S. J., Stark, S., & Drasgow, F. (2001). An examination of the comparative reliability, validity, and accuracy of performance ratings made using computerized adaptive rating scales. *Journal of Applied Psychology*, 86, 965-973. <http://dx.doi.org/10.1037/0021-9010.86.5.965>
- Buhrmester, M., Kwang, T., & Gosling, S. D. (2011). Amazon's Mechanical Turk a new source of inexpensive, yet high-quality, data?. *Perspectives on psychological science*, 6, 3-5.
<http://dx.doi.org/10.1177/1745691610393980>
- Brislin, R. W. (1980). Translation and content analysis of oral and written materials. In H. C. Triandis & J. W. Berry (Eds.), *Handbook of cross-cultural psychology* (Vol.2, pp. 389–444). Boston, MA: Allyn & Bacon.
- Brown, A. (2014). Item response models for forced-choice questionnaires: A common framework. *Psychometrika*, 79, 1-26. <http://dx.doi.org/10.1007/s11336-014-9434-9>
- Brown, A. (2016). Personality assessment, forced-choice. In: J.D. Wright (Ed.), *International Encyclopedia of the Social and Behavioral Sciences* (2nd Edition). Philadelphia, PA: Elsevier.

- Brown, A., & Maydeu-Olivares, A. (2011). Item response modeling of forced-choice questionnaires. *Educational and Psychological Measurement, 71*, 460-502. <http://dx.doi.org/10.1177/0013164410375112>
- Brown, A., & Maydeu-Olivares, A. (2013). How IRT can solve problems of ipsative data in forced-choice questionnaires. *Psychological Methods, 18*, 36. <http://dx.doi.org/10.1037/a0030641>
- Brown, A. & Maydeu-Olivares, A. (in press). Modeling forced-choice response formats. In P. Irwing, T. Booth, & D. Hughes (Eds.), *The Wiley Handbook of Psychometric Testing*. London: John Wiley & Sons.
- Cao, M., Drasgow, F., & Cho, S. (2014). Developing Ideal Intermediate Personality Items for the Ideal Point Model. *Organizational Research Methods*. Advance online publication. <http://dx.doi.org/10.1177/1094428114555993>
- Costa, P.T. Jr., & McCrae, R.R. (1992). *Revised NEO Personality Inventory (NEO-PI-R) and NEO Five-Factor Inventory (NEO-FFI) manual*. Odessa, FL: Psychological Assessment Resources.
- Chen, C., Lee, S., & Stevenson, H.W. (1995). Response style and cross-cultural comparisons of rating scales among East Asian and North American students. *Psychological Science, 6*, 170-175. <http://dx.doi.org/10.1111/j.1467-9280.1995.tb00327.x>
- Chernyshenko, O. S., Stark, S., Drasgow, F., & Roberts, B. W. (2007). Constructing personality scales under the assumptions of an ideal point response process: toward increasing the flexibility of personality measures. *Psychological Assessment, 19*, 88-106. <http://dx.doi.org/10.1037/1040-3590.19.1.88>

Chernyshenko, O. S., Stark, S., Prewett, M. S., Gray, A. A., Stilson, F. R., & Tuttle, M. D.

(2009) Normative scoring of multidimensional pairwise preference personality scales using IRT: Empirical comparisons with other formats. *Human Performance*, 22, 105-127.

<http://dx.doi.org/10.1080/08959280902743303>

Cronbach, L. J. (1946). Response sets and test validity. *Educational and Psychological*

Measurement, 6, 475-494. <http://dx.doi.org/10.1177/001316444600600405>

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, 16,

297-334. <http://dx.doi.org/10.1007/bf02310555>

Dalal, D. K., Carter, N. T., & Lake, C. J. (2014). Middle response scale options are inappropriate for ideal point scales. *Journal of Business and Psychology*, 29(3), 463-478.

<https://doi.org/10.1007/s10869-013-9326-5>

de Jong, M. G., Steenkamp, J.-B. E. M., Fox, J.-P., & Baumgartner, H. (2008). Using item response theory to measure extreme response style in marketing research: A global investigation. *Journal of Marketing Research*, 65, 104-115.

<http://dx.doi.org/10.1509/jmkr.45.1.104>

Dolnicar, S. & Grun, B. (2007). Cross-cultural differences in survey response patterns.

International Marketing Review, 24, 127-143.

<http://dx.doi.org/10.1108/02651330710741785>

Gelfand, M. J., Raver, J. L., Nishii, L., Leslie, L. M., Lun, J., Lim, B. C., & Yamaguchi, S.

(2011). Differences between tight and loose cultures: A 33-nation study. *Science*, 332, 1100–1104. <http://dx.doi.org/10.1126/science.1197754>

Goldberg, L. R. (1993). The structure of phenotypic personality traits. *American Psychologist*,

48, 26-34. <http://dx.doi.org/10.1037//0003-066x.48.1.26>

- Gordon, L. V. (1951). Validities of the forced-choice and questionnaire methods of personality measurement. *Journal of Applied Psychology*, 35, 407-412.
<http://dx.doi.org/10.1037/h0058853>
- Green, B. F., Bock, R. D., Humphreys, L. G., Linn, R. L., & Reckase, M. D. (1984). Technical guidelines for assessing computerized adaptive tests. *Journal of Educational Measurement*, 21, 347-360. <https://doi.org/10.1111/j.1745-3984.1984.tb01039.x>
- Hamamura, T., Heine, S., & Paulhus, D. (2007). Cultural differences in response styles: The role of dialectical thinking. *Personality and Individual Differences*, 44, 932-942.
<http://dx.doi.org/10.1016/j.paid.2007.10.034>
- Harzing, A. W., Brown, M., & Köster, K., Zhao, S. (2012). Response style differences in cross-national research: Dispositional and situational determinants. *Management International Review*, 52, 341-363. <http://dx.doi.org/10.1007/s11575-011-0111-2>
- Hofstede, G. (1980). Motivation, leadership, and organization: Do American theories apply abroad?. *Organizational dynamics*, 9, 42-63. [http://dx.doi.org/10.1016/0090-2616\(80\)90013-3](http://dx.doi.org/10.1016/0090-2616(80)90013-3)
- Huang, C. D., Church, A. T., & Katigbak, M. S. (1997). Identifying cultural differences in items and traits: Differential item functioning in the NEO personality inventory. *Journal of Cross-Cultural Psychology*, 28, 192-218. <http://dx.doi.org/10.1177/0022022197282004>
- Johnson, T., Kulesa, P., Cho, Y. I., & Shavitt, S. (2005). The relation between culture and response styles evidence from 19 countries. *Journal of Cross-cultural psychology*, 36, 264-277. <http://dx.doi.org/10.1177/0022022104272905>

- King, G., Murray, C. J. L., Salomon, J. A., & Tandon, A. (2004). Enhancing the Validity and Cross-Cultural Comparability of Measurement in Survey Research. *The American Political Science Review; Washington*, 98(1), 191–207.
- Khorramdel, L., & von Davier, M. (2014). Measuring response styles across the Big Five: A multiscale extension of an approach using multinomial processing trees. *Multivariate Behavioral Research*, 49(2), 161-177. <https://doi.org/10.1080/00273171.2013.866536>
- Landers, R. N., & Behrend, T. S. (2015). An inconvenient truth: Arbitrary distinctions between organizational, Mechanical Turk, and other convenience samples. *Industrial and Organizational Psychology*, 8, 142-164. <http://dx.doi.org/10.1017/iop.2015.13>
- Magidson, J., & Vermunt, J. K. (2001). Latent class factor and cluster models, bi-plots, and related graphical displays. *Sociological methodology*, 31, 223-264.
<http://dx.doi.org/10.1111/0081-1750.00096>
- Maydeu-Olivares, A., & Coffman, D. L. (2006). Random intercept item factor analysis. *Psychological Methods*, 11, 344-362. <http://dx.doi.org/10.1037/1082-989x.11.4.344>
- Moors, G. (2003). Diagnosing response style behavior by means of a latent class factor approach: Socio-demographic correlates of gender role attitudes and perceptions of ethnic discrimination reexamined. *Quality and Quantity*, 37, 277–302.
<http://dx.doi.org/10.1023/A:1024472110002>
- Moors, G. (2012). The effect of response style bias on the measurement of transformational, transactional, and laissez-faire leadership. *European Journal of Work and Organizational Psychology*, 21, 271-298.
<http://dx.doi.org/10.1080/1359432x.2010.550680>

- Morren, M., Gelissen, J. P. T. M., & Vermunt, J. K. (2011). Dealing with extreme response style in cross-cultural research: A restricted latent class factor analysis approach. *Sociological Methodology*, 41, 13-47. <http://dx.doi.org/10.1111/j.1467-9531.2011.01238.x>
- Möttus, R., Allik, J., Realo, A., Pullmann, H., Rossier, J., Zecca, G., ... Ng Tseung, C. (2012). Comparability of Self-Reported Conscientiousness Across 21 Countries: Comparability of self-reports across cultures. *European Journal of Personality*, 26(3), 303–317. <https://doi.org/10.1002/per.840>
- Muthén, B. O., & Muthén, L. K. (2012). Mplus 7 base program. *Muthén & Muthén: Los Angeles, CA*.
- Open Science Collaboration (2015) Estimating the reproducibility of psychological science. *Science*, 349(6251), aac4716. <http://dx.doi.org/10.1126/science.aac4716>.
- Paulhus, D. L. (1991). Measurement and control of response bias. *Measures of Personality and Social Psychological Attitudes*, 1, 17-59. <http://dx.doi.org/10.1016/b978-0-12-590241-0.50006-x>
- Pedhazur, E. J., & Schmelkin, L. P. (2013). *Measurement, design, and analysis: An integrated approach*. New York, NY: Psychology Press.
- Roberts, J. S., Donoghue, J. R., & Laughlin, J. E. (2000). A general item response theory model for unfolding unidimensional polytomous responses. *Applied Psychological Measurement*, 24, 3-32. <http://dx.doi.org/10.1177/01466216000241001>
- Roberts, J. S., Fang, H. R., Cui, W., & Wang, Y. (2006). GGUM2004: A Windows-based program to estimate parameters in the Generalized Graded Unfolding Model. *Applied Psychological Measurement*, 30, 64-65. <http://dx.doi.org/10.1177/0146621605280141>

- Rost, J., Carstensen, C., & von Davier, M. (1997). Applying the mixed Rasch model to personality questionnaires. In J. Rost & R. Langeheine (Eds.), *Applications of latent trait and latent class models in the social sciences*. Ann Arbor, MI: University of Michigan Library.
- Shirayev, E., & Levy, D. A. (2014). *Cross-cultural psychology*. Bergen, NJ: Pearson Education Limited.
- Shrout, P. E., & Rodgers, J. L. (2018). Psychology, science, and knowledge construction: Broadening perspectives from the replication crisis. *Annual Review of Psychology*, 69, 487-510. <https://doi.org/10.1146/annurev-psych-122216-011845>
- Stark, S., Chernyshenko, O. S., & Drasgow, F. (2005). An IRT approach to constructing and scoring pairwise preference items involving stimuli on different dimensions: The Multi-Unidimensional Pairwise-Preference model. *Applied Psychological Measurement*, 29, 184-203. <http://dx.doi.org/10.1177/0146621604273988>
- Stark, S., Chernyshenko, O. S., Drasgow, F., & Williams, B. A. (2006). Examining assumptions about item responding in personality assessment: Should ideal point methods be considered for scale development and scoring? *Journal of Applied Psychology*, 91(1), 25-39. <http://dx.doi.org/10.1037/0021-9010.91.1.25>
- Wang, W. (2013). *The Comprehensive Personality Scale*. Unpublished manuscript.
- Webster, H. (1958). Correcting personality scales for response sets or suppression effects. *Psychological Bulletin*, 55, 62-64. <http://dx.doi.org/10.1037/h0048031>
- Weijters, B., Cabooter, E., & Schillewaert, N. (2010). The effect of rating scale format in response styles: The number of response categories and response category labels.

International Journal of Research in Marketing, 27, 236-247.

<http://dx.doi.org/10.1016/j.ijresmar.2010.02.004>

Weijters, B., Geuens, M., & Schillewaert, N. (2010). The stability of individual response styles. *Psychological Methods*, 15(1), 96-110. <http://dx.doi.org/10.1037/a0018721>

Weijters, B., Schillewaert, N., & Geuens, M. (2008). Assessing response styles across modes of data collection. *Journal of the Academy of Marketing Science*, 36, 409-422.

<http://dx.doi.org/10.1007/s11747-007-0077-6>

Wetzel, E., Böhnke, J. R., & Brown, A. (2015). Response biases. *The ITC international handbook of testing and assessment*. Oxford, UK: Oxford University Press.

Wetzel, E., Böhnke, J. R., Carstensen, C. H., Ziegler, M., & Ostendorf, F. (2013). Do individual response styles matter? Assessing differential item functioning for men and women in the NEO-PI-R. *Journal of Individual Differences*, 34, 69-81. <http://dx.doi.org/10.1027/1614-0001/a000102>

Wetzel, E., & Carstensen, C. H. (2015). Multidimensional modeling of traits and response styles. *European Journal of Psychological Assessment*. Advance online publication.

<http://dx.doi.org/10.1027/1015-5759/a000291>

Wetzel, E., Lüdtke, O., Zettler, I., & Böhnke, J. R. (2016). The stability of extreme response style and acquiescence over 8 years. *Assessment*, 23(3), 279–291.

<https://doi.org/10.1177/1073191115583714>

Tables

Table 1. *Exemplary transformations of Likert responses into TPM representations.*

Exemplary Responses		Strongly Disagree	Disagree	Agree	Strongly Agree
Person 1 (American)	Item 1		x		
	Item 2				x
Person 2 (Chinese)	Item 1			x	
	Item 2	x			
Traditional Scoring					
Person 1 (American)	Item 1	2			
	Item 2	4			
Person 2 (Chinese)	Item 1	3			
	Item 2	1			
Pseudoitems Coding		Direction (f1)	Intensity (f2)	Culture (cul)	
Person 1	Item 1	0	0	1	
	Item 2	1	1	1	
Person 2	Item 1	1	0	2	
	Item 2	0	1	2	

Table 2. *Effect estimates of the tree-process model for cross-cultural data*

		Estimate	S.E.	Est./S.E.	Two-tailed P-Value
<u>Agreeableness</u>					
	f1 on cul	0.04	0.019	2.132	0.033
	f2 on cul	-0.296	0.038	-7.743	0
	f2 with f1	0.01	0.008	1.207	0.228
<u>Conscientiousness</u>					
	f1 on cul	0.15	0.017	8.8	0
	f2 on cul	-0.565	0.039	-14.306	0
	f2 with f1	0.02	0.008	2.643	0.008
<u>Extraversion</u>					
	f1 on cul	0.078	0.016	4.966	0
	f2 on cul	-0.56	0.04	-14.16	0
	f2 with f1	0.01	0.007	1.525	0.127
<u>Emotional Stability</u>					
	f1 on cul	0.002	0.016	0.101	0.92
	f2 on cul	-0.401	0.041	-9.755	0
	f2 with f1	0.007	0.007	1.049	0.294
<u>Openness</u>					
	f1 on cul	0.062	0.016	3.777	0
	f2 on cul	-0.683	0.048	-14.345	0
	f2 with f1	0.001	0.009	0.164	0.87

Note. $N = 1879$ ($N_{US} = 858$, $N_{Chinese} = 1021$).

f1 = direction (1 = positive endorsement, 0 = negative endorsement).

f2 = intensity (1 = strong endorsement, 0 = regular endorsement).

cul = culture (1 = American, 2 = Chinese).

Table 3. Descriptive statistics of trait estimates from single statements and FC pairs

Dimension\Scoring	Single Statements				2AFC Pairs			
	<u>Likert</u>		<u>Dicho_GGUM</u>		<u>Poly_GGUM</u>		<u>2AFC</u>	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
<u>Agreeableness</u>								
Reliabilities	<i>0.64</i>		<i>0.66</i>		<i>0.70</i>		<i>0.89</i>	
American	39.70	3.93	-0.29	0.83	-0.06	0.84	-0.84	0.63
Chinese	41.13	2.99	0.24	0.64	0.07	0.68	-0.43	0.83
Variance Ratio		<i>1.72</i>		<i>1.70</i>		<i>1.50</i>		<i>0.57</i>
<u>Extraversion</u>								
Reliabilities	<i>0.89</i>		<i>0.88</i>		<i>0.91</i>		<i>0.91</i>	
American	37.94	7.99	0.14	1.08	0.10	1.07	-0.02	0.98
Chinese	36.77	4.85	-0.12	0.76	-0.07	0.65	-0.28	0.67
Variance Ratio		<i>2.71</i>		<i>2.00</i>		<i>2.70</i>		<i>2.13</i>
<u>Openness</u>								
Reliabilities	<i>0.83</i>		<i>0.72</i>		<i>0.86</i>		<i>0.80</i>	
American	42.12	5.49	0.20	0.85	0.21	0.79	-0.32	0.76
Chinese	40.12	4.44	-0.17	0.78	-0.17	0.68	-0.87	0.61
Variance Ratio		<i>1.53</i>		<i>1.20</i>		<i>1.36</i>		<i>1.56</i>
<u>Emotional Stability</u>								
Reliabilities	<i>0.86</i>		<i>0.84</i>		<i>0.83</i>		<i>0.90</i>	
American	39.50	6.35	-0.11	0.97	-0.04	0.83	-0.01	0.94
Chinese	40.77	5.09	0.09	0.82	0.04	0.68	0.16	0.88
Variance Ratio		<i>1.56</i>		<i>1.38</i>		<i>1.52</i>		<i>1.14</i>
<u>Conscientiousness</u>								
Reliabilities	<i>0.68</i>		<i>0.65</i>		<i>0.74</i>		<i>0.74</i>	
American	40.39	4.43	0.19	0.79	0.22	0.83	0.01	0.90
Chinese	37.82	3.47	-0.16	0.78	-0.19	0.62	-0.40	0.79
Variance Ratio		<i>1.64</i>		<i>1.10</i>		<i>1.75</i>		<i>1.31</i>

Note. Dicho_GGUM = dichotomous GGUM. Poly_GGUM = polytomous GGUM.

Reliabilities (in *italics*) are the test score reliabilities (Cronbach's α for Likert scoring, and marginal reliabilities for IRT scoring)

Table 4. *Pearson correlations among individual trait scores across scoring methods*

	A_Likert	A_Dicho	A_Poly	A_2AFC
A_Likert	1			
A_Dicho	.612**	1		
A_Poly	.851**	.481**	1	
A_FC2A	.421**	.432**	.336**	1
	C_Likert	C_Dicho	C_Poly	C_2AFC
C_Likert	1			
C_Dicho	.783**	1		
C_Poly	.854**	.766**	1	
C_FC2A	.601**	.667**	.588**	1
	E_Likert	E_Dicho	E_Poly	E_2AFC
E_Likert	1			
E_Dicho	.900**	1		
E_Poly	.969**	.922**	1	
E_FC2A	.825**	.848**	.833**	1
	N_Likert	N_Dicho	N_Poly	N_2AFC
N_Likert	1			
N_Dicho	.869**	1		
N_Poly	.925**	.913**	1	
N_FC2A	.744**	.776**	.756**	1
	O_Likert	O_Dicho	O_Poly	O_2AFC
O_Likert	1			
O_Dicho	.836**	1		
O_Poly	.941**	.800**	1	
O_FC2A	.668**	.654**	.659**	1

Note. A = Agreeableness. C = Conscientiousness. E = Extraversion. N = Emotional stability. O = Openness. Likert = Likert scale. Dicho = GGUM dichotomous. Poly = GGUM polytomous. 2AFC = Two-alternative forced choice.

**. Correlation is significant at the 0.01 level (2-tailed).

Figures

Figure 1. Illustration of the three-process model

Figure 2. Items formatted as single statements and as two-alternative forced choice.

Please indicate your answer to each item by marking the appropriate oval on the scantron. Remember, it is important that you **answer honestly and accurately**.

	Strongly Disagree	Disagree	Agree	Strongly Agree
I finish my work on time but try not to work more than I have to.	☐	☐	☐	☐
I am willing to concede an issue if it leads to an efficient solution.	☐	☐	☐	☐
I'm unhappy that life is unfair to me.	☐	☐	☐	☐
I seldom change my own opinion to make others happy.	☐	☐	☐	☐
	Strongly Disagree	Disagree	Agree	Strongly Agree
I can always find something to talk about with strangers.	☐	☐	☐	☐
It isn't important to me to be friends with the people I work with.	☐	☐	☐	☐
I am about as well-off in life as most people.	☐	☐	☐	☐
I typically only talk to the people I know at parties.	☐	☐	☐	☐

(a) Single statement section example items

Please choose **one statement in each pair** that is **more like you**. Make a choice even when neither or both statements describe you particularly well. Just think about the two options a bit longer and choose the one that is more like you.

I prefer to read fiction books rather than non-fiction	☐ ☐	Most of the time, I am a listener instead of a talker
I don't think it is important to consider others' opinions	☐ ☐	I don't care very much about the quality of my work
Others might take advantage of me if I choose to cooperate	☐ ☐	I learn new things only when I have to
I typically only talk to the people I know at parties	☐ ☐	Being realistic is better than being optimistic or pessimistic
Usually I will not allow negative thoughts to occupy my mind for a long time	☐ ☐	I am excited about new knowledge
I always try to do my best work even when no one will know	☐ ☐	I would consider myself an optimistic person
I try to do the minimal amount of work possible to maintain my current status	☐ ☐	I easily feel discouraged
I don't like to do a project on my own	☐ ☐	Being successful is more important than most other things in my life
I prefer to explore new concepts rather than apply them	☐ ☐	I am about as well-off in life as most people
I prefer staying at home rather than going out with friends	☐ ☐	I would prefer a job where I don't have to learn anything new

(b) Two-alternative forced choice section example item pairs

Figure 3. Percentage of American and Chinese sample endorsing each single statement Likert scale categories.

Figure 4. Ratio of variance of American trait scores to variance of Chinese trait scores for all dimensions across scoring methods.

Figure 5. Total percentage of American and Chinese respondents in each category for single statement IRT scores and 2AFC scores.

(a)

(b)

(c)