Online Appendices for the Article "Response Scale Formats and Psychological Distances between Categories"

Appendix A: Computations for psychological distance

For each four, five, and seven response categories (m), Wakita, Ueshima, and Noguchi (2012) used the generalized partial credit model (GPCM; Muraki, 1992) from item response theory to estimate m-1 category parameters ($C_{j,p}$)—the locations along the normally distributed latent trait (θ) scale where two adjacent category response probability functions, $P_{j,k\text{-}1}(\theta)$ and $P_{j,k}(\theta)$, intersect. For an ordinal (or interval) scale, respondents with latent trait value θ between $C_{j,p\text{-}1}$ and $C_{j,p}$ should have the highest probability of selecting response category p (instead of the other m-1 categories) for item j (Muraki, 1992). Wakita et al. (2012) set $C_{j,0}$ as $-\infty$ and $C_{j,m}$ as ∞, and they defined scale values ($\mu_{j,p}$) as the expected value of each interval, [$C_{j,p\text{-}1}$, $C_{j,p}$], between two adjacent category parameters:

$$\mu_{j,p} = \frac{\int_{C_{j,p-1}}^{C_{j,p}} \theta * e^{-\frac{\theta^2}{2}} \Big/ \sqrt{2\pi}\, d\theta}{\int_{C_{j,p-1}}^{C_{j,p}} e^{-\frac{\theta^2}{2}} \Big/ \sqrt{2\pi}\, d\theta} = \frac{e^{-\frac{(C_{j,p-1})^2}{2}} \Big/ \sqrt{2\pi} - e^{-\frac{(C_{j,p})^2}{2}} \Big/ \sqrt{2\pi}}{\int_{C_{j,p-1}}^{C_{j,p}} e^{-\frac{\theta^2}{2}} \Big/ \sqrt{2\pi}\, d\theta}$$

for p = [1,…, m].

This results in m scale values ($\mu_{j,p}$). Because the latent trait scale is assumed to follow a standard normal distribution, the above formulas provide the expected values of the intervals between two adjacent category parameters (e.g., [$C_{j,p\text{-}1}$, $C_{j,p}$]), which estimate the average latent trait ($\mu_{j,p}$) among respondents most likely to select response category p for item j. Finally, they calculated converted scale values:

$$S_{j,p} = 1 + (m-1)\frac{\mu_{j,p} - \mu_{j,1}}{\mu_{j,m} - \mu_{j,1}}.$$

Note that $S_{j,1}$ = 1 and $S_{j,m}$ = m, mapping the normally distributed latent trait scale onto the m-point response scale. This formulation assumes that the "psychological location" of the middle response categories are linearly related to the mean latent trait values of respondents who are most likely to select the particular response category, and the psychological location of the endpoints are understood to be at the extremes of the response scale.

We agree with these assumptions, and we further assume that, if people perceived a scale as being interval, the scale values ($S_{j,p}$) would be closer to the category numbers (p) than if they perceived a scale as only being ordinal. We, therefore, use the following average psychological distance formula ($\overline{D}_j$) as a measure for how closely item j's scale is to being interval:

$$\overline{D}_j = \sum_{p=2}^{m-1} \left|S_{j,p} - p\right| \Big/ (m-2).$$

Appendix B: Computations for individual differences analyses

We calculated individual differences in psychological distances between categories and scale values by first computing individualized scale values for each combination of person (r), item (j), and response-scale length (m):

$$S_{j,m,r} = 1 + (m-1)\frac{\theta_r - \mu_{j,1}}{\mu_{j,m} - \mu_{j,1}}.$$

We then found the distance between the individual's scale value and the selected response option ($R_{j,m,r}$) for each item, and we found the average of these values for each the four, five, and seven-point scales for both extraversion and neuroticism:

$$\overline{D}_{m,r} = \sum_{j=1}^{5} \left|S_{j,m,r} - R_{j,m,r}\right| \Big/ 5.$$

We also calculated NARS and ERS for each respondent as formulated in Weijters, Cabooter, & Schillewaert (2010). They computed NARS as the log odds of the number of agreements plus one to the number of disagreements plus one and ERS as the log odds of the number of extreme responses plus one to the number of non-extreme responses plus one.

Using these measures, we developed the following multilevel linear model:

$$\overline{D}_{c,m,r} = b_{0,r} + b_1 Var_c + b_2 Label_r + b_3 \#RC_m + b_4 LabelX\#RC_{m,r} + b_5 ERS_{c,m,r} + b_6 NARS_{c,m,r} + e_{c,m,r},$$

where $r = 1,\ldots,882$ indexes the respondent, c and m are within-person indices for the construct measured and number of response categories. $b_{o,r}$ is the random-effects intercept, reflecting individual differences in psychological distance. Var_c and $\#RC_m$ are within-person variables for the construct (extraversion or neuroticism) and number of response categories (four, five, or seven), respectively; $Label_r$ is a between-person measure for the label format (ALL or END); $LabelX\#RC_{m,r}$ is the interaction between $\#RC_m$ and $Label_r$; $ERS_{c,m,r}$ and $NARS_{c,m,r}$ are the response style patterns that were computed for all six combinations of Var_c and $\#RC_m$; and $e_{c,m,r}$ is the residual error term. The random-effects intercept-only model significantly improved upon the fixed-effects intercept-only model by the likelihood ratio test, $\chi^2(1) = 434.89$, $p < .001$, and this model yielded a substantial intraclass correlation coefficient, ICC = .22. Hence we have evidence that there were a great deal of individual differences in psychological distance between categories. We retained the random intercept and ran the multilevel linear model with all predictor variables centered.

Appendix C: Results for individual differences analyses

Table C1. Multilevel Linear Model with Scale Formats and Response Styles Predicting Psychological Distance.

Predictor	*b*	*SE*	β
Var***	–.154	.017	–.167
Label**	–.095	.033	–.103
#RC***	.396	.007	.536
LabelX#RC*	–.032	.014	–.022
ERS***	.294	.011	.326
NARS†	.015	.008	.020

Notes. Var = dummy coded variable with 0 = extraversion and 1 = neuroticism; Label = dummy coded variable with 0 = ALL and 1 = END; #RC = number of response categories; LabelX#RC = interaction between number of response categories and label format; ERS = extreme response style; NARS = net acquiescence response style.

$^{\dagger}p < .10$. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.