OSF-Material D

RSA Variants and More Advanced Response Surface Methodology

The scope of our manuscript was to comprehensively line out how to correctly identify congruence effects with RSA. Here, we provide a short overview about some variants, extensions and adaptions of RSA that go beyond this specific application.

Beyond Congruence Effects

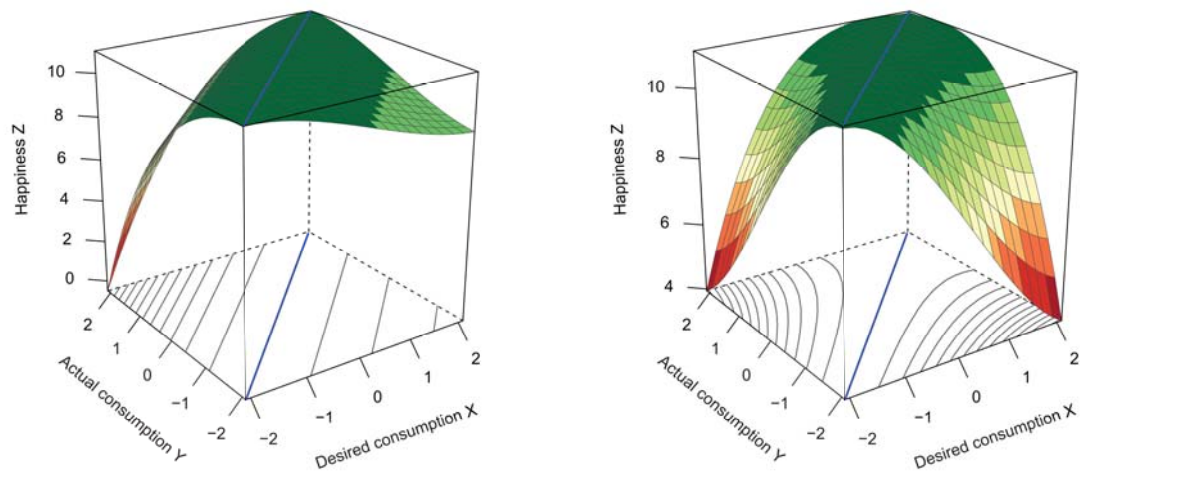
In case that a response surface does not reflect a congruence effect, further RSA tools should be used to derive working hypotheses on the effects that are present instead (e.g., see Cohen, Nahum-Shani, & Doveh, 2010; Edwards, 2002, 2007). These tools can for example reveal "optimal margin" effects (as in Figure 2a in the main part of the manuscript; see Baumeister, 1989). Furthermore, in case that the coefficients of the quadratic and interaction terms (i.e., b_3, b_4, and b_5) are non-significant, one can test for a linear effect of the discrepancy $X - Y$, which would require that $|a_3| > |a_1|$ (see Humberg et al., in press).

Beyond Second-Degree Effects

Because response surfaces based on Equation 3 are restricted to a "quadratic" shape, they cannot reflect arbitrarily complex effects. To test psychologically relevant hypotheses that are not detectable by quadratic surfaces (e.g., congruence effects where the direction of mismatch matters), one can extend the regression model in Equation 3 by "cubic" terms (i.e., X^3, X^2Y, XY^2, and Y^3):

$$Z = b_0 + b_1X + b_2Y + b_3X^2 + b_4XY + b_5Y^2 \quad + b_6X^3 + b_7X^2Y + b_8XY^2 + b_9Y^3 \tag{9}$$

This regression model can for example lead to a surface as in Figure 3a, where happiness is highest for persons whose chocolate-consumption matches their desire, while additionally, happiness falls faster when consumption exceeds desire than when desire exceeds consumption. Cubic RSA, in contrast to quadratic RSA, can also test whether exactly fulfilling one's chocolate-desire is more relevant for persons whose desire is low, compared to persons with high desire (Figure 3b).



(a) Response surface of the cubic model $Z = 11 + 0X + 0Y - 0.4X^2 + 0.8XY - 0.4Y^2 + 0.06X^3 - 0.18X^2Y + 0.18XY^2 - 0.06Y^3$.

(b) Response surface of the cubic model $Z = 11 + 0X + 0Y - 0.4X^2 + 0.8XY - 0.4Y^2 + 0.14X^3 - 0.14X^2Y - 0.14XY^2 + 0.14Y^3$.

Figure 3. Cubic response surfaces that reflect effects which cannot be detected with quadratic surfaces defined by Equation 3.

While cubic models can be estimated with the *RSA* package (Schönbrodt, 2016a), their interpretation is far more complex than the interpretation of quadratic RSA models. To ease a careful and correct application of cubic RSA, respective strategies are currently developed (Humberg, Nestler, Schönbrodt, & Back, 2017).

Beyond Multiple Parameter Tests

To test a congruence effect with RSA, instead of testing the four (or six) necessary conditions for a congruence effect one by one (Figure 3 in the main part of the manuscript), it can be convenient to test them simultaneously in a ”model testing” approach. The basic idea of the model testing approach is to fit a surface to the data that is restricted to perfectly reflect the expected effect (e.g., restricted to be shaped as in Figure 1a in the manuscript when testing strict congruence effects) and to test whether this *hypothesis-conform model* explains the data equally well as the freely estimated surface from Equation 1 in the manuscript (e.g., see Edwards, 2002; Schönbrodt, 2016b), by statistically comparing their R^2 values. This approach has the advantages that it (a) includes less significance tests than testing all six necessary conditions and (b) reduces the risk of unjustified interpretations for complex or equivocal surfaces.

Beyond Single Hypothesis Testing

In some disciplines, congruence hypotheses are challenged by theoretically grounded alternative expectations (e.g., optimal margin effects, see Baumeister, 1989). In these cases, the model testing approach can be extended to test all alternative hypotheses against each other. The idea is to derive respective hypothesis-conform models for all competing hypotheses and compare their empirical evidence, for example with an information-theoretic approach (e.g., see Burnham & Anderson, 2002; Humberg, Dufner, et al., 2017).

Beyond Simple Data Structures

In practice, we are often confronted with data structures that are more complex than the data described here, which require adapted versions of RSA. As some examples, one might want to apply RSA to multilevel data (e.g., students nested in classes Nestler, Humberg, & Schönbrodt, 2017), dyadic data (e.g., predicting both male and female relationship satisfaction from couples' similarity; see Nestler, Grimm, & Schönbrodt, 2015; Schönbrodt, Humberg, & Nestler, 2017). Moreover, one might want to investigate more complex effects, such as the longitudinal development of congruence effects (e.g., does friend similarity get more important over time), or congruence effects referring to profile similarity rather than to level congruence (e.g., social consequences of similar Big Five profiles; see also Edwards, 2007; Edwards & Parry, 1993). To allow a broad application of RSA, future research needs to adapt or extend RSA to such special research questions and data structures, while paying particular attention to the interpretation in terms of relevant hypotheses in the social and personality psychological literature.