Enhanced Versus Simply Positive: A New Condition-Based Regression Analysis to Disentangle
Effects of Self-Enhancement from Effects of Positivity of Self-View

Sarah Humberg¹, Michael Dufner², Felix D. Schönbrodt³, Katharina Geukes¹,
Roos Hutteman⁴, Maarten H. W. van Zalk^{1,5}, Jaap J. A. Denissen⁶,
Steffen Nestler², Mitja D. Back¹

¹Westfälische Wilhelms-University Münster

²University of Leipzig

³Ludwig-Maximilians-Universität München

⁴Utrecht University

⁵Oxford University

⁶University of Tilburg

This is the final author version (before journal's typesetting and copyediting) of the following article:

Humberg, S., Dufner, M., Schönbrodt, F. D., Geukes, K., Hutteman, R., van Zalk, M. H. W., Denissen, J. J. A., Nestler, S., & Back, M. D. (2018). Enhanced versus simply positive: A new condition-based regression analysis to disentangle effects of self-enhancement from effects of positivity of self-view. *Journal of Personality and Social Psychology*, 114(2), 303-322.
doi:10.1037/pspp0000134

Author Note

This research was supported by Grant BA 3731/6-1 given by the German Research Foundation (DFG) to Mitja D. Back, Steffen Nestler, and Boris Egloff.

Correspondence concerning this article should be sent to Sarah Humberg, University of Münster, Department of Psychology, Fliednerstr. 21, 48149 Münster, Germany. Phone: (00)49-(0)251-8331342; E-Mail: sarah@humberg.name.

Supplemental Material for this article can be found in the OSF at osf.io/e8p5r. We embrace the values of openness and transparency in science (Schönbrodt, Maier, Heene, & Zehetleitner, 2015). Therefore, we followed the 21-word solution provided by Simmons, Nelson, and Simonsohn (2012) or referred to the complete project documentation in the OSF. We are furthermore publishing all raw data necessary to reproduce the reported results and are providing scripts for all data analyses reported in this manuscript (see the Supplemental Materials at osf.io/e8p5r).

Abstract

Despite a large body of literature and ongoing refinements of analytical techniques, research on the consequences of self-enhancement (SE) is still vague about how to define SE effects, and empirical results are inconsistent. In this paper, we point out that part of this confusion is due to a lack of conceptual and methodological differentiation between effects of individual differences in how much people enhance themselves (SE) and in how positively they view themselves (positivity of self-view; PSV). We show that methods commonly used to analyze SE effects are biased because they cannot differentiate between the effects of PSV and the effects of SE. We provide a new condition-based regression analysis (CRA) that unequivocally identifies effects of SE by testing intuitive and mathematically derived conditions on the coefficients in a bivariate linear regression. Using data from three studies on intellectual SE (total $N = 566$), we then illustrate that the CRA provides novel results as compared with traditional methods. Results suggest that many previously identified SE effects are in fact effects of PSV alone. The new CRA approach thus provides a clear and unbiased understanding of the consequences of SE. It can be applied to all conceptualizations of SE and, more generally, to every context in which the effects of the discrepancy between two variables on a third variable are examined.

Keywords: self-view, self-enhancement, self-knowledge, psychological adjustment, discrepancy model

Enhanced Versus Simply Positive: A New Condition-Based Regression Analysis to Disentangle Effects of Self-Enhancement from Effects of Positivity of Self-View

People differ substantially in how much they self-enhance or self-deface, that is, in the extent to which they perceive their characteristics as more positive or negative than these characteristics really are (e.g., Alicke & Sedikides, 2011; Dunning, Heath, & Suls, 2004; Dunning, Meyerowitz, & Holzberg, 1989; Epley & Dunning, 2000, 2006). These self-enhancement differences have been investigated in various psychological disciplines, such as social psychology and personality psychology, as well as in applied fields, such as health, work, organizational, clinical, and educational contexts (e.g., Alicke & Sedikides, 2011). But are these differences in self-enhancement (SE) related to individual differences in intra- or interpersonal adjustment? Theoretical accounts of both positive and negative consequences of SE have been proposed, and empirical findings have likewise been characterized by heterogeneity. Some researchers have argued that SE has positive effects on intra- and interpersonal adjustment, and many studies have indeed provided empirical support for this contention (e.g., Anderson, Brion, Moore, & Kennedy, 2012; Bonanno, Field, Kovacevic, & Kaltman, 2002; Bonanno, Rennieke, & Dekel, 2005; Church et al., 2006; Dufner et al., 2013; Dufner et al., 2012; Dufner, Reitz, & Zander, 2015; Gabriel, Critelli, & Ee, 1994; Goorin & Bonanno, 2009; Gramzow, Willard, & Mendes, 2008; Kurman, 2006; Lafrenière, Vallerand, & Sedikides, 2013; Sedikides & Gregg, 2008; Taylor & Brown, 1988; Taylor, Lerner, Sherman, Sage, & McDowell, 2003b). Other scholars, by contrast, have argued that SE is maladaptive, and a number of studies point toward *negative* effects of SE on intra- and interpersonal adjustment (e.g., Church et al., 2006; Colvin, Block, & Funder, 1995; Paulhus, 1998; Polzer, Kramer, & Neale, 1997; Robins & Beer, 2001).

Independent of moderator variables such as the length of an acquaintanceship (Paulhus, 1998) or the outcome under consideration (Kurt & Paulhus, 2008), we propose a more general explanation for the inconsistencies in the literature: A lack of differentiation exists between the consequences of SE and the consequences of the positivity of the self-view (PSV) alone - both conceptually and methodologically. Conceptually, SE and PSV have often been used interchangeably to describe (overly) positive self-views. Methodologically, empirical studies investigating the consequences of SE have applied an intuitive but problematic two-step

approach for data analysis: First, an SE score as some sort of discrepancy between the self-view and "reality" is computed, and this score is then correlated with an outcome in a second step. However, as all SE scores are correlated with people's self-views, the two-step nature of this approach makes it impossible to distinguish SE effects from effects that are due to the positivity of self-view by itself. In the words of Griffin, Murray, and Gonzalez (1999), *"too often, stories are told about discrepancy (...) models when only simple main effect stories are there to be told"* (p. 510).

To systematically disentangle the concepts of SE and PSV and to allow for more robust empirical insights, we (a) differentiate between SE (positive deviation of the self-view from reality) and PSV (mere positivity of self-view) and emphasize the fundamental need for such a differentiation, (b) summarize different operationalizations of SE, (c) point out why the analytical procedures typically used to investigate associations of different kinds of SE scores with outcome measures are not able to differentiate the effects of SE from the effects of PSV, (d) provide a novel straightforward condition-based regression analysis (CRA) that enables researchers to differentiate between the effects of the two different concepts and can be adapted for various operationalizations of SE, and (e) illustrate the utility of this CRA approach by applying it to data from three studies in the domain of intellectual SE.

Two Concepts and their Operationalization: An Enhanced versus a Positive View of Oneself

When examining research questions related to SE, true *self-enhancement* needs to be theoretically and empirically distinguished from a mere *positivity of self-view* (PSV). SE is defined as the degree to which the self-view (e.g., about one's ability) exceeds some kind of criterion (e.g., one's objectively measured ability). Imagine, for example, individuals completing a 20-item math test. Asking an individual afterwards how many items he¹thinks he solved correctly would indicate his self-view of his ability on this test. A comparison of this self-viewed ability with the actual number of items he solved correctly would then indicate this person's degree of SE. For example, Ray's and Tom's self-viewed abilities S and their actual numbers of correctly solved items R can be found in the first two rows of Table 1. We can immediately see that Ray enhances his ability more than Tom because they solved the same number of items, but Ray's self-rating is much higher than Tom's. In other words, the discrepancy between self-rated and real skills is higher for Ray than for Tom. We will focus on

the understanding of SE as a *dimensional* construct (rather than a categorical one²), ranging from self-defacement (negative SE) to accurate self-perception (zero SE) to a tendency to self-enhance (positive SE) on a continuous scale. We furthermore consider SE regarding specific trait levels (rather than profile correlations),³ although the problems outlined in this paper pertain to profile-based measures of SE in an analogous way.

Positivity of self-view (PSV), by contrast, describes how positive an individual's self-perception is. Consequently, it involves only information about how (positively) people see themselves and, in contrast to SE, it can therefore be considered even when we know nothing about individuals' real abilities. In Table 1, for example, Tom's and Sam's self-views are equally positive because both of them claimed that they correctly solved six items. It is important to note that PSV is conceptually different from SE because it focuses on nothing but self-viewed ability and says nothing about the relation between a person's self-perception and reality. As an example of this conceptual difference, again consider Tom and Sam, who have the same level of PSV. Sam, however, has a much higher level of SE because he solved four fewer items than Tom yet has the same self-view.

When turning to an empirical investigation of these two constructs, measuring PSV is relatively easy: A person's PSV is reflected by his self-view with respect to the characteristic of interest. For example, this might be his estimation of how many items he solved correctly on a math test. By contrast, measuring SE is far more complex by definition. For a person's SE score to be valid, it must provide a measure of the extent to which the person's self-perception is *overly* positive when compared with a criterion. The measurement of SE has been discussed frequently in the literature and covers divergent conceptualizations of SE. Here, we consider only SE measurements that include some kind of reality-based criterion measure with which the self-view is compared. This ensures that differentiations can be made between individuals who have unrealistically high opinions of themselves, individuals who really are as smart as they think, and individuals who underrate themselves (see Block & Colvin, 1994; Colvin & Block, 1994; Colvin et al., 1995; John & Robins, 1994; Klar & Giladi, 1999; Krueger & Wright, 2011; Paulhus, 2008; Robins & Beer, 2001)⁴.

For a wide range of domains in which people self-enhance, there are several conceptually and mathematically different measures for SE that include both a self-rating and some criterion. These prior approaches can be classified according to two methodological choices

concerning: (a) the types of measures (i.e., the self-rating S and the reality criterion R) that are used and (b) the mathematical score that is computed to compare S and R . We will briefly point out the ways in which these two choices affect the construct that is reflected by the resulting SE score. While the method to investigate *effects* of SE that are outlined in this manuscript can be applied to various conceptualizations of SE, it is crucial to choose S , R , and the comparison score to reflect exactly the theoretical construct one is aiming at in the respective research question (see Table 2 for the most common operationalizations of SE).

First, the choice of a specific kind of self-rating S and reality criterion R reflects a researcher's understanding of what the "enhancement" component in SE conceptually refers to (see the first column of Table 2). In the domain of intellectual ability, for example, one possible conceptualization of SE is the extent to which a person's estimation of his absolute intelligence score (S) exceeds a respective objectively assessed operational criterion ($R = C$; e.g., the number of items solved correctly on a quiz, Moore & Healy, 2008; intelligence test scores, Paulhus, 1998; school grades, Robins & Beer, 2001; or behavior ratings of personality, Gosling et al., 1998). As an interesting variation, Gramzow et al. (2008) assessed individuals' self-reports (S = self-reported GPA) in a domain where the criterion scores (R = real GPA) were known to the participants, such that the discrepancy of S and R reflects the amount to which individuals "knowingly" enhance their ability (see also Gramzow & Willard, 2006). Another approach reflects a social-comparison perspective of SE, which is focused on the degree to which a person rates himself (S) more positively than he rates others ($R = P$; Brown, 1986). Here, the reality criterion can, for example, be a person's evaluation of the "average other" in some domain (Heckhausen & Krueger, 1993; Taylor & Gollwitzer, 1995; a related approach is the "overplacement" index by Moore & Healy, 2008). Another approach is to assess the degree to which a person evaluates himself (S) more positively than he is (on average) evaluated *by* others ($R = T$; Colvin et al., 1995; John & Robins, 1994; see also Kwan, John, Kenny, Bond, & Robins, 2004; Leising, Locke, Kurzius, & Zimmermann, 2016).

The specific choices of self-rating S and reality criterion R depend on one's research question and the specific conceptualization of SE in this context. Especially the choice of an appropriate reality criterion can be fairly complex within some content domains (e.g., personality attributes). While the methodological considerations outlined in this manuscript apply to all choices of S and R , it is important to note that cautiously choosing an

appropriate criterion value is a necessary precondition for every meaningful empirical investigation in the SE context. As a demonstrative example for our methodological derivations, we chose the self-estimated number of items solved correctly on a math test S and the real number of correct answers R .

The selection of a mathematical score that compares S with R is the second choice that affects the construct under investigation (see the second column in Table 2). Independent of the choice of self-rating S and criterion R , two approaches can be found in the literature for calculating each person's level of SE: the algebraic difference and residuals. The algebraic difference ($S - R$) reflects the degree to which a person's self-rating S exceeds his score on the criterion R (Colvin et al., 1995) and can be applied only when S and R are located on the same scale (Edwards, 1994). For example, the algebraic difference between the self-estimated number of correctly solved math items S and the true number R is negative for a person who solved more items than he thinks he solved (negative SE), it is zero for someone who correctly estimated his test score (zero SE), and it is positive for someone who overestimated the number of items he solved (positive SE). One advantage of the difference score as a measure of SE is its very intuitive interpretation: The more a person overestimates the number of items he solved, the higher his SE is. Using the algebraic difference with other choices of S and R leads to some more complex SE scores that can be found in the literature. Kwan et al. (2004), for example, took persons' rating tendencies into account: They computed a subject's perceiver effect P (rating tendency when evaluating others) using the Social Relations Model (Kenny, 1994) and subtracted it from the self-rating S . That is, they chose $S' = S - P$ as the corrected self-rating of interest. Comparing it with their criterion measure R , which they chose to be represented by the person's target effect (average evaluation by others), resulted in the *Kwan index* $S - P - R$ as a measure of SE. Other complex choices for S and R resulted in the SE scores suggested by Moore and Healy (2008)⁵ and by Borkenau, Zaltauskas, and Leising (2009).⁶

The residual procedure can also be frequently found in the literature. This mathematical operation compares the self-rating S with the reality criterion R by calculating the residuals from the regression of S on R (John & Robins, 1994). Each person's residual in this regression is then defined as his amount of SE. The basic idea underlying this residual approach is that partialling out all variance from the self-view that is shared with the criterion

removes the substantive part of the self-view and leaves pure bias. This approach reflects a conceptually different understanding of SE than offered by the difference approach. A person's residual value indicates how far his self-viewed ability exceeds the self-rating that is predicted from his respective real ability on the basis of the association between real and self-rated ability in the sample. As for the algebraic difference, more complex choices for S and R lead to specialized residual-based SE scores (e.g., Leising et al., 2016). Analogous to the choice of a specific self-rating and criterion, the choice of a mathematical operation for their comparison reflects the specific construct under investigation. We will introduce a statistical approach to investigate whether individual differences in SE are associated with individual differences in outcome variables, which can be adapted to fit *all* of the mentioned operationalizations of SE.

To summarize, a variety of different conceptualizations of SE have been considered in the literature. Depending on the specific construct under investigation, choices have been made with respect to self-ratings, reality criteria, and a mathematical operation to compare them. Each combination of choices reflects at least a slightly different facet of SE. Conceptual comparisons of different choices can for example be found in Kurt and Paulhus (2008), Kwan et al. (2004), Kwan, John, Robins, and Kuang (2008), Moore and Healy (2008), Paulhus (2008), and in Robins and Paulhus (2001).

Confounding Effects of Self-Enhancement with Effects of the Positivity of Self-View

The different SE scores summarized in Table 2 have been used in many studies to investigate the different facets of SE: It was found that within most content domains, people self-enhance on average, but there also seem to exist situations in which people self-deface on average; many different operationalizations of SE have been applied to gain a differentiated picture of the SE tendency (e.g., see Alicke & Sedikides, 2011).

For the research question that we address in this manuscript, it is not the average amount of SE that is of interest, but rather its *variability* across individuals. It was consistently found that individuals *differ* in the extent to which they self-enhance (e.g., Leising et al., 2016; Noble, Heath, & Toste, 2011; Polzer et al., 1997). Given this finding, a question that arises as a next logical step concerns associations between SE and potential outcome variables: Are individual differences in SE systematically related to individual differences in psychological adjustment, for example? This question is one of the most

controversially discussed topics in SE research (e.g., see Block & Colvin, 1994; Colvin & Block, 1994; John & Robins, 1994; Taylor & Brown, 1988, 1994; Taylor, Lerner, Sherman, Sage, & McDowell, 2003a). Both hypotheses in favor of *positive* consequences and hypotheses in favor of *negative* consequences have been formulated. For example, a hypothesis that proposes that SE is beneficial could be "The more a person enhances his own cognitive ability, the happier he is." We will label hypotheses of this kind *self-enhancement hypotheses*.⁷ It is important to note that we must conceptually and empirically differentiate the SE hypothesis from a *positivity of self-view hypothesis* such as "The more positively a person sees his own cognitive ability, the happier he is." The difference between the two hypotheses follows directly from the two different underlying concepts: The SE hypothesis states that Sam is happier than Tom only if Sam's self-view exceeds Sam's *real* ability more than Tom's self-perception exceeds Tom's real ability. The PSV hypothesis does not consider real ability because it states that Sam should be happier than Tom as long as Sam's self-perception exceeds Tom's self-perception, regardless of how (un)realistic it is. A visualization of the crucial difference between the two hypotheses can be found in Figure 1.

However, prior research sometimes treated SE and PSV as synonymous phenomena and did not differentiate between the effects of SE and PSV. In their groundbreaking paper, Taylor and Brown (1988) defined SE (or "positive illusions") as "unrealistically positive self-evaluations" (p. 193). Their descriptions of theoretical and empirical evidence for benefits of SE, however, were focused on effects of PSV. In particular, they presented empirical findings that indicated that "happy people have higher opinions of themselves" (p. 198) and that "positive conceptions of the self are associated with working harder and longer on tasks" (p. 199), which pertain to the effects of self-perceptions alone (i.e., effects of PSV). Similarly, Higgins (1996) seemed to focus on PSV (and less on SE) when he stated that "the function [of SE] emphasized in the literature is to feel good about oneself - the pleasure of positive self-regard" (p. 1075). As these examples demonstrate, the two different concepts SE and PSV have often both been labeled "self-enhancement" (or "positive illusions", see Taylor & Brown, 1988) and have been used interchangeably. This makes it difficult to estimate how much evidence in fact exists for the consequences of SE (vs. the consequences of PSV alone). Here, we argue for more distinct definitions of SE effects (effects of individual differences in how much the self-view exceeds reality on individual differences in an outcome) and PSV effects

(effects of individual differences in how positive the self-view is on individual differences in an outcome).

How can we test both kinds of effects empirically? To test the PSV hypothesis, one possible statistical approach involves correlating persons' self-rated ability with a variable that reflects their happiness. In many content domains, however, it is reasonable to adapt this method slightly by controlling for real ability when investigating the association of the self-view with the outcome. Such an adaption avoids the risk of a confounding bias, which can be relevant in situations in which the self-rating and the outcome variable are both associated with the reality criterion. We will choose such an approach below by including real ability as a control variable in the linear regression predicting the outcome from the self-view. The regression coefficient of the self-view then reflects the effect of PSV on the outcome when the reality criterion is held constant. Consequently, the PSV hypothesis reflected by this analysis states that PSV is expected to affect the outcome under control for potential effects of real ability. It is important to note that this version of the PSV hypotheses still reflects effects of PSV and *not* effects of SE, as it focuses on the association of self-view and the outcome controlled for effects of real ability, but does *not* reflect effects of intra-individual discrepancies of self-view and reality.⁸

Testing the SE hypothesis is disproportionally more difficult than one might initially think. An intuitive approach for data analysis is to (a) compute an SE score that measures the kind of SE one wants to consider (based on algebraic differences or residuals, see Table 2) and (b) calculate the correlation of this SE score and the outcome variable (or, equivalently, regress the outcome on the SE score). However, although this approach appears to provide a test of the SE hypothesis at first glance, it is in fact not doing what we would expect: Correlating an SE score (no matter which one) with an outcome variable will in many cases lead us to falsely accept the SE hypothesis because this approach often mistakes effects of PSV for effects of SE, that is, this two-step approach cannot differentiate the SE hypothesis from the PSV hypothesis.

To illustrate this shortcoming, consider first an operationalization of SE as an algebraic difference $S - R$, for example, where S represents the self-rated and R the real number of items solved correctly on a math test. Correlating this SE score with some outcome variable in a second step can lead to biased results because the algebraic difference $S - R$ is correlated⁹

with S and R (e.g., Asendorpf & Ostendorf, 1998; Edwards & Parry, 1993; Griffin et al., 1999; Krueger & Wright, 2011; Ullrich, 2009; Zuckerman & Knee, 1996; see Table 3). This can easily lead to false interpretations of results as can be seen if we use example data that were constructed according to the PSV hypothesis (see Table 1): The more positive the self-view of a person, the happier he is, regardless of the extent to which this self-view is supported by actual ability. For this example data, the correlation between $(S - R)$ and Z is .66, leading us to falsely accept the SE hypothesis. To see that SE is in fact really independent of the outcome here, note that Sam, for example, self-enhances much more than Tom despite having the same outcome value. This shows that with the two-step approach for which an algebraic difference was used to measure SE, it is not possible to differentiate the SE hypothesis from the PSV hypothesis. Analogously, implementing the two-step approach with other SE scores that are based on algebraic differences (e.g., the Kwan index) leads to analogous limitations because all of these scores are correlated with the self-rating (see Table 3).

If residuals are used to measure SE, the two-step approach is hampered by limitations that are similar to those that arise when difference scores are used. Having estimated the coefficients $\hat{b}_0$ and $\hat{b}_1$ in the regression $S = b_0 + b_1R + \xi$, the SE score of person i is defined as his residual $\xi_i = S_i - (\hat{b}_0 + \hat{b}_1R_i) = -\hat{b}_0 + S_i - \hat{b}_1R_i$. Residuals are thus computed as $\xi = -\hat{b}_0 + S - \hat{b}_1R$. Residuals are not correlated with real ability R , but they are highly correlated¹⁰ with self-rated ability S (see Table 3, and see Supplemental Material A for the proof). Therefore, correlating residual scores with some outcome variable does not allow effects of SE to be differentiated from effects of PSV. As a brief example of this limitation, consider again the Table 1 data that were constructed to match the PSV hypothesis. The correlation between the residuals and happiness is .98. Thus, similar to the difference approach, we would interpret the results as supporting the SE hypothesis, whereas in fact there is only an effect of the self-view and not of true SE. Consequently, the two-step approach with SE operationalized as residuals can easily lead to false interpretations of empirical patterns. The use of other residual-based SE scores (e.g., residuals that are controlled for rating tendencies) in the two-step approach results in analogous problems (see Table 3).

In summary, the different methodologies used to operationalize SE have provided an important foundation for SE research with regard to the existence of SE and its variation across individuals. However, when it comes to investigating potential associations between

individual differences in SE and some outcome variable, the situation is more complex. The intuitive two-step approach, namely, correlating one's favorite SE score with a potential outcome, is not able to empirically differentiate between the SE hypothesis and the PSV hypothesis. This limitation occurs for all operationalizations of SE because all SE scores are correlated with the self-rating. Consequently, this approach may lead to a confirmation of the SE hypothesis ("the more SE, the higher/lower the outcome") when the outcome was in fact only systematically related to PSV ("the more positive the self-view, the higher/lower the outcome"), but *not* to SE. Because the interpretation and theoretical implications of the SE versus PSV hypothesis highly differ from each other, there is an essential need to conduct an empirical analysis that overcomes the risk of misinterpreting PSV effects as evidence for the SE hypothesis.

A New Condition-Based Regression Analysis: Separating Effects of Self-Enhancement from Effects of Positivity of Self-View

When aiming at testing an SE hypothesis, we need to apply a statistical method that, in contrast to the two-step approach, enables to unequivocally identify SE effects while disentangling them from PSV effects¹¹ (see Footnote 11 for other proposed approaches that are however no valid tools to test the SE hypothesis). Prior to such an investigation of SE effects, two preliminary steps can be taken: First, the concrete construct under investigation must be defined, and respective choices of the self-rating, the criterion variable, and the respective comparison operation (e.g., algebraic difference, residuals, Kwan index) must be conducted. The resulting SE score should reflect the kind of SE that is described in one's theory. In the following, we will introduce and demonstrate a new approach to investigate the SE hypothesis on the basis of a conceptual understanding of SE that is analogous to the difference score $S - R$ as an example. Because the statistical method itself is independent of the specific choices of S and R , our exemplary self-rating and criterion variable can be replaced by any other assessments of these two corresponding variables. Modifications for other choices of the comparison operation (e.g., residuals or the Kwan index) are straightforward. For all operationalizations that are displayed in Table 2, respective approaches for testing the SE hypothesis are derived in Supplemental Materials C, D, and E and briefly summarized in Table 4. Second, after data has been assessed, one can check whether subjects differ in the considered SE score (and in the outcome variable), because it only then makes sense to test

whether individual differences in SE are associated with individual differences in the outcome. Note that the calculation of an SE score is a valid procedure to investigate characteristics of the *distribution* of SE itself in the sample (e.g., its variance, or the average amount of SE if it is of interest). However, when aiming at investigating *associations* of the SE score with other variables, a one-step approach is needed that takes full information on S and R (instead of the SE score) as input, and tests for an association of the difference $S - R$ with the outcome variable without mistaking PSV effects as evidence for the SE hypothesis.

Aiming to derive such a one-step approach, note that the main problem with the two-step approach in testing an SE hypothesis is that it merges the self-rating and the criterion score into one single variable (each person's algebraic difference or residual). As a consequence of this procedure, it is no longer possible to identify the "ingredients" of the resulting scores or the sources of differences between persons (i.e., the values of S and R): For example, Tom ($S = 6, R = 5$, see Table 1) and Sam ($S = 6, R = 1$) have different ($S - R$) values, which result from different values in real ability level. This implies that a correlation between the chosen SE score and an outcome cannot differentiate between an SE effect and the simple main effect(s) of one or two of its ingredients. For example, a non-zero correlation could be driven by the total score that results from merging the self-rating and the criterion or by only one of these variables. To apply this to our example: When we lose Tom's and Sam's detailed information about their S and R scores by considering only their ($S - R$) difference scores, it is impossible to determine who of the two has the higher self-viewed ability. However, this information would be necessary to identify effects on an outcome that are driven only by people's self-viewed ability. Thus, merging the two variables "self-rating" and "real ability" for each person into one single discrepancy score results in the inability to differentiate between SE effects and PSV effects.

Having identified the main source of the limitations of the two-step approach, the solution is straightforward: Instead of merging the self-view and the criterion into a single score and thereby losing information, we keep them separated when investigating effects on an outcome (see Edwards, 1994; Griffin et al., 1999). Mathematically, this means computing a regression with two predictors (S and R) predicting the outcome: $Z = c_0 + c_1S + c_2R + \varepsilon$. Using this procedure, we are able to clearly identify the source of possible effects. The effects of S and R alone can be directly uncovered by considering the coefficients c_1 and c_2 . What is

left to be done is to reveal how the result of this regression can be used to identify an effect of SE: What are the conditions that need to hold for the coefficients to unequivocally indicate an effect of SE?

To identify the conditions that describe what we intuitively understand when talking about a positive association between SE and happiness, consider Chris ($S = 1, R = 1$), who correctly stated that he solved one task on the math test (see Table 1), thus having an SE score of $D := S - R = 0$. We compare Chris with two other people in the sample to identify two necessary conditions for the SE hypothesis: First, we compare Chris with Sam ($S = 6, R = 1$), who solved one task like Chris but stated that he solved six. Sam therefore has an SE score of $D = 5$. Because Sam self-enhances more than Chris, the SE hypothesis would predict that Sam is happier than Chris. In other words, because Sam's self-rating is higher than Chris', Sam should be happier than Chris if the SE hypothesis holds. This is the first SE condition: For two persons with the same real ability, the rule "the higher S is, the higher happiness will be" must hold. Second, compare Chris ($S = 1, R = 1$) with Ann ($S = 1, R = 5$). The only difference between them is that Ann correctly solved 5 tasks. Because she stated that she solved only 1, she has an SE score of $D = -4$. Our SE hypothesis would thus suggest that Chris is happier than Ann because he self-enhances more (i.e., has an accurate self-perception, whereas Ann self-effaces). In other words: If the SE hypothesis holds, given that Chris and Ann have identical self-views, Ann should be less happy than Chris only because she has a higher real score. This is the second condition that is implied by the SE hypothesis: For two people with the same self-view, the rule "the higher R is, the lower happiness will be" must hold.

What now remains to be done is to translate these two intuitive SE conditions into the mathematical context in which we compute the regression $Z = c_0 + c_1S + c_2R + \varepsilon$ and derive SE conditions for the coefficients. Each coefficient in the linear regression can be interpreted in the following way: The coefficient c_1 of S tells us what happens to the outcome Z when we change S while holding R constant (i.e., controlling for R). In other words, the coefficient c_1 of S reflects how the outcome Z depends on the self-ratings of persons with the same real ability R . The first condition that we intuitively deduced can thus be translated into the condition $c_1 > 0$: For persons with the same real ability R , happiness is higher for individuals with higher self-rated ability S . Analogously, the second condition can also be transferred into the

mathematical framework. The coefficient c_2 reflects how happiness depends on real ability R for persons with the same self-rating S . The second condition thus states that $c_2 < 0$, that is, for persons with the same self-rating, happiness is lower for persons with higher real ability.

In summary, we know that a positive effect of SE on a respective outcome Z exists if in the regression $Z = c_0 + c_1S + c_2R + \varepsilon$, the conditions (a) $c_1 > 0$ and (b) $c_2 < 0$ are satisfied (see also Griffin et al., 1999). In an analogous way, for a *negative* effect of SE (i.e., self-effacement is beneficial), the signs in the conditions must be reversed. We, thus, know that there is a (positive or negative) effect of SE if the coefficients c_1 and c_2 are not zero and have opposite signs. Note that this condition can be proven mathematically in a straightforward way (see Supplemental Material B). Because the conditions $c_1 \neq 0$, $c_2 \neq 0$, and " c_1 has the opposite sign of c_2 " for an effect of SE require two tests for significance, it is convenient to compress them into a single condition instead, requiring only one significance test. The following theorem states such a single condition that is mathematically equivalent to the conditions described above (see Supplemental Material F for the proof for the equivalence). The condition stated in the theorem therefore exactly reflects the conceptually intuitive conditions that were derived above.

Theorem: A self-enhancement effect (either positive or negative) on a variable Z exists, if and only if the coefficients of the regression $Z = c_0 + c_1S + c_2R + \varepsilon$ satisfy the condition $|c_1 - c_2| > |c_1 + c_2|$; that is, if $abs := |c_1 - c_2| - |c_1 + c_2| > 0$. In this case, the SE effect is positive when $(c_1 - c_2)$ is positive, and it is negative when $(c_1 - c_2)$ is negative.

The theorem constitutes a novel condition-based regression analysis (CRA) approach for testing the SE hypothesis. Given that the self-view S , the reality criterion R and the outcome variable Z were assessed for each person in the sample, this new approach consists of the following steps: First, one estimates the coefficients and their standard errors in the linear regression $Z = c_0 + c_1S + c_2R + \varepsilon$. This can for example be done with the help of the *sem* function in the R package *lavaan* (Rosseel, 2012). The second step is the computation of $abs := |c_1 - c_2| - |c_1 + c_2|$, based on the estimates for c_1 and c_2 . To test abs for significance in the third step, the Lemma in Supplemental Material G must be applied. It states that, depending on the signs of $(c_1 - c_2)$ and of $(c_1 + c_2)$, the term abs equals one of the terms $2c_1$, $-2c_1$, $2c_2$ or $-2c_2$. The standard errors of these terms can be estimated using the delta

method (Sobel, 1982). This method is for example implemented in *lavaan*. Therefore, when we add the terms to the initial lavaan model, then the output of the *sem* function automatically provides us with the standard error and significance test of *abs*. An example R code including this significance test can be found in the Supplemental Materials (see osf.io/e8p5r). Only if *abs* is significantly positive, an association of the discrepancy $S - R$ with Z has been detected by the CRA. In this case, it remains to be discovered in the fourth step, whether the effect is positive or negative. To this aim, we can consider the term $(c_1 - c_2)$. If $(c_1 - c_2)$ is positive, the association of SE with Z is positive, in the sense that higher discrepancy values $S - R$ tend to go along with higher values in the outcome Z . If $(c_1 - c_2)$ is negative, the association is negative in the sense that higher SE values go along with lower outcome values.

As an example, imagine the coefficient estimates of $Z = c_0 + c_1S + c_2R + \varepsilon$ were $c_1 = -3$ and $c_2 = 2$. Then $c_1 - c_2 = -5$, $c_1 + c_2 = -1$, and thus $abs := |c_1 - c_2| - |c_1 + c_2| = 4$. If the significance test of *abs* (see Supplemental Material G) reveals that this value is significantly positive, then the condition for a SE effect is satisfied. Because in this case, $(c_1 - c_2)$ is negative, it follows that there is a negative association of SE and Z (see Table 5 for further examples).

In the example R code that we provide in the Supplemental Materials and in the OSF project (see osf.io/e8p5r), all steps of the CRA are implemented in *lavaan*. By loading own data and replacing the variable names of S , R and Z by the respective variables of interest, this code can easily be adapted to conduct the whole CRA for real data.

Because the CRA requires estimation of a multiple regression model, it is based on the classical assumptions of multiple regression analyses (i.e., linearity, independent and normally distributed errors with mean zero and homoscedastic variances). From these assumptions it follows that the regression coefficients estimated in the CRA are normally distributed variables. Hence, the significance test of *abs* can be derived by use of the delta method (e.g., see Castella & Berger, 2002). Note that one advantage of the single condition from the theorem is that it directly implies a parameter indicating the strength of an SE effect: The more the parameter $abs := |c_1 - c_2| - |c_1 + c_2|$ exceeds zero, the higher the SE effect is in the data. When working with standardized variables S , R , and Z , this value can be compared across different analyses. Furthermore, the CRA provides a direct methodological comparison

of the SE hypothesis versus the PSV hypothesis: If the coefficients in the regression $Z = c_0 + c_1S + c_2R + \varepsilon$ reveal (a) an effect of the self-view, $c_1 \neq 0$, then the data support the PSV hypothesis, which claims a positive or negative effect of the self-view on the outcome, controlled for a potential effect of real ability. If (b) the *stronger* condition $|c_1 - c_2| - |c_1 + c_2| > 0$ holds, then there is an effect of SE that has the same sign as $(c_1 - c_2)$.

Note that the CRA is able to identify associations of the discrepancy $S - R$ with Z , *although* the term $S - R$ is not calculated explicitly during the analysis (see also Edwards, 1994; Schönbrodt, 2016b; Shanock, Baran, Gentry, Pattison, & Heggstad, 2010). Further ways to conceptually understand why the one-step CRA indeed reflects effects of $S - R$ (in contrast to prior two-step approaches) include (a) identifying the role of $S - R$ in the intuitive derivation of the conditions $c_1 \neq 0$, $c_2 \neq 0$, and " c_1 has the opposite sign of c_2 " for a SE effect (see above), (b) following the mathematical derivation of the conditions just stated, because the role of $(S - R)$ becomes explicit here (see Supplemental Material B), or (c) considering a graphical interpretation of the condition $|c_1 - c_2| - |c_1 + c_2| > 0$ by considering plots of respective regression surfaces (see Supplemental Material H).

In summary, we are providing a general solution that overcomes the problems of prior approaches for investigating the consequences of SE. The novel CRA approach, in contrast to prior two-step approaches, enables to test whether higher values in the discrepancy of self-view and criterion are systematically related to higher values in the outcome (SE hypothesis), without misinterpreting mere main effects of the self-view (PSV hypothesis) as effects of SE. The CRA approach that is described in the main part of this manuscript investigates whether individual differences in the discrepancy $S - R$ of self-rating S and criterion R are associated with individual differences in the outcome variable Z . However, the proposed method can be adapted to fit other common conceptualizations of SE, for example, reflected by the Kwan index or residual scores (see Table 4 and Supplemental Materials C, D, and E). Moreover, this technique can be applied to all choices of self-reports and criterion scores, and to all kinds of SE content domains, ranging from ability and performance to personality to attractiveness.

The Case of Intellectual SE: An Illustration of the CRA Approach Using Three Exemplary Empirical Studies

For illustration, we now apply the CRA approach to three exemplary empirical studies in the frequently investigated domain of intellectual SE (e.g., see Alicke, 1985; Kruger &

Dunning, 1999). In doing so, we aim to (a) demonstrate how this method can be applied and how results can be interpreted, (b) illustrate the difference between the results of the traditional two-step approach and our novel method, and (c) provide initial evidence for the empirical difference between SE and PSV in their relation to indicators of psychological adjustment. We considered indicators from different adjustment domains as potential outcome variables. Broadly speaking, SE hypotheses were formulated in the literature for different intrapersonal (e.g., Bonanno et al., 2005; Gramzow et al., 2008; Sedikides & Gregg, 2008; Taylor & Brown, 1988) and interpersonal domains (e.g., Paulhus, 1998; Taylor et al., 2003b). For the intrapersonal domain, we considered *self-esteem* as a potential outcome of intellectual SE. For the interpersonal domain, we considered self-reported leadership ability, self-reported trustworthiness, peer-reported leadership ability, and peer-reported friendship potential as manifold indicators of self- and peer-rated social adjustment. We tested the two hypotheses for each of the five outcomes separately:

1. *Self-Enhancement Hypothesis*: Psychological adjustment is systematically associated with SE, in the sense that higher values in the discrepancy $S - R$ of self-view S and real ability R tend to go along with higher (or lower) values in a specific outcome.
2. *Positivity of Self-View Hypothesis*: Psychological adjustment is systematically associated with PSV, in the sense that higher self-views tend to go along with higher (or lower) values in a specific outcome under control for effects of real ability.

Method

We used data from three large studies. The PILS study (Sample B) has been approved by the Research Ethics Committee of the University of Mainz. The Connect study (Sample C) has been approved by both the Ethics Committees of the University of Mainz and of the University of Münster. Sample A was assessed during a time (2006-2007) when it was not yet mandatory to obtain ethical permission for non-medical research. This is why no ethical permission was requested for this study.

Sample A was already used in an article that investigated effects of SE on various outcome variables (Dufner et al., 2012). However, these previous analyses were conducted with the traditional two-step approach by correlating residuals with the outcome variables. It was therefore not possible to differentiate between true SE effects and PSV effects. We therefore reanalyzed this valuable data set with our new approach, enabling us to clarify which

correlations reflected effects of SE and which effects were driven by PSV. Samples B and C were added as two additional large-scale studies.

A detailed description of the three studies and of the applied measurements is provided in Supplemental Material I. The samples used include (a) a study conducted at Utrecht University, The Netherlands (*Sample A*, see "Study 2" in Dufner et al., 2012; see also Selfhout, Denissen, Branje, and Meeus, 2009), where the relevant variables were assessed in 188 psychology students (157 female; ages ranged from 17 to 31, $M_{age} = 18.89$, $SD_{age} = 1.67$) in online questionnaires and round robin ratings at three waves (T1 in the second week of the first semester, T2 4 months after T1, T3 8 months after T1), (b) a study conducted at the Johannes Gutenberg University in Mainz, Germany (*Sample B*, see Geukes et al., 2016), where the variables of interest were assessed in 295 students (162 female; ages ranged from 18 to 39, $M_{age} = 23.8$, $SD_{age} = 3.95$) in online-questionnaires and in three laboratory group sessions with four to six participants per group, and (c) a study conducted at the University of Münster, Germany (*Sample C*, see Geukes et al., 2016), where the relevant variables were assessed in 83 psychology freshman (67 female; ages ranged from 18 to 42, $M_{age} = 20.57$, $SD_{age} = 3.43$) in four online surveys (Survey 1 at the very beginning and follow-up surveys after 2 [S2], 8 [S3], and 19 [S4] months), in 22 phases of time-based assessments (three diaries per week during the first 3 weeks, one diary per week until the end of the first semester, and one follow-up diary along with the last online survey) and in a follow-up laboratory session approximately 1 year after the beginning of the study.

In each study, we assessed objectively measured reasoning ability with a shortened 15-item version (see Denissen, Schönbrodt, van Zalk, Meeus, & van Aken, 2011) of Raven's advanced progressive matrices (Raven, Raven, & Court, 1962), used one self-report item to assess self-rated reasoning ability, and applied various instruments to assess up to five self- and peer-rated outcome variables (peer-rated trustworthiness was not assessed in Sample A). In all studies, we removed subjects who had missing values on the ability test, self-viewed ability, or on every outcome variable, but no other data were excluded. Whenever possible, we used measurements of the respective outcome variables that were assessed later in time than the ability measures, and we always used the first assessments of self-rated and objective ability. In cases where the outcome was assessed repeatedly, we averaged each person's scores across the time points. Across the three samples, self-rated and objectively measured reasoning

ability had a (meta-analytically integrated) correlation of $Cor(S, R) = .17$. The average variance of the SE score $S - R$ was 1.77. The SE score $S - R$ was, furthermore, highly correlated with the self-rating S : The meta-analytically integrated correlation was $Cor(S - R, S) = .65$. This would most likely lead to biased results when using the correlation of $S - R$ and the outcome to investigate effects of SE in a two-step approach, and further underlines the need for the one-step CRA. More detailed descriptive statistics and internal consistencies are presented in Supplemental Material J. Please note that we report only a few exemplary outcomes to show how the CRA procedure can be applied. Results for additional outcome variables can be found in Supplemental Material K.

Analytical Strategy

For all peer-rated variables that were assessed via round robin ratings (where each subject rated every other subject in the study or in his group), we computed target effects (average peer-ratings) according to the Social Relations Model (Kenny, 1994). We used the R package *TripleR* (Schönbrodt, Back, & Schmukle, 2012) to compute the target effects. All variables were z-standardized prior to the analysis. We applied single analyses for each of the three studies as well as a meta-analysis across all studies. We considered each outcome aggregate Z separately. Each analysis included (a) the computation of the linear regression $Z = c_0 + c_1S + c_2R + \varepsilon$ and (b) the computation of the parameters $(c_1 - c_2)$, $(c_1 + c_2)$ and $abs := |c_1 - c_2| - |c_1 + c_2|$, using the estimated regression coefficients. The linear regression was estimated in *lavaan* (version 0.5.20, see Rosseel, 2012) using the *sem* function. The parameters $(c_1 - c_2)$ and $(c_1 + c_2)$ as well as the difference $abs := |c_1 - c_2| - |c_1 + c_2|$ were included in the model (see Supplemental Material G for details on how *abs* can be included in the model). Their standard errors were then automatically estimated within the *sem* function by use of the delta method (Sobel, 1982), and the *lavaan* output therefore included respective p-values. For the plotting of surfaces, we used the *RSA* package (version 0.9.10; Schönbrodt, 2016a). To provide a comparison with classical methods, we also computed the correlation of the algebraic difference $(S - R)$ with each outcome as well as the correlation of ξ with each outcome, where ξ are the residuals from the regression $S = b_0 + b_1R + \xi$. These analyses were conducted in *lavaan*. All significance tests were two-sided. All raw data and reproducible R-scripts for all analyses are provided in the Supplemental Materials (see osf.io/e8p5r). All single study results were meta-analytically integrated by applying the multivariate generalized

least squares approach described by Becker and Wu (2007). In brief, this approach computes a weighted average of the single study slopes. The weights for the single study slopes take into account not only the slopes' standard errors but also their intercorrelations.

Results

Results can be found in Table 6 for self-rated outcomes and in Table 7 for peer-rated outcomes. In each table, the first two columns present the results of the classical two-step approach. The correlation of the respective outcome with the algebraic difference can be found in the first column, and the respective correlation with the residuals can be found in the second column. The other five columns present the coefficients of S and R in the linear regression $Z = c_0 + c_1S + c_2R + \varepsilon$, the computation of $c_1 + c_2$ and $c_1 - c_2$, as well as the difference $abs := |c_1 - c_2| - |c_1 + c_2|$. For all meta-analyses, the regression surfaces (without intercepts) are illustrated in Figure 2.

Remember that we tested for associations between SE and the outcomes as well as for associations between PSV and the outcomes, controlled for potential effects of real ability. To interpret the results in Tables 6 and 7 for a specific outcome, we will first focus on the condition required to test the SE hypothesis, namely, $abs := |c_1 - c_2| - |c_1 + c_2| > 0$. If this condition is fulfilled, there is an association with SE that is positive if $c_1 - c_2$ is positive and negative if $c_1 - c_2 < 0$. In this case, $abs = |c_1 - c_2| - |c_1 + c_2|$ can be interpreted as the strength of the relationship. If the condition $abs > 0$ is *not* fulfilled, we then test for the PSV hypothesis, which requires that either $c_1 > 0$ (positive effect of PSV under control for effects of real ability) or $c_1 < 0$ (negative effect).

Effects of SE and PSV on self-rated outcomes. Consider first the meta-analysis for the outcome *self-esteem* (see Table 6). In the very last column "*abs*," we see that $abs := |c_1 - c_2| - |c_1 + c_2|$ was *not* significantly positive. This contradicts the SE hypothesis because the theorem's SE condition was not satisfied. However, the outcome was positively related to the self-view under control for effects of real ability ($c_1 > 0$), thus providing support for the PSV hypothesis. A graphical representation of the regression surface can be found in Figure 2a (see Supplemental Material H for a detailed description of how the condition for an SE effect can be interpreted graphically). It illustrates the PSV-effect: The regression surface rises in the direction of higher self-rated reasoning ability (parallel to the x-axis) but is nearly constant in the direction of higher real ability (parallel to the y-axis). Thus, two persons with

the same self-rated ability have similar values of self-esteem, even if one of them is not as smart and thus self-enhances more than the other. For *self-rated leadership ability*, the result pattern was very similar to the pattern found for self-esteem (see Table 6 and Figure 2b). There was no association between SE and the outcome, but PSV was positively related to the outcome under control for real ability.

When considering the results of the two classical approaches for these two outcomes (i.e., the correlation of difference scores and of residuals with the outcome), we see that they would both have led to the conclusion that the SE hypothesis was valid. However, our novel CRA method made it apparent that these correlations were driven purely by the respective association with the self-view. An interpretation in terms of SE effects would therefore provide the wrong conclusion. Note that the correlation with residuals was highly similar to the coefficient of S in the linear regression. As mentioned earlier, this results from the fact that residuals are computed as the algebraic difference $\xi = -\hat{b}_0 + S - \hat{b}_1 R$, where real ability is weighted by $\hat{b}_1 = \text{Cov}(S, R) / \text{Var}(R)$, which is $\hat{b}_1 = .17$ in this case. Thus, this is the first case where the new method was able to show its advantages above and beyond the prior two-step approach, for both SE conceptualized as the algebraic difference and as residuals.

Now consider the outcome *self-rated trustworthiness* in Table 6. In this case, $abs := |c_1 - c_2| - |c_1 + c_2|$ was significantly positive, which means that the theorem's condition was satisfied. Moreover, $c_1 - c_2$ was positive, indicating that the association of SE and the outcome was positive. That is, the more a participant self-enhanced with respect to his reasoning ability, the higher he estimated his own trustworthiness. Here, the two classical approaches would have led to the same interpretation. Note that the positive relationship of self-rated trustworthiness and SE can be seen graphically in Figure 2c by noting that the rise of the surface is positive above the SE line (left corner to right corner of the cube) and near zero above the self-insight line (front corner to back corner of the cube). This indicates that the outcome increases when SE increases, and it is constant for persons with the same amount of SE, that is, at the same distance from the self-insight line.

Effects of SE and PSV on peer-rated outcomes. *Peer-rated leadership ability* (see Table 7) was not associated with SE because abs was not significantly positive, but it was positively associated with the self-view and also positively associated with real ability. Thus, the PSV hypothesis was supported here, and there was also a relationship between real ability

and the outcome under control for self-views (see also Figure 2c). Here, out of the two classical approaches, only the residuals but not the algebraic difference had a positive correlation with the outcome. As we pointed out above, the algebraic difference is correlated with self-viewed ability and with real ability. In this case, these two effects canceled each other out, leaving the algebraic difference with a correlation near zero. Residuals, however, are highly similar to the self-view alone because they are computed as $\xi = S - .17R$. Therefore, the residual approach would once again have led to the conclusion that the outcome was positively related to SE when it was in fact related only to PSV.

For *peer-rated friendship potential*, the difference $abs := |c_1 - c_2| - |c_1 + c_2|$ was not significantly positive at a significance level of $\alpha = .05$. There was only a significantly positive association between real ability and the outcome under control for self-views. However, with a p-value of $p = .093$, abs was marginally significant. If we chose a level of $\alpha = .1$, we would interpret this pattern as a *negative* effect of SE on peer-rated friendship potential (see also Figure 2e). Regarding the results of the two classical approaches, the difference approach would have led us to conclude that there was a negative effect of SE at $\alpha = .05$, and the correlation between the residuals and the outcome was marginally significantly negative ($p = .085$).

Summary

In sum, our results demonstrate that differentiating between the SE hypothesis and the PSV hypothesis is crucial, not only theoretically but also to attain valid empirical conclusions. In our illustrative analyses on intellectual SE, only a few of the outcomes we considered were related to SE, whereas others were related to PSV but not to SE. It is important to note that when we compared our results with the results of the classical two-step approach (i.e., the correlation of an outcome with the algebraic difference or with residuals), we found that all true effects of SE would also have been detected. It is also important to note, however, that the two-step approach indicated SE effects when there were in fact only effects of PSV. In these cases, the outcome was completely independent of SE, and classical approaches would have led to the false acceptance of the SE hypothesis. These findings show that the condition-based regression analysis (CRA) can be applied to distinguish between true SE effects and effects of PSV, whereas classical approaches cannot.

Discussion

In this paper, we deduced a novel method of analysis that can be used to investigate the consequences of SE. Moving beyond prior statistical approaches, it enables researchers to investigate effects of SE without misinterpreting main effects of PSV as evidence for the SE hypothesis. Our novel CRA approach retains all information that is present in the data by simultaneously regressing the outcome on both the self-rating S and some criterion R and then provides conditions for the regression coefficients that unequivocally define the effects of SE.

Prior Research on the Consequences of SE

We explained that one major reason for the many theoretical and empirical inconsistencies in the SE literature is the fact that effects of PSV have often been treated as "self-enhancement" effects. It is important to note that SE and PSV can easily be confused when thinking about intraindividual dynamics *within* persons and not about interindividual differences *between* persons. Within one person, increases in SE and increases in PSV can happen only together because actual ability is relatively fixed. When a person increases the positivity of his self-view from 6 to 7 solved tasks, his SE automatically increases too (or self-effacement decreases, respectively). In particular, for a single individual, a confirmation of the PSV hypothesis would have had the very same implications as a confirmation of the SE hypothesis: The more positive your thoughts of your ability are, the better. However, the difference between the two concepts is of crucial importance when changing to a differential, interindividual perspective, that is, when investigating effects of individual differences in SE on outcomes. The most important ingredient of SE is the comparison of people's self-view with an objective criterion (e.g., real intelligence). The value of this criterion is no longer fixed when considering several persons; it can be different for each of them. Here, the two hypotheses state two different things: The SE hypothesis expects that the outcome will be higher for persons who have a higher discrepancy between their self-viewed ability and their objective ability. By contrast, the PSV hypothesis simply states that the outcome will be higher for persons who have a more positive view of themselves.

Prior approaches that have been used to investigate the SE hypothesis suffer from the major disadvantage that they entangle effects that we in fact want to differentiate: As many authors have pointed out before (Asendorpf & Ostendorf, 1998; Edwards & Parry, 1993; Griffin et al., 1999; Krueger & Wright, 2011; Ullrich, 2009; Zuckerman & Knee, 1996), the

algebraic difference between a self-view and reality has a non-zero correlation with an outcome when there is an effect of SE (SE hypothesis), an effect of the self-view (PSV hypothesis), or an effect of real ability. This means that when prior research detected a non-zero correlation between the algebraic difference (including the Kwan index, Kwan et al., 2004; and the overplacement score, Moore & Healy, 2008) and some outcome, it was impossible to know which of the three scenarios (SE hypothesis, PSV hypothesis, effect of real ability) was actually represented in the data. The results of our illustrative analyses provide first tentative hints towards the fact that this methodological entangling might have led to an overestimation of SE effects in recent research: In our analyses, only one outcome variable was found to be associated with SE, while the classical difference-correlation approach would have accepted the SE hypothesis for three further outcome variables, that were in fact only associated with PSV. Other research considered residuals instead of difference scores and correlated the residuals with an outcome. As we pointed out, this procedure is also not able to unequivocally identify effects of SE because residuals are also correlated with the self-view (in many cases even more strongly than difference scores). However, the correlation between residuals and an outcome can be used to correctly identify effects of PSV that are controlled for potential effects of real ability, because it is equivalent to the semi-partial correlation of the self-rating with the outcome, for which real ability is removed from the self-view. Therefore, all empirical findings for which residuals were correlated with an outcome must be interpreted in terms of the PSV hypothesis. Without using raw data, however, it is impossible to say whether some of those correlations also reflected effects of SE.

Please note again that the problem with prior approaches is *not* the operationalization of SE as an algebraic difference or residual score, but their *two-step* nature when such SE scores were correlated with the outcome variable.

A Novel CRA Approach for the Investigation of SE Hypotheses

The CRA overcomes the limitation of the two-step approach by keeping all variables separate. That is, the CRA uses all information available in the data to explain the outcome. Depending on the chosen operationalization of SE, it tells us how to diagnose whether the results point to an association between SE and the outcome or not. Because the CRA uses only multiple linear regression, it can easily be implemented, for example, by using the R package *lavaan*. For a conceptualization of SE as reflected by the algebraic difference, for

example, the only required input consists of a self-rating, a variable that is considered a valid criterion, and an outcome variable. We provide the R code for testing the SE and PSV hypotheses in the Supplemental Materials (downloadable from osf.io/e8p5r). For other conceptualizations of SE, for example in terms of residuals or when additionally controlling for rating tendencies, the R code can easily be adjusted to fit the respective adaption of the CRA as described in Table 4 and in Supplemental Materials C, D, and E. Moreover, because the CRA identifies associations of the discrepancy $S - R$ and a variable Z for every choice of the variables S , R and Z , it can be applied to other research contexts where individual differences in some discrepancy measure are expected to be related to individual differences in a third variable.

When empirically investigating the SE hypothesis, an additional question that needs to be addressed before data assessment is how to choose the measurement scales for the self-ratings and the criterion. For SE conceptualized as a difference score (and the respective CRA), S and R (as well as any other potential variables, e.g., rating tendencies) need to be located on commensurable scales in order for the algebraic difference $S - R$ to be interpretable. In our illustrative empirical study, we achieved commensurability by standardizing S and R , which forced them onto the same scale. Of course, the resulting conceptualization of SE must be interpreted in terms of rank-order enhancement because the scale reflects deviations from the sample mean in standard deviation units. Within this context, a person with a real ability level that is one standard deviation above the sample mean, for example, has an accurate self-perception if his self-rating is also one standard deviation above the average self-rating in the sample. In cases in which one wants to interpret effects of SE in terms of specific ability levels, for example, the data must be assessed on appropriate scales. Ongoing efforts in the literature have already provided us with valid and sophisticated approaches for assessing commensurable self-perceptions and criterion scores for a wide range of different domains (e.g., see Anderson et al., 2012; Gramzow et al., 2008; John & Robins, 1994; Kurt & Paulhus, 2008; Moore & Healy, 2008; Noble et al., 2011; Polzer et al., 1997).

Future Research: Toward Deeper and More Robust Insights into the Consequences of Self-Enhancement

Future research on the effects of individual differences in self-views and their deviations from reality should very carefully define the construct under investigation. An illustrative

question could be: Out of two individuals, who is supposed to have the higher (lower) outcome: the one whose self-view surpasses his real ability to a greater degree (SE hypothesis) or the one with the more positive self-view, regardless of how it compares with reality (PSV hypothesis)? Given such specific research questions about the consequences of PSV or SE, the CRA is able to clarify whether potential effects in the data are driven by SE or PSV. While our illustrative analyses provide first hints that SE might be less consequential than indicated in the literature, there is an essential need for cross-laboratory (re-)analyses of strong existing and novel datasets, aiming at robust insights regarding what outcomes are affected by SE versus PSV. Furthermore, SE research might focus on a number of exciting implications and extensions of the presented approach.

First, a strict differentiation between the SE hypothesis and the PSV hypothesis is essential for drawing conceptual conclusions from SE research. Consider for example the potential intra- and interpersonal processes implied by the SE versus the PSV hypothesis. If we find evidence for the SE hypothesis that "more SE results in more happiness," we would have to explain which processes resulting from the discrepancy between self-view and reality (e.g., expecting a higher result on the test than one gets), influence the outcome. It has, for example, been argued that the discrepancy between self-estimated and real capacity could lead to mistakes in decision making or unrealistically high goals, which could hinder personal well-being (e.g., Robins & Beer, 2001) and performance outcomes (e.g., Barber & Odean, 2000). Other authors argued that SE could cause social problems and conflicts when peers sense a discrepancy between someone's explicit expectation of entitlement and his or her actual performance (Anderson, Ames, & Gosling, 2008; John & Robins, 1994; Polzer et al., 1997), or when an individual shows no distress in situations that, based on his or her real ability or trait, are evaluated by others to be stressful events for this person (Bonanno et al., 2002; Paulhus, 1998). Evidence for the PSV hypothesis "a more positive self-view results in more happiness," by contrast, makes it necessary to explain how processes that depend on the self-view alone (e.g., seeing oneself as able to solve many items, independent of reality) affect the outcome. Higher self-views have, for example, been assumed to help dealing with adversities (Bonanno et al., 2005; Sedikides, Gregg, & Hart, 2007; Taylor & Brown, 1988), to go along with higher motivation and persistence in goal pursue (Taylor & Armor, 1996), and to lead to more salient display of competence cues that might lead to higher peer-perceived competence and status

(Anderson et al., 2012). Only if we are able to decide which of the two hypotheses is supported by the data can we evaluate existing hypotheses and develop valid new hypotheses regarding underlying processes. The CRA enables to achieve this crucial differentiation.

Second, the CRA can be used to gain more insights into main effects and SE effects regarding self-perceived as well as actual ability. A positive SE effect includes a negative effect of real ability in the regression with self-rated and real ability as predictors. It is important to note that this does *not* contradict the well-established positive effects of ability on a variety of beneficial outcomes, for example, mortality risk (e.g., Batty, Deary, & Gottfredson, 2007; Deary, Weiss, & Batty, 2010), educational attainment, annual income, occupational prestige (Damian, Su, Shanahan, Trautwein, & Roberts, 2015), popularity in school (Meijs, Cillessen, Scholte, Segers, & Spijkerman, 2009), or probability of divorce (Duchek, Balota, Storandt, & Larsen, 2007). It is possible that real ability is positively correlated with an outcome but has a negative relation with the very same outcome when self-viewed ability is controlled for, as is done in the regression that forms the basis of the CRA.¹² If, however, the effect of real ability on the outcome is still positive when controlling for self-rated ability, then there is definitely no *positive* SE effect because such an effect would require that out of two persons with the same self-viewed ability, the one who has less real ability (and not more, as would be the case in this situation) is happier. There might, of course, still be a positive effect of PSV.

Third, the CRA approach can be used in all kinds of different content domains (ability, personality, attractiveness, etc.) involving different criterion measures (objective tests, peer reports, behavioral observations, etc.) and different conceptualizations of SE (e.g., algebraic difference, residuals, Kwan index). Due to the large number of possible combinations of content domains, criterion measures, and comparison scores, it is fundamental in SE research to clearly communicate the choices made and to reason why they reflect the type of SE that shall be investigated (e.g., with respect to potential consequences). Identifying an appropriate criterion measure is often the most complicated choice and it strongly depends on the content domain that is investigated. The results of our illustrative analyses suggest that consequences of SE versus PSV might also differ across different outcome domains, indicating that a systematic differentiation between outcome domains is needed when testing the SE hypothesis. It is important to note that the wealth of existing data sets on the consequences of SE can be re-analyzed with the help of the CRA approach, as we did with Sample A. We regard this as a

major goal for future research. Such re-analyses of previously published findings would allow us to obtain more robust and differentiated insights into the consequences of SE and PSV by disentangling the effects of these two concepts. This will help us understand whether, when, and why SE is (mal-)adaptive and whether previously reported SE effects were true SE effects or were instead driven by PSV. Future research might also adapt the CRA methodology to systematically investigate in detail associations of individual differences in SE across different content domains, for example clarifying whether persons who enhance (or deface) their intelligence also tend to enhance (or deface) the desirability of their personality traits.

Fourth, the CRA approach presented here can be extended to examine additional nonlinear hypotheses about the consequences of SE. In this article, we focused on linear effects of SE and PSV by formulating hypotheses that adhered to the general form of "the more SE/PSV, the higher (or lower) the outcome." We introduced a valid tool that can be applied to identify such linear effects in the data, which was not possible with prior statistical approaches. In an empirical application, one might want to test the linear SE hypothesis against alternative hypotheses or consider potential moderators of effects. In the literature, there are at least two nonlinear hypotheses about the relation between SE and outcome variables: First, the self-insight hypothesis (Allport, 1937; Jahoda, 1958; Kim & Chiu, 2011; Kim, Chiu, & Zou, 2010) expects a curvilinear relation where the outcome is highest for a perfectly accurate self-perception, namely, when the self-view and the criterion agree. Second, the optimal margin hypothesis (Baumeister, 1989) also formulates a curvilinear relation between SE and the outcome, yet it states that the outcome will be highest for a small degree of SE, namely, when the self-view is slightly more positive than the criterion. When investigating of nonlinear hypotheses such as these, classical approaches typically compute SE scores (e.g., algebraic differences, residuals), which are then used as predictors in a quadratic regression. As was pointed out above, the loss of information that goes along with reducing people's self-views and real ability scores into one single SE score renders it impossible to differentiate any further between effects of SE and PSV. This is equally true for nonlinear effects. That is, when first calculating some kind of SE score, quadratic effects of this score on outcomes can result from quadratic effects of PSV or SE. For example, as Edwards (2007) pointed out, this problem can be solved in a manner that is similar to the solution presented here, namely, by using both self-viewed and real ability as predictors in the regression (of

second degree, i.e., including S^2 , R^2 , and SR as predictors). The conditions that must hold for the coefficients to represent the hypotheses of interest can then be deduced by means of Response Surface Analysis (RSA; see Edwards, 2007; Myers, Khuri, & Carter, 1989; Schönbrodt, 2016b). To test different kinds of SE hypotheses simultaneously and against each other, CRA can be combined with RSA. Furthermore, CRA (and also RSA) can be used not only to investigate consequences of SE, but also potential *causes* of individual differences in SE. To this aim, a potential moderator of SE can be used as the variable Z in the CRA. Future research will benefit from applying an integrated approach of both CRA and RSA to both linear and curvilinear hypotheses about the consequences and moderators of SE.

Conclusions

In sum, the novel CRA approach can be applied to overcome a major limitation of the prior two-step approach in the investigation of SE hypotheses. We hope that the CRA will be applied to a variety of domains in which people self-enhance, to a broad range of potential outcome variables, and in strong longitudinal and experimental study designs. There is a wealth of rich data sets that were previously analyzed with statistical methods that were not able to differentiate actual self-enhancement effects from effects that were exclusively driven by the positivity of self-views. To gain differentiated knowledge about the consequences of SE and PSV, we encourage researchers to re-analyze existing data and to analyze novel data with the CRA approach. The conceptual and methodological differentiations introduced here will help to reveal more robust and replicable insights into the fascinating area of self-enhancement and its consequences for psychological adjustment and interpersonal functioning.

References

- Alicke, M. D. (1985). Global self-evaluation as determined by the desirability and controllability of trait adjectives. *Journal of Personality and Social Psychology*, 49(6), 1621–1630. doi:10.1037/0022-3514.49.6.1621
- Alicke, M. D. & Sedikides, C. (2011). *Handbook of self-enhancement and self-protection*. New York, NY: Guilford Press.
- Allport, G. W. (1937). *Personality: A psychological interpretation*. Oxford, England: Holt.
- Anderson, C., Ames, D. R., & Gosling, S. D. (2008). Punishing hubris: The perils of overestimating one's status in a group. *Personality and Social Psychology Bulletin*, 34(1), 90–101. doi:10.1177/0146167207307489
- Anderson, C., Brion, S., Moore, D. A., & Kennedy, J. A. (2012). A status-enhancement account of overconfidence. *Journal of Personality and Social Psychology*, 103(4), 718–735. doi:10.1037/a0029395
- Asendorpf, J. B. & Ostendorf, F. (1998). Is self-enhancement healthy? Conceptual, psychometric, and empirical analysis. *Journal of Personality and Social Psychology*, 74(4), 955–966. doi:10.1037//0022-3514.74.4.955
- Barber, B. M. & Odean, T. (2000). Trading is hazardous to your wealth: The common stock investment performance of individual investors. *The Journal of Finance*, 55(2), 773–806. doi:10.2139/ssrn.219228
- Batty, G. D., Deary, I. J., & Gottfredson, L. S. (2007). Premorbid (early life) IQ and later mortality risk: Systematic review. *Annals of Epidemiology*, 17, 278–288. doi:10.1016/j.annepidem.2006.07.010
- Baumeister, R. F. (1989). The optimal margin of illusion. *Journal of Social and Clinical Psychology*, 8(2), 176–189. doi:10.1521/jscp.1989.8.2.176
- Becker, B. J. & Wu, M.-J. (2007). The synthesis of regression slopes in meta-analysis. *Statistical Science*, 22(3), 414–429. doi:10.1214/07-STS243
- Block, J. & Colvin, C. R. (1994). Positive illusions and well-being revisited: Separating fiction from fact. *Psychological Bulletin*, 116(1), 28–28. doi:10.1037/0033-2909.116.1.28
- Bonanno, G. A., Field, N. P., Kovacevic, A., & Kaltman, S. (2002). Self-enhancement as a buffer against extreme adversity: Civil war in Bosnia and traumatic loss in the United

- States. *Personality and Social Psychology Bulletin*, 28(2), 184–196.
doi:10.1177/0146167202282005
- Bonanno, G. A., Rennie, C., & Dekel, S. (2005). Self-enhancement among high-exposure survivors of the September 11th terrorist attack: Resilience or social maladjustment? *Journal of Personality and Social Psychology*, 88(6), 984–998.
doi:10.1037/0022-3514.88.6.984
- Borkenau, P., Zaltauskas, K., & Leising, D. (2009). More may be better but there may be too much: Optimal trait level and self-enhancement bias. *Journal of Personality*, 77(3), 825–858. doi:10.1111/j.1467-6494.2009.00566.x
- Brown, J. D. (1986). Evaluations of self and others: Self-enhancement biases in social judgments. *Social Cognition*, 4, 353–376.
- Castella, G. & Berger, R. L. (2002). *Statistical Inference*. Arizona State University.
- Church, A. T., Katigbak, M. S., del Prado, A. M., Valdez-Medina, J. L., Miramontes, L. G., & Ortiz, F. A. (2006). A cross-cultural study of trait self-enhancement, explanatory variables, and adjustment. *Journal of Research in Personality*, 40(6), 1169–1201.
doi:10.1016/j.jrp.2006.01.004
- Colvin, C. R. & Block, J. (1994). Do positive illusions foster mental health? An examination of the Taylor and Brown formulation. *Psychological Bulletin*, 116(1), 3–20.
doi:10.1037/0033-2909.116.1.3
- Colvin, C. R., Block, J., & Funder, D. C. (1995). Overly positive self-evaluations and personality: Negative implications for mental health. *Journal of Personality and Social Psychology*, 68(6), 1152–1162. doi:10.1037//0022-3514.68.6.1152
- Damian, R. I., Su, R., Shanahan, M., Trautwein, U., & Roberts, B. W. (2015). Can personality traits and intelligence compensate for background disadvantage? Predicting status attainment in adulthood. *Journal of Personality and Social Psychology*, 109(3), 473–489. doi:10.1037/pspp0000024
- Deary, I. J., Weiss, A., & Batty, G. D. (2010). Intelligence and personality as predictors of illness and death: How researchers in differential psychology and chronic disease epidemiology are collaborating to understand and address health inequalities. *Psychological Science in the Public Interest*, 11, 53–79. doi:10.1177/1529100610387081

- Denissen, J. J. A., Schönbrodt, F. D., van Zalk, M., Meeus, W. H. J., & van Aken, M. A. G. (2011). Antecedents and consequences of peer-rated intelligence. *European Journal of Personality*, 25(2), 108–119. doi:10.1002/per.799
- Duchek, J. M., Balota, D. A., Storandt, M., & Larsen, R. (2007). The power of personality in discriminating between healthy aging and early-stage Alzheimer's disease. *Journal of Gerontology: Psychological Sciences*, 62(4), 353–361. doi:10.1093/geronb/62.6.P353
- Dufner, M., Denissen, J. J. A., Sedikides, C., van Zalk, M., Meeus, W. H. J., & van Aken, M. A. G. (2013). Are actual and perceived intellectual self-enhancers evaluated differently by social perceivers? *European Journal of Personality*, 27, 621–633.
- Dufner, M., Denissen, J. J. A., van Zalk, M., Matthes, B., Meeus, W. H. J., van Aken, M. A. G., & Sedikides, C. (2012). Positive intelligence illusions: On the relation between intellectual self-enhancement and psychological adjustment. *Journal of Personality*, 80(3), 537–572. doi:10.1111/j.1467-6494.2011.00742.x
- Dufner, M., Reitz, A. K., & Zander, L. (2015). Antecedents, consequences, and mechanisms: On the longitudinal interplay between academic self-enhancement and psychological adjustment. *Journal of Personality*, 83(5), 511–522. doi:10.1111/jopy.12128
- Dunning, D., Heath, C., & Suls, J. M. (2004). Flawed self-assessment: implications for health, education, and the workplace. *Psychological Science in the Public Interest*, 5(3), 69–106.
- Dunning, D., Meyerowitz, J. a., & Holzberg, A. D. (1989). Ambiguity and self-evaluation: The role of idiosyncratic trait definitions in self-serving assessments of ability. *Journal of Personality and Social Psychology*, 57(6), 1082–1090. doi:10.1037/0022-3514.57.6.1082
- Edwards, J. R. (2001). Ten Difference Score Myths. *Organizational Research Methods*, 4(3), 265–287. doi:10.1177/109442810143005
- Edwards, J. R. (1994). The study of congruence in organizational behavior research: Critique and a proposed alternative. *Organizational Behavior and Human Decision Processes*, 58(1), 51–100.
- Edwards, J. R. (2007). Polynomial regression and response surface methodology. In C. Ostroff & T. A. Judge (Eds.), *Perspectives on organizational fit* (pp. 361–372). San Francisco: Jossey-Bass.

- Edwards, J. R. & Parry, M. E. (1993). On the use of polynomial regression equations as an alternative to difference scores in organizational research. *Academy of Management Journal*, 36(6), 1577–1613. doi:10.2307/256822
- Epley, N. & Dunning, D. (2000). Feeling "holier than thou": Are self-serving assessments produced by errors in self- or social prediction? *Journal of Personality and Social Psychology*, 79(6), 861–875. doi:10.1037/0022-3514.79.6.861
- Epley, N. & Dunning, D. (2006). The mixed blessings of self-knowledge in behavioral prediction: Enhanced discrimination but exacerbated bias. *Personality and Social Psychology Bulletin*, 32(5), 641–655. doi:10.1177/0146167205284007
- Gabriel, M. T., Critelli, J. W., & Ee, J. S. (1994). Narcissistic illusions in self-evaluations of intelligence and attractiveness. *Journal of Personality*, 62(1), 143–155. doi:10.1111/1467-6494.ep9406221282
- Geukes, K., Breil, S. M., Hutteman, R., Küfner, A. C. P., Nestler, S., & Back, M. D. (2016). *Explaining the longitudinal interplay of personality and social relationships in the laboratory and in the field: The PILS and CONNECT study*. Manuscript in preparation.
- Goorin, L. & Bonanno, G. A. (2009). Would you buy a used car from a self-enhancer? Social benefits and illusions in trait self-enhancement. *Self and Identity*, 8, 162–175. doi:10.1080/15298860802501607
- Gosling, S. D., John, O. E., Craik, K. H., Robins, R. W., Cheek, J., Funder, D., ... McCrae, R. (1998). Do people know how they behave? Self-reported act frequencies compared with on-line codings by observers. *Journal of Personality and Social Psychology*, 74(5), 1337–1349.
- Gramzow, R. H. & Willard, G. (2006). Exaggerating current and past performance: Motivated self-enhancement versus reconstructive memory. *Personality and Social Psychology Bulletin*, 32(8), 1114–1125. doi:10.1177/0146167206288600
- Gramzow, R. H., Willard, G., & Mendes, W. B. (2008). Big tales and cool heads: Academic exaggeration is related to cardiac vagal reactivity. *Emotion*, 8(1), 138–144. doi:10.1037/1528-3542.8.1.138
- Griffin, D., Murray, S., & Gonzalez, R. (1999). Difference score correlations in relationship research: A conceptual primer. *Personal Relationships*, 6, 505–518.

- Heck, P. R. & Krueger, J. I. (2015). Self-enhancement diminished. *Journal of Experimental Psychology: General*, 144(5), 1003–1020.
- Heckhausen, J. & Krueger, J. (1993). Developmental expectations for the self and most other people: Age grading in three functions of social comparison. *Developmental Psychology*, 29(3), 539–548. doi:10.1037/0012-1649.29.3.539
- Higgins, E. T. (1996). The "self digest": Self-knowledge serving self-regulatory functions. *Journal of Personality and Social Psychology*, 71(6), 1062–1083.
doi:10.1037//0022-3514.71.6.1062
- Jahoda, M. (1958). *Current concepts of positive mental health*. New York, NY: Basic Books.
- John, O. P. & Robins, R. W. (1994). Accuracy and bias in self-perception: Individual differences in self-enhancement and the role of narcissism. *Journal of Personality and Social Psychology*, 66(1), 206–219. doi:10.1037/0022-3514.66.1.206
- Kenny, D. A. (1994). *Interpersonal perception: A social relations analysis*. New York, NY: Guilford Press.
- Kim, Y.-H. & Chiu, C.-Y. (2011). Emotional costs of inaccurate self-assessments: Both self-effacement and self-enhancement can lead to dejection. *Emotion*, 11(5), 1096–1104.
doi:10.1037/a0025478
- Kim, Y.-H., Chiu, C.-Y., & Zou, Z. (2010). Know thyself: Misperceptions of actual performance undermine achievement motivation, future performance, and subjective well-being. *Journal of Personality and Social Psychology*, 99(3), 395–409.
doi:10.1037/a0020555
- Klar, Y. & Giladi, E. E. (1999). Are most people happier than their peers, or are they just happy? *Personality and Social Psychology Bulletin*, 25(5), 586–595.
doi:10.1177/0146167299025005004
- Krueger, J. (1998). Enhancement bias in descriptions of self and others. *Personality and Social Psychology Bulletin*, 24, 505–516. doi:10.1177/0146167298245006
- Krueger, J. I. & Wright, J. C. (2011). Measurement of self-enhancement (and self-protection). In M. D. Alicke & C. Sedikides (Eds.), *Handbook of self-enhancement and self-protection* (pp. 472–494). Guilford Press.

- Kruger, J. & Dunning, D. (1999). Unskilled and unaware of it: How difficulties in recognizing one's own incompetence lead to inflated self-assessments. *Journal of Personality and Social Psychology*, 77(6), 1121–1134. doi:10.1037//0022-3514.77.6.1121
- Kurman, J. (2006). Self-enhancement, self-regulation and self-improvement following failures. *British Journal of Social Psychology*, 45, 339–56. doi:10.1348/014466605X42912
- Kurt, A. & Paulhus, D. L. (2008). Moderators of the adaptiveness of self-enhancement: Operationalization, motivational domain, adjustment facet, and evaluator. *Journal of Research in Personality*, 42(4), 839–853. doi:10.1016/j.jrp.2007.11.005
- Kwan, V. S. Y., John, O. P., Kenny, D. A., Bond, M. H., & Robins, R. W. (2004). Reconceptualizing individual differences in self-enhancement bias: An interpersonal approach. *Psychological Review*, 111(1), 94–110. doi:10.1037/0033-295X.111.1.94
- Kwan, V. S. Y., John, O. P., Robins, R. W., & Kuang, L. L. (2008). Conceptualizing and assessing self-enhancement bias: A componential approach. *Journal of Personality and Social Psychology*, 94(6), 1062–77. doi:10.1037/0022-3514.94.6.1062
- Lafrenière, M.-A. K., Vallerand, R. J., & Sedikides, C. (2013). On the relation between self-enhancement and life satisfaction: The moderating role of passion. *Self and Identity*, 12(6), 597–609. doi:10.1080/15298868.2012.713558
- Leising, D., Locke, K. D., Kurzius, E., & Zimmermann, J. (2016). Quantifying the Association of Self-Enhancement Bias With Self-Ratings of Personality and Life Satisfaction. *Assessment*, 23(5), 588–602. doi:10.1177/1073191115590852
- Meijs, N., Cillessen, A. H. N., Scholte, R. H. J., Segers, E., & Spijkerman, R. (2009). Social intelligence and academic achievement as predictors of adolescent popularity. *Journal of Youth and Adolescence*, 39, 62–72. doi:10.1007/s10964-008-9373-9
- Moore, D. A. & Healy, P. J. (2008). The trouble with overconfidence. *Psychological Review*, 115(2), 502–517. doi:10.1037/0033-295X.115.2.502
- Myers, R., Khuri, A., & Carter, W. (1989). Response Surface Methodology: 1966 - 1988. *Technometrics*, 31(2), 137–157.
- Noble, R. N., Heath, N. L., & Toste, J. R. (2011). Positive illusions in adolescents: The relationship between academic self-enhancement and depressive symptomatology. *Child Psychiatry and Human Development*, 42(6), 650–65. doi:10.1007/s10578-011-0242-5

- Paulhus, D. L. (1998). Interpersonal and intrapsychic adaptiveness of trait self-enhancement: A mixed blessing? *Journal of Personality and Social Psychology*, 74(5), 1197–1208.
doi:10.1037//0022-3514.74.5.1197
- Paulhus, D. L. (2008). Self-presentation of personality: An agency-communion framework. In O. P. John, R. W. Robins, & L. A. Pervin (Eds.), *Handbook of personality: Theory and research* (3rd ed., pp. 492–517). New York, NY: Guilford Press.
- Paulhus, D. L., Harms, P. D., Bruce, M. N., & Lysy, D. C. (2003). The over-claiming technique: Measuring self-enhancement independent of ability. *Journal of Personality and Social Psychology*, 84(4), 890–904. doi:10.1037/0022-3514.84.4.890
- Polzer, J. T., Kramer, R. M., & Neale, M. A. (1997). Positive illusions about oneself and one's group: Antecedents and consequences. *Small Group Research*, 28(2), 243–266.
doi:10.1177/1046496497282004
- Raven, J. C., Raven, J., & Court, J. H. (1962). *Advanced progressive matrices set II*. Oxford, England: Oxford Psychologists Press.
- Robins, R. W. & Paulhus, D. L. (2001). The character of self-enhancers: Implications for organizations. In B. W. Roberts & R. Hogan (Eds.), *Personality psychology in the workplace* (pp. 193–219). American Psychological Association.
- Robins, R. W. & Beer, J. S. (2001). Positive illusions about the self: Short-term benefits and long-term costs. *Journal of Personality and Social Psychology*, 80(2), 340–352.
doi:10.1037//0022-3514.80.2.340
- Rosseel, Y. (2012). lavaan: An R package for structural equation modeling. *Journal of Statistical Software*, 48(2), 1–36.
- Schönbrodt, F. D., Back, M. D., & Schmukle, S. C. (2012). TripleR: An R package for social relations analyses based on round-robin designs. *Behavior Research Methods*, 44(2), 455–470. doi:10.3758/s13428-011-0150-4
- Schönbrodt, F. D. (2016a). *RSA: An R package for response surface analysis (version 0.9.10)*. Retrieved from <https://cran.r-project.org/package=RSA>
- Schönbrodt, F. D. (2016b). *Testing fit patterns with polynomial regression models*. Retrieved from <http://papers.ssrn.com/abstract=2753669>

- Schönbrodt, F. D., Maier, M., Heene, M., & Zehetleitner, M. (2015). *Voluntary commitment to research transparency and open science*. Retrieved from <http://www.researchtransparency.org>
- Sedikides, C. & Gregg, A. P. (2008). Self-enhancement: Food for thought. *Perspectives on Psychological Science*, 3(2), 102–116. doi:10.1111/j.1745-6916.2008.00068.x
- Sedikides, C., Gregg, A. P., & Hart, C. M. (2007). The importance of being modest. In C. Sedikides & S. Spencer (Eds.), *The self: frontiers in social psychology* (pp. 163–184). New York, NY: Psychology Press.
- Selfhout, M., Denissen, J. J. A., Branje, S., & Meeus, W. H. J. (2009). In the eye of the beholder: Perceived, actual, and peer-rated similarity in personality, communication, and friendship intensity during the acquaintanceship process. *Journal of Personality and Social Psychology*, 96(6), 1152–1165. doi:10.1037/a0014468
- Shanock, L. R., Baran, B. E., Gentry, W. A., Pattison, S. C., & Heggstad, E. D. (2010). Polynomial Regression with Response Surface Analysis: A Powerful Approach for Examining Moderation and Overcoming Limitations of Difference Scores. *Journal of Business and Psychology*, 25(4), 543–554. doi:10.1007/s10869-010-9183-4
- Simmons, J. P., Nelson, L. D., & Simonsohn, U. (2012). *A 21 word solution*. Retrieved from <http://dx.doi.org/10.2139/ssrn.2160588>
- Sinha, R. R. & Krueger, J. (1998). Idiographic self-evaluation and bias. *Journal of Research in Personality*, 32, 131–155.
- Sobel, M. E. (1982). Asymptotic confidence intervals for indirect effects in structural equation models. *Sociological Methodology*, 13(1982), 290–312. doi:10.2307/270723
- Taylor, S. E. & Armor, D. A. (1996). Positive Illusions and Coping with Adversity. *Journal of Personality*, 64(4), 873–898.
- Taylor, S. E. & Brown, J. D. (1988). Illusion and well-being: A social psychological perspective on mental health. *Psychological Bulletin*, 103(2), 193–210.
- Taylor, S. E. & Brown, J. D. (1994). Positive illusions and well-being revisited: Separating fact from fiction. *Psychological Bulletin*, 116(1), 21–27.
- Taylor, S. E. & Gollwitzer, P. M. (1995). Effects of mindset on positive illusions. *Journal of Personality and Social Psychology*, 69(2), 213–226. doi:10.1037//0022-3514.69.2.213

- Taylor, S. E., Lerner, J. S., Sherman, D. K., Sage, R. M., & McDowell, N. K. (2003a). Are self-enhancing cognitions associated with healthy or unhealthy biological profiles? *Journal of personality and social psychology*, 85(4), 605–15. doi:10.1037/0022-3514.85.4.605
- Taylor, S. E., Lerner, J. S., Sherman, D. K., Sage, R. M., & McDowell, N. K. (2003b). Portrait of the self-enhancer: Well adjusted and well liked or maladjusted and friendless? *Journal of Personality and Social Psychology*, 84(1), 165–176. doi:10.1037/0022-3514.84.1.165
- Ullrich, J. (2009). Reconsidering the "relative" in relative ingroup prototypicality. *European Journal of Social Psychology*, 39, 299–310. doi:10.1002/ejsp.540
- Zuckerman, M. & Knee, C. R. (1996). The relation between overly positive self-evaluation and adjustment: A comment on Colvin, Block, and Funder (1995). *Journal of Personality and Social Psychology*, 70(6), 1250–1251.

Footnotes

¹One aim of this manuscript is to point out the crucial importance of differentiating between intra- versus interindividual perspectives when considering SE. To avoid bias, we therefore decided against pluralized formulations or other unspecific rephrasings that are typically used. Throughout this article, please view the pronoun "he" as referring to male and female persons equally.

²An example of a categorical conceptualization is the "decision-theoretic index" by Heck and Krueger (2015).

³Most SE research is based on an understanding of SE in terms of trait levels. Within this interpretation, an individual has a high level of SE when he overestimates his score on a specific trait (e.g., intelligence). By contrast, there is another branch of SE research in which SE is interpreted in terms of profile desirability, where an individual is considered to have a high level of SE when the shape of his profile across several traits (e.g. the Big Five) equals a profile that is considered to be desirable. One profile approach for the measurement of SE was suggested by Krueger (1998; see also Sinha and Krueger, 1998), who considered the correlation between people's self-ratings on several traits and their ratings of trait desirability on the very same traits while controlling for their "true" score and for average trait-desirability ratings. A similar approach is the "projection-based index" by Heck and Krueger (2015). This profile-based conceptualization of SE does not consider trait levels. This approach is therefore fundamentally different from level-based SE measurements from both conceptual and mathematical points of view.

⁴For a specific type of SE, Paulhus, Harms, Bruce, and Lysy (2003) found a sophisticated way to compare persons' self-views with their real ability even though participants gave only their self-ratings. On the "Over-Claiming Questionnaire," participants had to indicate their familiarity with items, some of which did not actually exist. With regard to these items, all participants thus had "real knowledge" of zero items. However, due to its construction, this approach remains restricted to a specific domain of SE.

⁵Moore and Healy (2008) deduced an approach that was similar to Kwan et al.'s (2004) for measuring what they call "overplacement": Their respective SE score is (in our notation) defined as $(S - P) - (R - T)$, where S is an individual's estimate of his own performance on a quiz, P is his estimate of a randomly selected other participant's performance, R is the individual's real performance, and T is the other person's real score. This index therefore reflects "an individual's belief that he or she is better than others and corrects that for the degree to which he or she actually is better than others" (p. 509).

⁶The approach suggested by Borkenau et al. (2009) aimed to control for the non-linearity of trait-level desirability. They first determined the "optimal" level on the trait of interest (optimal trait level; OTL). They then chose the negative distance between a persons' actual self-rating (actual self-rating; ASR) and this optimal level as this person's self-rating S ($S = -|OTL - ASR|$). Higher values thus indicated more favorable self-ratings. Similarly, as the criterion R , they chose the negative distance between the optimal trait level and the "predicted self-rating" (PSR), and this prediction was based on the self-rating group mean, the person's rating tendencies (perceiver effect), and the other subjects' rating of the person (target effect; $R = -|OTL - PSR|$). Using the algebraic difference to compare S and R , these choices resulted in the SE score $SE = -|OTL - ASR| - (-|OTL - PSR|) = |OTL - PSR| - |OTL - ASR|$.

⁷Additional hypotheses that can be found in the literature refer to some sort of curvilinear effect: Some

hypotheses expect effects from a match between self-perceptions and reality ("self-insight hypothesis"; Allport, 1937; Jahoda, 1958), and some expect that a slight amount of SE is most beneficial ("optimal margin hypothesis"; Baumeister, 1989). These hypotheses are not addressed here in detail. However, the proposed framework can easily be adapted to tackle these questions with the help of Response Surface Analysis (e.g., Edwards, 2007).

⁸Another way to see that testing for a main effect of the self-view while controlling for the reality criterion does *not* provide a statistical test for the SE hypothesis is the following: Imagine that we estimated the regression $Z = c_0 + c_1S + c_2R + \varepsilon$. A significantly positive value of the coefficient c_1 then indicates a positive association of self-viewed ability S with happiness Z under control for real ability R . This instance implies that out of two persons with the same value in real ability, the person with the higher self-rating is the happiest. Note that the latter person is also the one with the higher value in SE, which would be in line with the SE hypothesis expecting a positive association of SE and happiness. However, imagine now that the coefficient c_2 , which we ignored in our interpretation, is also significantly positive. This means that out of two persons with the same value in the self-rating S , the person with the higher value in R has the higher value in happiness Z . Because the latter is the person who self-enhances less, this situation would be in line with the SE hypothesis expecting a negative association of SE and happiness, contradicting the conclusion made above. Consequently, SE is not related to happiness in this situation. Note that the logic applied here will be described in detail in a later part of this manuscript, because it builds the basis of the suggested approach to test the SE hypothesis.

⁹The covariance of the difference score and S is $\text{Cov}(S - R, S) = \text{Cov}(S, S) - \text{Cov}(R, S) = \text{Var}(S) - \text{Cov}(R, S)$, which is zero only if S and R are equal up to a constant. Analogously, the covariance of the difference score and R is $\text{Cov}(S - R, R) = \text{Cov}(S, R) - \text{Cov}(R, R) = \text{Cov}(S, R) - \text{Var}(R)$. As an example, for standardized variables S and R and given a typical correlation of $\text{Cor}(S, R) = .3$, the algebraic difference would covary .7 with S (which would result in a respective correlation of .59) and $-.7$ with R (correlation = $-.59$).

¹⁰The correlation of the residuals and S is $\text{Cor}(\xi, S) = \sqrt{1 - \text{Cor}(S, R)^2}$, which is zero only if S and R are equal up to a constant. As an example, given a typical correlation of $\text{Cor}(S, R) = .3$, the residuals would correlate .95 with S .

¹¹Note that there are various procedures that might appear to solve the problem at first glance, but in fact do not do what we want (please note that more detailed discussions of these approaches can be found in the supplemental materials at osf.io/e8p5r): First, given that the problem with the two-step approach is that the SE score is correlated with S , one might wonder whether a possible solution is to control for effects of the self-view in the regression of the outcome on SE. That is, one might want to consider the regression equation $Z = b_0 + b_1(S - R) + b_2S + \varepsilon$ and interpret the coefficient b_1 as the effect of SE. However, this procedure does not provide a test of the SE hypothesis: The regression equation is equivalent to $Z = b_0 + (b_1 + b_2)S - b_1R + \varepsilon$. Therefore, the parameter b_1 reflects only a possible association of real ability and the outcome when controlling for the self-view. In particular, this implies that in a situation in which the outcome is positively associated with real ability and is independent of the self-view, the coefficient b_1 would be significantly positive. However, we cannot interpret this as a positive SE effect as it reflects merely the association between real ability and the outcome.

Second, another analytical tool that might at first glance appear to test the SE hypothesis is the self-view

by criterion interaction effect on the outcome variable Z . To see that the interaction term does not reflect an SE effect (see also Edwards, 2001), note that an interaction effect implies that the association of the self-view and the outcome is *different* for groups of persons on different levels of real ability. A non-zero interaction term can even reflect a situation in which S is positively related to Z on some level of R , while it is negatively related to Z on another level of R . The latter situation even contradicts the SE hypothesis, because it implies that on some level of real ability, SE has a *positive* association with an outcome, while on another level of R , the association of SE and the outcome is *negative*.

Third, one might expect a SE effect to exist if the association of the outcome Z and the self-view S is more positive (or less negative) than the association of Z and the criterion R . There are two versions of this conjecture: First, one could consider standard correlations and expect that the condition $Cor(S, Z) > Cor(R, Z)$ is indicative of an SE effect. Second, one might include statistical control for the self-view and the reality criterion, respectively, by assuming that an effect of SE would be indicated by the condition $c_1 > c_2$, for c_1 and c_2 denoting the regression coefficients of S and R in the regression $Z = c_0 + c_1S + c_2R + \varepsilon$. However, *none* of these two approaches does reflect effects of SE. To see this, the following reasoning can be applied to both approaches: Imagine that both the association of S and Z (with or without control for R) and the association of R and Z (with or without control for S) were positive, with the former being higher than the latter. In this situation, the condition $Cor(S, Z) > Cor(R, Z)$ (or the condition $c_1 > c_2$, respectively) would be satisfied. To see that SE is *not* associated with Z in such a situation, consider two persons having the same value in the reality criterion R . The positive association of the self-view S and the outcome Z then indicates that the person with the higher value in S should have the higher value in Z . Because the latter is also the person with the higher value in the discrepancy $S - R$, this situation would point towards a *positive* association of SE and Z . However, when considering two persons with the same value in the self-rating S , the positive association of R and Z implies that the person with the higher value in R should have the higher value in Z . Because the latter is the person who self-enhances *less*, this situation would point towards a *negative* association of SE and the outcome Z . In sum, a positive association of S and Z hints towards a positive SE effect, while a positive association of R and Z points to a negative SE effect. In case that both S and R are positively associated to Z , we would therefore not speak of an effect of SE, as it would not even be clear whether the effect is positive (e.g., “SE is adaptive”) or negative (e.g., “SE is maladaptive”).

¹²Given that the correlation of real ability R and the outcome Z is positive, the coefficient c_2 is negative if and only if the relation $Cor(R, Z) < Cor(S, Z) \times Cor(S, R)$ holds. This is the case, for example, if $Cor(R, Z) = .1$, $Cor(S, Z) = .4$ and $Cor(S, R) = .3$.

Tables

Table 1
Simulation Data Set

	S	R	D	Res	Z
Ray	10	5	5	4.84	20
Tom	6	5	1	0.84	12
Sam	6	1	5	1.58	12
Kate	5	1	4	0.58	10
John	6	4	2	1.02	12
Ann	1	5	-4	-4.16	2
Chris	1	1	0	-3.42	2
Dan	7	7	0	1.47	14

Note. Assessed variables are self-rated ability S , real ability R , and happiness Z , which was constructed as $Z = 2S + 0R$. Self-enhancement in the difference approach was computed as $D = S - R$. Self-enhancement in the residual approach was computed as a person's residual in the regression in which S is predicted from R .

Table 2

Operationalizations of SE

Chosen reality criterion R	Chosen comparison operation	Resulting SE-score	For example applied in
Own rating of others P (e.g., perceiver effects; social comparison)	Difference	$S - P$	Kwan, John, Robins, and Kuang (2008); Polzer, Kramer, and Neale (1997)
	Residuals	Residuals of $S = b_0 + b_1P + \xi$	
	Difference	$S - C$	Moore and Healy (2008); Noble, Heath, and Toste (2011)
Objective criterion C	Residuals	Residuals of $S = b_0 + b_1C + \xi$	Anderson, Brion, Moore, and Kennedy (2012); Dufner et al. (2013); Dufner et al. (2012); Dufner, Reitz, and Zander (2015); Gabriel, Critelli, and Ee (1994); Gramzow, Willard, and Mendes (2008); Kurman (2006); Robins and Beer (2001)
	Difference	$S - T$	Colvin, Block, and Funder (1995); John and Robins (1994); Kurt and Paulhus (2008); Kwan, John, Robins, and Kuang (2008); Paulhus (1998)
Rating by others T (e.g., target effects)	Residuals	Residuals of $S = b_0 + b_1T + \xi$	Church et al. (2006); Dufner et al. (2012); John and Robins (1994); Kurt and Paulhus (2008); Paulhus (1998); Robins and Beer (2001); Taylor, Lerner, Sherman, Sage, and McDowell (2003b)
	Difference	$S - P - T$	Kwan, John, Kenny, Bond, and Robins (2004); Kwan, John, Robins, and Kuang (2008)
P and C	Residuals	Residuals of $S = b_0 + b_1P + b_2T + \xi$	Anderson, Ames, and Gosling (2008); Leising, Locke, Kurzius, and Zimmermann (2016)
	Difference	$S - P - C$	Moore and Healy (2008; additionally controlling for the true performance of others)
	Residuals	Residuals of $S = b_0 + b_1P + b_2C + \xi$	Dufner et al. (2012)

Note. S denotes the self-rating.

Table 3

Problems with the two-step approach for investigating an SE hypothesis, for all operationalizations of SE

Chosen reality criterion R	Chosen comparison operation	Resulting SE score	Covariance of SE-score and S	Example correlations with all variables standardized
Own rating of others P (e.g., perceiver effects; social comparison)	Difference	$S - P$	$\text{Var}(S) - \text{Cov}(S, P)$	If $\text{Cor}(S, P) = .3$ then $\text{Cor}(S - P, S) = .59$
	Residuals	Residuals of $S = b_0 + b_1P + \xi$	$\text{Var}(S) - \frac{\text{Cov}(S, P)^2}{\text{Var}(P)}$	If $\text{Cor}(S, P) = .3$ then $\text{Cor}(Res, S) = .95$
	Difference	$S - C$	$\text{Var}(S) - \text{Cov}(S, C)$	If $\text{Cor}(S, C) = .3$ then $\text{Cor}(S - C, S) = .59$
	Residuals	Residuals of $S = b_0 + b_1C + \xi$	$\text{Var}(S) - \frac{\text{Cov}(S, C)^2}{\text{Var}(C)}$	If $\text{Cor}(S, C) = .3$ then $\text{Cor}(Res, S) = .95$
Rating by others T (e.g., target effects)	Difference	$S - T$	$\text{Var}(S) - \text{Cov}(S, T)$	If $\text{Cor}(S, T) = .3$ then $\text{Cor}(S - T, S) = .59$
	Residuals	Residuals of $S = b_0 + b_1T + \xi$	$\text{Var}(S) - \frac{\text{Cov}(S, T)^2}{\text{Var}(T)}$	If $\text{Cor}(S, T) = .3$ then $\text{Cor}(Res, S) = .95$
P and T	Difference	$S - P - T$	$\text{Var}(S) - \text{Cov}(S, P) - \text{Cov}(S, T)$	If $\text{Cor}(S, P) = .3$, $\text{Cor}(S, T) = .3$ and $\text{Cor}(P, T) = .3$ then $\text{Cor}(S - P - T, S) = .26$
	Residuals	Residuals of $S = b_0 + b_1P + b_2T + \xi$	$\text{Var}(S) - \hat{b}_1 \text{Cov}(S, P) - \hat{b}_2 \text{Cov}(S, T)$	If $\text{Cor}(S, P) = .3$, $\text{Cor}(S, T) = .3$ and $\text{Cor}(P, T) = .3$ then $\text{Cor}(Res, S) = .93$
P and C	Difference	$S - P - C$	$\text{Var}(S) - \text{Cov}(S, P) - \text{Cov}(S, C)$	If $\text{Cor}(S, P) = .3$, $\text{Cor}(S, C) = .3$ and $\text{Cor}(P, C) = .3$ then $\text{Cor}(S - P - C, S) = .26$
	Residuals	Residuals of $S = b_0 + b_1P + b_2C + \xi$	$\text{Var}(S) - \hat{b}_1 \text{Cov}(S, P) - \hat{b}_2 \text{Cov}(S, C)$	If $\text{Cor}(S, P) = .3$, $\text{Cor}(S, C) = .3$ and $\text{Cor}(P, C) = .3$ then $\text{Cor}(Res, S) = .93$

Note. S denotes the self-rating. For chosen reality criteria P and T , $\hat{b}_1 = \frac{(\text{Cor}(S, P) - \text{Cor}(S, T)\text{Cor}(P, T))\text{Var}(S)}{(1 - \text{Cor}(P, T)^2)\text{Var}(P)}$ and $\hat{b}_2 = \frac{(\text{Cor}(S, T) - \text{Cor}(S, P)\text{Cor}(P, T))\text{Var}(S)}{(1 - \text{Cor}(P, T)^2)\text{Var}(T)}$. For chosen reality criteria P and C respectively.

Table 4

The novel CRA approach for all operationalizations of SE

Chosen reality criterion R	SE score	Regression for CRA	Conditions for positive SE effect	Conditions for negative SE effect
Own rating of others P (e.g., perceiver effects; social comparison)	Difference $S - P$ Residuals of $S = b_0 + b_1P + \xi$	$Z = c_0 + c_1S + c_2P + \varepsilon$ $Z = c_0 + c_1S + c_2P + \varepsilon$	$abs := c_1 - c_2 - c_1 + c_2 > 0$ and $c_1 - c_2 > 0$ $abs_2 := c_1 - c_2\hat{b}_1 - c_1\hat{b}_1 + c_2 > 0$ and $c_1 - c_2\hat{b}_1 > 0$	$abs > 0$ and $c_1 - c_2 < 0$ $abs_2 > 0$ and $c_1 - c_2\hat{b}_1 < 0$
Objective criterion C	Difference $S - C$	$Z = c_0 + c_1S + c_2C + \varepsilon$	$abs := c_1 - c_2 - c_1 + c_2 > 0$ and $c_1 - c_2 > 0$	$abs > 0$ and $c_1 - c_2 < 0$
Residuals of $S = b_0 + b_1C + \xi$		$Z = c_0 + c_1S + c_2C + \varepsilon$	$abs_2 := c_1 - c_2\hat{b}_1 - c_1\hat{b}_1 + c_2 > 0$ and $c_1 - c_2\hat{b}_1 > 0$	$abs_2 > 0$ and $c_1 - c_2\hat{b}_1 < 0$
Rating by others T (e.g., target effects)	Difference $S - T$ Residuals of $S = b_0 + b_1T + \xi$	$Z = c_0 + c_1S + c_2T + \varepsilon$ $Z = c_0 + c_1S + c_2T + \varepsilon$	$abs := c_1 - c_2 - c_1 + c_2 > 0$ and $c_1 - c_2 > 0$ $abs_2 := c_1 - c_2\hat{b}_1 - c_1\hat{b}_1 + c_2 > 0$ and $c_1 - c_2\hat{b}_1 > 0$	$abs > 0$ and $c_1 - c_2 < 0$ $abs_2 > 0$ and $c_1 - c_2\hat{b}_1 < 0$
P and T	Difference $S - P - T$ Residuals of $S = b_0 + b_1P + b_2T + \xi$	$Z = c_0 + c_1S + c_2P + c_3T + \varepsilon$ $Z = c_0 + c_1S + c_2P + c_3T + \varepsilon$	$abs_3 > 0$ and $(c_1 - c_2 - c_3) > 0$ $abs_4 > 0$ and $(c_1 - b_1c_2 - b_2c_3) > 0$	$abs_3 > 0$ and $(c_1 - c_2 - c_3) < 0$ $abs_4 > 0$ and $(c_1 - b_1c_2 - b_2c_3) < 0$
P and C	Difference $S - P - C$ Residuals of $S = b_0 + b_1P + b_2C + \xi$	$Z = c_0 + c_1S + c_2P + c_3C + \varepsilon$ $Z = c_0 + c_1S + c_2P + c_3C + \varepsilon$	$abs_3 > 0$ and $(c_1 - c_2 - c_3) > 0$ $abs_4 > 0$ and $(c_1 - b_1c_2 - b_2c_3) > 0$	$abs_3 > 0$ and $(c_1 - c_2 - c_3) < 0$ $abs_4 > 0$ and $(c_1 - b_1c_2 - b_2c_3) < 0$

Note. S denotes the self-rating.

$$abs_3 := \left| \frac{1}{\sqrt{3}}(c_1 - c_2 - c_3) \right| - \left| \frac{2c_1^2 + c_2^2 + c_3^2 + 2c_1c_2 + 2c_1c_3}{\sqrt{6c_1^2 + 2c_2^2 + 2c_3^2 + 6c_1c_2 + 6c_1c_3 + 2c_2c_3}} \right| \cdot abs_4 := \left| \frac{c_1 - b_1c_2 - b_2c_3}{\sqrt{1 + b_1^2 + b_2^2}} \right| - \left| \frac{(b_1^2 + b_2^2)c_1^2 + c_2^2 + c_3^2 + 2b_1c_1c_2 + 2b_2c_1c_3 + b_0c_1}{\sqrt{(b_0 + (b_1^2 + b_2^2)c_1 + b_1c_2 + b_2c_3)^2 + (b_1c_1 + c_2)^2 + (b_2c_1 + c_3)^2}} \right|.$$

Table 5
Example Analyses of SE and PSV Effects for Simulation Data

c_1	c_2	$c_1 + c_2$	$c_1 - c_2$	$abs > 0?$	Interpretation	Figure (see SOM)
1	-1	0	2	2*	positive SE effect	(H3)
2	0.2	2.2	1.8	-0.5	no SE effect, but pos. effect of S	(H4)
0.8	1.2	2	-0.4	-1.6	no SE effect, but pos. effects of S and R	(H5)
0	1	1	-1	0	no SE effect, but pos. effect of R	(H6a)
2	-1	1	3	2*	positive SE effect	(H6b)
1	-2	-1	3	2*	positive SE effect	(H6c)
-3	2	-1	-5	4*	negative SE effect	(H6d)

Note. Assessed variables are self-rated ability S , real ability R , and different outcome variables Z . c_1 and c_2 are the coefficients in the regression $Z = c_1S + c_2R + \varepsilon$, with $abs := |c_1 - c_2| - |c_1 + c_2|$. SOM = Supplemental Online Material (downloadable from osf.io/e8p5r).

Table 6

Results of Two Classical Analyses and the CRA Approach for all Self-Rated Outcomes

	Correlation with ($S - R$)	Correlation with residuals	Linear regression $Z = c_0 + c_1S + c_2R + \varepsilon$			Interpretation of meta-analytical result		
			c_1	c_2	$c_1 + c_2$ abs			
Self-Esteem								
Sample A	0.13	0.3	0.3	0.11	0.41	0.19	-0.22	Positive association of self-esteem and PSV
Sample B	0.16	0.29	0.3	0.04	0.34	0.26	-0.08	
Sample C	0.08	0.19	0.19	0.07	0.26	0.11	-0.15	
Meta-analysis	0.14	0.28	0.28	0.07	0.36	0.21	-0.14	
Leadership ability (self-rating)								
Sample A	0.1	0.11	0.11	-0.04	0.07	0.15	0.08	Positive association of self-rated leadership ability and PSV
Sample B	0.13	0.25	0.26	0.05	0.3	0.21	-0.09	
Sample C	0.2	0.32	0.32	0.04	0.36	0.28	-0.09	
Meta-analysis	0.13	0.22	0.22	0.02	0.24	0.21	-0.03	
Trustworthiness (self-rating)								
Sample B	0.21	0.22	0.22	-0.12	0.11	0.34	0.23	Positive association of self-rated trustworthiness and SE
Sample C	0.53	0.42	0.42	-0.32	0.1	0.73	0.63	
Meta-analysis	0.3	0.27	0.29	-0.18	0.1	0.47	0.37	

Note. S denotes self-rated reasoning ability, R denotes objectively measured reasoning ability, Z denotes the respective outcome variable. Bold coefficients are significant at $p < .05$. According to the CRA approach, an effect of self-enhancement exists if $abs := |c_1 - c_2| - |c_1 + c_2|$ is significantly positive. Sample A: $N = 188$, Sample B: $N = 295$, Sample C: $N = 83$.

Table 7
Results of Two Classical Analyses and the CRA Approach for all Peer-Rated Outcomes

	Correlation with ($S - R$)	Correlation with residuals	Linear regression $Z = c_0 + c_1S + c_2R + \varepsilon$				Interpretation of meta-analytical result	
			c_1	c_2	$c_1 + c_2$	$c_1 - c_2$		abs
Leadership ability (peer-rating)								
Sample A	-0.05	0.1	0.1	0.19	0.29	-0.09	-0.2	Positive association of peer-rated leadership ability with PSV and with real ability
Sample B	-0.04	0.08	0.08	0.15	0.24	-0.07	-0.17	
Sample C	-0.08	0.07	0.07	0.17	0.24	-0.1	-0.13	
Meta-analysis	-0.05	0.09	0.09	0.17	0.25	-0.08	-0.17	
Friendship potential (peer-rating)								
Sample A	-0.09	0.04	0.04	0.17	0.21	-0.14	-0.07	Marginally significant negative association of peer-rated friendship potential and SE
Sample B	-0.16	-0.1	-0.1	0.15	0.05	-0.26	0.21	
Sample C	-0.2	-0.22	-0.22	0.05	-0.17	-0.28	0.1	
Meta-analysis	-0.14	-0.07	-0.07	0.15	0.08	-0.22	0.14	

Note. S denotes self-rated reasoning ability, R denotes objectively measured reasoning ability, Z denotes the respective outcome variable. Bold coefficients are significant at $p < .05$. According to the CRA approach, an effect of self-enhancement exists if $abs := |c_1 - c_2| - |c_1 + c_2|$ is significantly positive. Sample A: $N = 188$, Sample B: $N = 295$, Sample C: $N = 83$.

Figure 1. A visualization of the SE hypothesis versus the PSV hypothesis.

If the SE hypothesis holds...

...we would expect **Paul** to be very happy because he estimates his ability as higher than it really is (very high level of SE)

...we would expect **Greg** to be very unhappy because he estimates his ability as lower than it really is (low level/negative SE)

...we would expect **Simon** to be equally happy as Paul because he has an equally high level of SE

...we would expect **Kim** to be moderately happy because she estimates her ability almost accurately (i.e., close to how it really is; medium/near zero level of SE)

Figures

If the PSV hypothesis holds...

...we would expect **Paul** to be very unhappy because he estimates his ability as very low (very low level of PSV)

...we would expect **Greg** to be quite unhappy because he estimates his ability as low (low level of PSV)

...we would expect **Simon** to be quite happy because he estimates his ability as high (high level of PSV)

...we would expect **Kim** to be very happy because she estimates her ability as very high (very high level of PSV)

(a) Positive effect of self-viewed reasoning ability (PSV) on the outcome.

(b) Positive effect of self-viewed reasoning ability (PSV) on the outcome.

(c) Positive effect of SE on the outcome.

(d) Positive effect of self-viewed (PSV) and "real" reasoning ability on the outcome.

(e) Negative effect of SE on the outcome (marginally significant).

Figure 2. Plotted regression surfaces of the meta-analytical regression $Z = c_0 + c_1S + c_2R + \varepsilon$ for all five outcomes Z . S is self-rated reasoning ability, R is objectively measured (via the Raven test) reasoning ability. In each subfigure, the blue (black) line on the surface that connects the front corner with the back corner of the cube is the line where S and the R match (the *self-insight line*; SI line). It represents the area where people have accurate self-perceptions. The slope of the SI line is $c_1 + c_2$. Perpendicular to the SI line, ranging from the left to the right corners of the cube, lies the *self-enhancement line* (SE line) where $S = -R$. It contains information about how the outcome changes when SE increases, that is, when moving farther into the right corner of the cube. The slope of the SE line is $c_1 - c_2$. Note that the CRA condition $|c_1 - c_2| > |c_1 + c_2|$ for an SE effect thus states that the slope above the SE line is "stronger" than the slope above the SI line (see Supplemental Material H for a more detailed description of how the condition for an SE effect can be interpreted graphically).