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INTERVENTION-RELATED CORRELATED CHANGE BETWEEN PERSONALITY TRAITS AND SELF-ESTEEM

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A growing body of research suggests that personality traits can be changed through psychological interventions, but it is unclear whether and to what extent these trait changes are accompanied by changes in self-esteem. The present study examined the link between changes in personality traits and self-esteem during a coaching intervention for personality change. We used data (N = 1,179) from a 3-month digital coaching intervention study with three measurement occasions (pretest, posttest, follow-up) across 6 months and focused on the three largest intervention groups, which included participants who wanted to decrease negative emotionality (n = 406), increase extraversion (n = 375), or increase conscientiousness (n = 398). Accordingly, we focused on the associations between self-esteem and the three personality traits that were targeted in the intervention groups. The main results are as follows: First, self-esteem increased on average for those participants who wanted to decrease their negative emotionality or increase their extraversion. Second, the rates of change in personality traits and self-esteem were strongly associated with each other, most notably between negative emotionality and self-esteem. Third, these associations were similar across all three intervention groups and also between the intervention and postintervention phase of the study, indicating a more general pattern of correlated change. We discuss the potential relevance of correlated change for consulting research and practice.

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continued

What's It Mean? Implications for Consulting Psychology

This article introduces the concept of intervention-related correlated change, which addresses the question of whether and to what extent change processes occur together or in different ways. This study found that changes in personality traits, particularly a decrease in negative emotionality and an increase in extraversion as a result of a coaching intervention, are associated with an increase in self-esteem.

Keywords: personality traits, self-esteem, coaching intervention for personality change, intervention-related correlated change, general and specific change

Personality change through psychological intervention has recently received much attention in the field of personality development. Research has demonstrated that personality traits can be changed both by clinical and nonclinical interventions (see Jackson et al., 2021; Roberts et al., 2017). Studies in clinical populations have shown that clinical interventions with a focus on mental-health problems not only impact targeted outcomes in terms of symptom change but also in terms of personality traits (Osma et al., 2022; Sauer-Zavala et al., 2020; Stieger et al., 2022). For example, a systematic review of 207 clinical intervention studies in which personality traits were not the direct target found decreases in the personality trait of negative emotionality and increases in the trait of extraversion (Roberts et al., 2017). Further evidence of personality change through intervention comes from recent studies in nonclinical populations using different intervention approaches, such as goal setting (Hudson et al., 2020; Hudson & Fraley, 2015), engagement in behavioral activities (Hudson et al., 2019), social skills training (Allemand et al., 2022), cognitive training (Jackson et al., 2012), arts education (Grosz et al., 2022), and digital coaching interventions with chatbots and text-messaging services (Allemand & Flückiger, 2022; Stieger, Wepfer, et al., 2020). The promising results of these studies suggest that people can change personality traits in the desired direction.

An open research question, however, is whether and to what extent personality trait changes through a coaching intervention are linked to changes in internalized self-evaluation processes, particularly self-esteem as a general evaluation of one's worth or value. It is often the case that people have negative self-views or are self-critical about themselves in particular domains of their lives, including physical appearance, academic competence, relationships, and parenting (Ellis, 2005; Steiger et al., 2014). Low self-esteem is considered a vulnerability or risk factor for depression, anxiety, and other mental-health disorders (Sowislo & Orth, 2013; Steiger et al., 2015), whereas high self-esteem helps individuals to adapt to and succeed in a variety of life domains (Orth & Robins, 2022). Negative self-evaluative processes can be targeted through psychological interventions including coaching, counseling, and consulting. Indeed, research has shown that psychological interventions directly targeting self-esteem are effective in the improvement of self-esteem (Niveau et al., 2021). However, it is unclear whether interventions that do not directly target self-esteem but modify associated variables like personality traits are also effective in changing self-evaluative processes. The purpose of this study was to address this gap in the personality-change literature by

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Data, analysis code, and research materials are available on the Open Science Framework repository and can be accessed at https://osf.io/5cb6r/.

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applying the concept of correlated change to examine the associations between rates of change in personality traits and self-esteem.

The Malleability of Personality Traits

Personality traits are typically defined as relatively stable dispositional tendencies that affect our behavior, thoughts, and feelings (Baumert et al., 2017). Traits describe the most basic dimensions upon which individuals are usually perceived to differ. These individual differences are often organized within the conceptual framework of the Big Five and include five broad traits (see John et al., 2008). Briefly, extraversion refers to individual differences in the propensity to be sociable, active, assertive, and to experience positive affect. Agreeableness refers to traits that reflect individual differences in the propensity to be altruistic, trusting, modest, and warm. Conscientiousness reflects the propensity to be self-controlled, task- and goal-directed, planful, and rule-following. Neuroticism, or negative emotionality (Soto & John, 2017), is a tendency to experience negative emotional experiences, such as anxiety, worry, anger, and depression. Finally, openness to experience refers to individual differences in the proneness to be original, complex, creative, and open to new ideas.

Despite the relatively enduring nature of personality traits, numerous longitudinal studies have shown that traits are malleable and continue to evolve across adulthood, albeit slowly (Graham et al., 2020; Mroczek et al., 2021; Roberts et al., 2006). Recent research suggests that the rather slow process of personality-trait change can be accelerated by psychological interventions, provided that people also desire change (Hudson et al., 2019, 2020; Jackson et al., 2021). For instance, a 2-week intervention study tested the effectiveness of a digital coaching intervention using text-messaging services to either target self-discipline, a facet of conscientiousness, or openness to action, a facet of openness to experience (Stieger, Wepfer, et al., 2020). People who chose to become more self-disciplined showed a greater increase in self-discipline than openness; the reverse was true for those who wanted to increase in openness to action. The observed changes were maintained at the follow-up 2 weeks and 6 weeks later. Furthermore, a recent intervention trial, which forms the data basis for the present secondary data analyses, tested the effectiveness of a 3-month personality-change coaching intervention with a digital application using a randomized controlled trial design in a large sample (Stieger et al., 2021). The results showed that participants were able to change a selected personality trait such as extraversion in the desired direction and these changes persisted until at least the 3-month follow-up. In particular, participants who desired to decrease in negative emotionality ($d = -0.54$), increase in extraversion ($d = 0.58$), and increase in conscientiousness ($d = 0.58$) showed significant mean-level changes in the desired directions with medium-sized effects over time. The available empirical evidence suggests that people can and do change personality traits in desired directions.

The underlying personality traits in the aforementioned interventions are generally targeted with bottom-up approaches or more specifically by changing momentary behaviors, thoughts, and feelings and building new behavioral, affective, or cognitive habits in line with the desired change goals (see Allemand & Flückiger, 2017, for a discussion). If these are maintained for long enough, it is assumed that the underlying traits will change as well and affect a wider range of trait-associated behaviors, thoughts, and feelings that were not targeted by the intervention directly. For instance, a person wanting to change their conscientiousness (or organization facet) might start using implementation intentions (i.e., "if–then plans"; e.g., Hudson & Fraley, 2015) to clean their workspace regularly until this becomes habitual. This in turn might change their cognitive and affective responses to a clean surrounding (i.e., the trait), which might lead them in turn to also clean and organize their household more regularly (see Olaru et al., 2022, for a discussion). Although this reflects other changes in trait-related behaviors, one core assumption on the utility of trait change through interventions is that it will also affect other related outcomes, such as self-esteem. To date, however, it is unclear whether and how these personality changes through intervention influence how people perceive and evaluate themselves.

Self-Esteem as a Correlate of Personality Traits

Self-esteem is typically characterized as an individual's overall evaluation of his or her worth or value (Donnellan et al., 2011). It is a subjective positive or negative orientation toward oneself that does not

necessarily reflect a person's objective characteristics, competencies, abilities, or how a person is evaluated by others and is thus typically assessed using self-report measures (Orth & Robins, 2019). Self-esteem is frequently discussed as an important predictor and correlate of clinical symptoms and syndromes, such as depression and anxiety (Sowislo & Orth, 2013; Steiger et al., 2014, 2015), and thus represents a target of intervention efforts (Niveau et al., 2021). Moreover, there is accumulating research that high self-esteem is beneficial in multiple life domains, including more success at school and work, better mental and physical health, and better social relationships (Orth et al., 2012; Orth & Robins, 2022).

Research has shown that individual differences in self-esteem are relatively stable and thus supports the claim that self-esteem is a traitlike characteristic (see Orth & Robins, 2019). Despite relatively stable individual differences in self-esteem as a personality trait, longitudinal research has shown that self-esteem is malleable across the entire life span (see Orth & Robins, 2019, for a review). For instance, longitudinal studies with time intervals ranging from 4 to 16 years have shown that self-esteem increases from adolescence to midlife, peaks at about 50–60 years of age, and decreases in old age (Orth et al., 2012, 2018). Also, intervention work has demonstrated that self-esteem can be modified with psychological interventions over short time periods (Niveau et al., 2021).

There are several theoretical reasons to expect associations between self-esteem and personality traits. First, personality traits and self-esteem can be seen as interrelated components of personality, all of which have some heritability, stability, and predictive power (Kandler et al., 2015). Second, personality traits may influence how people perceive and evaluate themselves (Robins et al., 2001). For example, because of lower thresholds for the experience of negative and positive affect, respectively, people high in negative emotionality are likely to have negative self-views, whereas extraverted people tend to see themselves in more positive ways (John et al., 2008). Third, self-esteem, in contrast, may play a role in shaping personality processes (Robins et al., 2001). Specifically, people's positive self-evaluations may influence how they act in certain situations, the goals they pursue in life, how they feel about life events and social interactions, and the ways in which they select or create environments or cope with new environments. For example, people with high self-esteem tend to report better work experiences (Krauss & Orth, 2021), which may provide a working environment that promotes conscientious behaviors through the pursuit of person–environment fit (Woods et al., 2019).

Following these arguments, one would expect significant associations between self-esteem and personality traits. Indeed, existing cross-sectional and longitudinal observational studies found personality trait–self-esteem associations (Erol & Orth, 2011; Fetvadjiev & He, 2019; Gebauer et al., 2015; Robins et al., 2001; Wagner et al., 2013). These studies observed positive associations with all of the Big Five personality traits, except for the negative association with negative emotionality. For instance, findings from a large internet sample evidenced self-esteem associations primarily with personality traits with an affective signature, namely negative emotionality (negative affect) and extraversion (positive affect), as well as with conscientiousness (Robins et al., 2001). Even though personality traits and self-esteem tend to share some commonality, it is an open question whether and to what extent personality-trait changes through intervention are linked to changes in self-esteem.

Correlated Change Between Personality Traits and Self-Esteem

One of the most fundamental observations in intervention and coaching science is that people often differ in how they respond to and change because of psychological interventions. The same treatment can have different effects on people in the way change processes occur within people. One way to better understand individual differences in intraindividual change processes is correlated change (Allemand & Martin, 2016; Olaru & Allemand, 2022). Correlated change aims to answer questions such as, "When people change in a personality trait as a result of an intervention, do they also simultaneously learn to perceive and evaluate themselves in more positive ways?" Or does change in a personality trait unfold independently of change in self-esteem? Correlated change refers to relative change and essentially reflects the longitudinal variant of cross-sectional correlations between personality traits and self-esteem (Allemand & Martin, 2016; Olaru & Allemand, 2022). The main idea

of correlated change is to examine whether there are commonalities between change processes or whether the change processes occur independently of each other. Put differently, it addresses the question of whether and to what extent change processes unfold together or in different ways.

Researchers recently suggested that correlated change may be a particularly unique way to better understand change processes triggered by psychological interventions (Könen & Karbach, 2021). An important scientific implication of correlated change for intervention science is that it can provide insight into how change processes are the product of a few general and broadly acting mechanisms or of specific, narrowly acting mechanisms (Allemand & Martin, 2016; Olaru & Allemand, 2022). On the one hand, changes may unfold in general ways as a result of broadly acting mechanisms, which are characterized by substantial correlations among intraindividual change processes (Allemand & Martin, 2016). The strong commonality in change may imply that the same underlying causes of change, such as genetic and environmental factors, life events, or a treatment, would operate simultaneously on multiple constructs, such as negative emotionality and self-esteem, in the same or similar ways. Consequently, knowing that changes across different outcome variables are highly correlated might suggest that a coordinated integration of different outcomes led to correlated change. Then it seems unlikely that the process that triggers change processes, such as intervention efforts to increase extraversion, will affect extraversion in isolation. In this case, self-esteem will also increase as a result of the same broad mechanism.

On the other hand, changes may unfold in more nuanced or unconnected ways as a result of narrowly acting mechanisms, which are characterized by no or low correlations among intraindividual changes in different constructs (Allemand & Martin, 2016). This would imply that the causes of change are unique for each construct and that specific mechanisms affect specific constructs in different ways. In such a case, intervention efforts to increase extraversion would only affect extraversion, whereas changes in self-esteem could be the result of causes other than the intervention.

One possible reason for differential associations between change processes may refer to different intervention phases. An intervention study classically starts with assessments in the preintervention phase. The intervention phase is typically a guided and structured intervention phase with the aim of actively promoting change processes by providing different treatment tools and strategies for change efforts (Allemand & Flückiger, 2017; Krebs et al., 2018; Stieger et al., 2022). This should eventually result in more commonality in change processes compared to earlier phases. In contrast, the postintervention phase typically reflects a largely self-organized learning phase that may include further self-directed learning. For instance, people may continue to implement what they have learned and they may broaden their behavioral repertoire for further developments. However, because this phase is less structured and probably more heterogeneous, one would expect less strongly correlated change processes.

Another important scientific implication of correlated change for intervention and coaching science is that it provides a methodological approach to examine the potential transfer effects of interventions. Transfer effects refer to effects of an intervention on other constructs that were not directly targeted by the intervention (e.g., effects of working-memory training on other cognitive abilities; Sala et al., 2019). Evidence for transfer effects is traditionally based on the intervention group showing greater improvement on the mean level compared to a control group without any treatment or an active control group with a different treatment. Correlated change takes an individual-differences approach to transfer effects. Stronger change correlations may be indicative for transfer effects that are probably affected by broadly acting intervention mechanisms, whereas mean-level changes without correlated change would indicate isolated change processes.

Correlated change has been examined primarily in developmental studies using data from longitudinal observational studies covering longer periods of time (Allemand et al., 2008, 2015; Hülür et al., 2015; Klimstra et al., 2013; Mascherek & Zimprich, 2011; Olaru & Allemand, 2022; Pfund & Allemand, 2022). These studies have shown that there is some commonality in developmental changes in the studied constructs across time. To the best of our knowledge, however, none of the previous intervention studies on personality change have used this approach to examine whether and how change processes unfold together or in different ways.

The Present Study

The main goal of this study was to examine whether and to what extent changes in personality traits (i.e., negative emotionality, extraversion, and conscientiousness) through coaching intervention were associated with changes in self-esteem, although self-esteem was not specifically targeted with the intervention. To examine correlated changes between personality traits and self-esteem, we conducted secondary data analyses using data from a recent digital coaching intervention study of personality change (Stieger et al., 2021). For the present study, we focused on three intervention groups that included individuals who desired to (a) decrease in negative emotionality, (b) increase in extraversion, or (c) increase in conscientiousness. These three personality traits are discussed as consistent correlates of self-esteem (Robins et al., 2001). Initial results from Stieger et al. (2021) using this data set discussed below demonstrated significant medium-sized mean-level personality-trait changes in all three intervention groups (i.e., decrease in negative emotionality, increase in extraversion, and increase in conscientiousness) but also individual differences in intraindividual change, which are important requirements for the present study.

We addressed the following three questions: (1) Does self-esteem increase during participation in a coaching intervention for personality change? We expected self-esteem mean levels to increase in all three intervention groups (i.e., decrease negative emotionality, increase extraversion, and increase conscientiousness). Because research shows that self-esteem is most strongly correlated with low negative emotionality, followed by extraversion and conscientiousness (Robins et al., 2001), we expected that changes at the mean level would be strongest in the negative emotionality group. (2) Are changes in personality traits correlated with changes in self-esteem? We expected self-esteem to change proportionally with personality traits, and the change correlation to be highest for negative emotionality, followed by extraversion and conscientiousness (Robins et al., 2001). (3) Does the pattern of correlated change differ depending on the intervention group (i.e., decrease negative emotionality, increase extraversion, and increase conscientiousness) or phase (i.e., preintervention phase, intervention phase, and postintervention phase)? We explored intervention groups and phases as potential moderators of correlated change. Based on our reasoning above, we expected a greater correlated change between personality traits and self-esteem during the intervention phase than during the other phases.

Method

Participants and Procedure

This article is based on new secondary data analyses of data from a digital personality change intervention trial (Stieger et al., 2021). The study protocol of the trial was approved by the Ethics Committee of the Philosophical Faculty of the University of Zurich (No. 17.8.4; date of approval: August 31, 2017). Participants were primarily recruited via university mailings and social-media advertisements. Additionally, participants responded to flyers or word-of-mouth recruitment. The focus of the study was explicitly on healthy adults, excluding participants with mental-health illnesses and other psychosocial problems. Specifically, participants who had higher scores in a brief checklist of mental symptoms and higher scores in a depression scale or who were currently in a psychotherapeutic or psychiatric treatment were excluded from the study at the screening assessment. More details about the study design and sample-size calculation can be found in the intervention study protocol (Stieger et al., 2018).

For the present analyses, we used the data of the 1,179 available participants ($n = 616$ female), who were part of the three largest intervention groups. Participants were on average 24.83 years old ($SD = 6.57$). At the pretest assessment, participants had to select one out of nine change goals for the intervention. It was not possible to pursue several goals at the same time. Change goals included all Big Five traits in both directions (i.e., increases or decreases) except for negative emotionality (only decreases were possible). To help participants with the goal selection, they received descriptions of normal characteristics of individuals with high versus low levels in each trait (Stieger, Eck, et al., 2020). With respect to the chosen intervention, 406 participants (34.4%) wanted to decrease negative

emotionality, 398 wanted to increase conscientiousness (33.8%), and 375 wanted to increase extraversion (31.8%). Because of the sample-size requirements of the models, we only used data from these three intervention groups (the next largest group was increase in openness with $n = 113$; 7.4%).[1] Personality traits and self-esteem were measured before the intervention (pretest), after the 3-month intervention (posttest), and 3 months after the end of the intervention (follow-up).

Digital Coaching Intervention for Personality Change

The 3-month digital coaching intervention with a chatbot was conducted using the smartphone application PErsonality CoACH (Android and iOS), a digital coach that automatically guides and supports people in achieving their personality-change goals (Stieger et al., 2018, 2021). People interacted daily with a chatbot and received intervention content, education, feedback, encouragement, and support. Conceptually, the digital coaching intervention was developed based on a common change-factors model (Allemand & Flückiger, 2017, 2022). The idea is that four common change factors might provide some useful heuristic principles for personality-change interventions and should be targeted in intervention efforts. First, coaching efforts should actuate discrepancy awareness, which refers to the idea that desired changes can be most effectively targeted when people are aware that they want to be different than they are. Second, coaching should activate people's capabilities, preferences, and resources to initiate and sustain positive-feedback circuits and expectations. Third, coaching should target reflective processes, with the goal of helping people better understand their underlying assumptions, expectations, and motivations to promote insight. Fourth, coaching should target behavioral processes of mastery in action, with the goal of helping people explore and practice new behaviors and gradually increase their engagement in new activities and behaviors outside their "comfort zone." The main goal of the change-factor perspective is to optimally realize and integrate all four change factors to maximize intervention effects (Allemand & Flückiger, 2017, 2022).

The digital coaching intervention included weekly core themes and microinterventions that aimed to target and activate the proposed common change factors and thus promote personality change. The weekly core themes include themes such as organizing a supportive change team, learning from others via observational learning, or keeping a diary of strengths and resources. Microinterventions are small techniques that help people change their thoughts, feelings, and behaviors in everyday life and trigger and sustain the change process such as individualized implementation intentions (if–then plans), behavioral activation, self-reflection, or individual progress feedback. Chatbot interactions were used as a means to deliver daily content, education, feedback, encouragement, and support. Each intervention to increase or decrease a specific trait includes both similar techniques, such as a self-reflection tool to learn from successes and failures in exhibiting new behaviors, and unique techniques related to the targeted trait, such as learning to behave in a more extraverted way (see Stieger et al., 2018, 2021, for more details).

Measures

Big Five Personality Traits

Personality traits were measured three times (pretest, posttest after the 3-month intervention, and follow-up 3 months after the end of the intervention) with the Big Five Inventory–2 (Soto & John, 2017). The Big Five Inventory–2 is a 60-item measure of the Big Five personality traits and 15 corresponding facets (i.e., three facets per trait). Each facet is measured by four items, two of which are negatively keyed. For the present study, we focused on negative emotionality (example items are: "I

[1] The design of the digital intervention study included a randomized control trial with an intervention condition and a wait-list control condition with a 4-week waiting period followed by the same intervention as in the intervention condition (see figure 1 in Stieger et al., 2021). Moreover, the intervention condition was oversampled and included two thirds of all participants. Because of the smaller size of the personality-change intervention groups in the control condition and the time-limited waiting period, we focused on the three largest intervention groups across both conditions for this article.

am someone who relaxed, handles stress well" [reverse-scored], "I am someone who is moody, has up and down mood swings"), extraversion (example items are: "I am someone who is outgoing, sociable," "I am someone who has an assertive personality") and conscientiousness (example items are "I am someone who tends to be disorganized" [reverse-scored], "I am someone who is efficient, gets things done"). Participants indicated how strongly they agreed or disagreed with each statement on a 5-point Likert scale ranging from 1 (*strongly agree*) to 5 (*strongly disagree*).

Self-Esteem

Self-esteem was measured three times using the established 10-item Rosenberg Self-Esteem Scale (Rosenberg, 1965). The measure consists of 10 items (example items are: "On the whole, I am satisfied with myself," "I take a positive attitude toward myself"). Participants indicated how strongly they agreed or disagreed with each statement on a 5-point Likert scale ranging from 1 (*strongly agree*) to 5 (*strongly disagree*).

Statistical Analysis

The statistical analysis approach was as follows: We first tested for measurement invariance across time and intervention groups for each personality trait and self-esteem using (multigroup) longitudinal correlated factor models to first ensure that the measures function equivalently across time and intervention groups. To examine correlated change over time, we specified latent change score models for each construct and estimated the correlations between levels and between change scores based on pairwise combinations of the models. Models were estimated in R using the lavaan package (Rosseel, 2012) and *full information maximum likelihood* estimation to account for missing data. More details are given below.

Measurement Models and Invariance

We first established longitudinal correlated factor models for each personality trait and self-esteem to test for measurement invariance across the measurement occasions (i.e., pretest, posttest, follow-up) and the three intervention groups (decrease negative emotionality, increase extraversion, increase conscientiousness; cf. Könen & Karbach, 2021). Self-esteem factors loaded on the items at the corresponding measurement occasions. For personality traits, we used facet parcels as indicators (i.e., the average across the four items of each facet; Soto & John, 2017), as higher order models based on items yielded convergence issues in the pairwise combinations of models. To scale the factors, we constrained the first factor loading to 1 and factor means to 0. Residuals of the same item were allowed to correlate across time (Little, 2013). For self-esteem, we additionally included a residual correlation within time points between Item 1 ("On the whole, I am satisfied with myself") and Item 10 ("I take a positive attitude toward myself"), as well as between Item 2 ("At times I think I am no good at all") and Item 6 ("I certainly feel useless at times") because the common factor was not able to fully account for the correlations between these items. We evaluated the overall model fit with a combination of the comparative fit index (CFI), the root-mean-square error of approximation (RMSEA), and the standardized root-mean-square residual (SRMR) based on common standards (acceptable/good fit: CFI $\geq$ .90/.95; RMSEA $\leq$ .08/.06; SRMR $\leq$ .08/.06; Bentler, 1990; Hu & Bentler, 1999).

We tested for measurement invariance across time and the three groups (Könen & Karbach, 2021). Tests of measurement invariance typically involve fitting confirmatory factor models with increasingly severe restrictions on measurement parameters (Little, 2013; Meredith, 1993). We started with an unconstrained measurement model in which the factor loadings are freely estimated across time and intervention groups (configural invariance), and then we constrained the respective factor loadings to be equal across time and intervention groups (metric invariance). Finally, we constrained the respective factor loadings and intercepts to be equal over time (scalar invariance). For correlated change analyses, metric invariance is required. Measurement invariance was tested by evaluating the increase in model misfit between nested models based on a cutoff of ΔCFI = −.010, ΔRMSEA = .015, and ΔSRMR = .030/.015 (metric/scalar measurement invariance; Chen, 2007; Cheung & Rensvold, 2002).

Latent Change Score Models

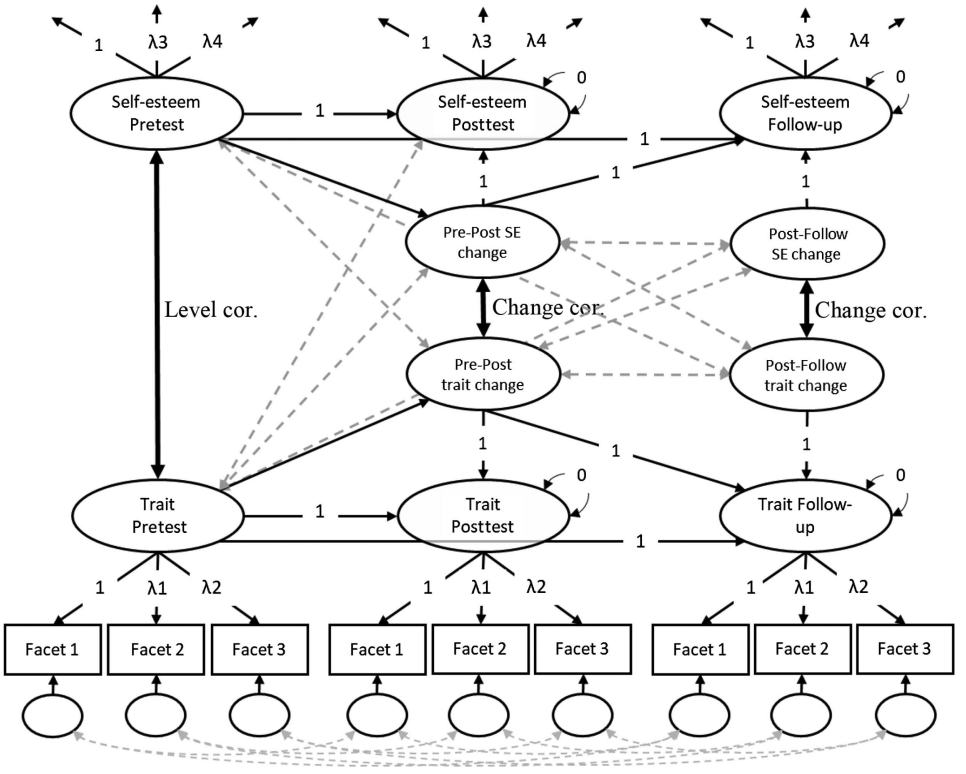
To differentiate between the baseline level and change during the different intervention phases, we used latent change score models, as these models focus on intraindividual change and interindividual differences in intraindividual change (Ferrer & McArdle, 2010; Hertzog & Nesselroade, 2003). Specifically, we used bivariate latent change score models (Figure 1; see also Könen & Karbach, 2021) based on the metric invariance measurement models. We regressed the second (i.e., posttest) and third (i.e., follow-up) measurement occasion on the first (i.e., pretest) by $\beta = 1$. We then specified a factor representing a change from the pre- to posttest loading by $\lambda = 1$ on the second and third measurement occasions. The factor representing change between the posttest and follow-up measure loaded on the third measurement occasion by $\lambda = 1$. To control for regression to the mean, we regressed the first change score (i.e., pre- to posttest difference) on the corresponding pretest measures.

Transparency and Openness

The present secondary data analyses of this study were exploratory and not preregistered. Reporting standards are followed throughout, including clear reports of the data set, sample selection, any exclusions, and measurements used. Data, analysis code, and research materials are available in a repository on Open Science Framework (OSF; Olaru & Allemand, 2021). Previous articles have used

Figure 1

Latent Change Score Model



Note. This is a simplified illustration with only three indicators per factor. The black double-headed arrows represent the correlations of interest (level cor. = level correlation; change cor. = change correlation). Gray dashed double-headed arrows represent other correlations allowed (i.e., between change scores and between indicator residuals across time). Single-headed arrows represent factor loadings or regressions. To control for regression to the mean, we regressed the first change score (i.e., pre- to posttest difference) on the corresponding pretest measures. *SE* = self-esteem.

outcome data from the digital intervention trial to examine the effects of the digital coaching intervention on personality traits (Stieger et al., 2021), facets and nuances (Olaru et al., 2022), satisfaction with life domains (Olaru et al., 2023), and predictors of personality-change goals including self-esteem at pretest (Stieger, Eck, et al., 2020). Other articles have used ambulatory assessment data from the study to examine associations between personality states and situational cues (Lindner et al., 2023) and associations between personality states and smartphone sensing (Rüegger et al., 2020). Analyses of the mean-level change in self-esteem, and of correlated change between personality traits and self-esteem, are unique to this study and have not been reported anywhere yet.

Results

Descriptive statistics and correlations of the examined constructs are presented in Table 1. On average, self-esteem levels correlated by $r = -.59$ with negative emotionality, $r = .41$ with extraversion, and $r = .35$ with conscientiousness measured at the same time point. These correlations are similar to those reported in meta-analyses or large-scale studies on the Big Five self-esteem associations (e.g., Robins et al., 2001). Retest correlations across 3 months were on average $r = .74$ for self-esteem, $r = .74$ for negative emotionality, $r = .83$ for extraversion, and $r = .78$ for conscientiousness.

Model Fit, Measurement Invariance, and Reliability

An overview of model fit for the measurement invariance levels is presented in OSF Table 1 in additional online material. All models achieved acceptable overall model fit (but see the "Method" section for added residual correlations for self-esteem) and metric measurement invariance. For self-esteem—for which we also examined mean-level differences—scalar measurement invariance was only achieved when freeing two item intercepts (see OSF Table 1 in additional online material for details). Reliability (Cronbach's α and McDonald's ω) was adequate for all traits (average across measurement occasions: negative emotionality α/ω = .80/.80; extraversion α/ω = .77/.78; conscientiousness α/ω = .76/.77) and self-esteem (average across measurement occasions: α/ω = .88/.87).

Mean-Level Change in Self-Esteem

With respect to our first research question, we examined mean-level changes in self-esteem for each intervention group with the longitudinal correlated factor (see Figure 2 in Stieger et al., 2021, for mean-level changes in personality traits). We expected self-esteem to increase in all intervention groups but most strongly in the negative emotionality group. The results are presented in Figure 2. In the negative emotionality group, participants increased significantly in their self-esteem (pretest to posttest: $d = 0.22$, $p = .001$; pretest to follow-up: $d = 0.37$, $p < .001$). Notably, self-esteem levels for the negative emotionality group further increased even after the intervention (posttest to follow-up: $d = 0.15$, $p = .007$). For the extraversion group, the increase in self-esteem was only significant between the pretest and the follow-up (pretest to posttest: $d = 0.10$, $p = .268$; pretest to follow-up: $d = 0.24$, $p = .001$; posttest to follow-up: $d = 0.14$, $p = .061$). For the conscientiousness group, there were no significant increases in self-esteem (pretest to posttest: $d = 0.07$, $p = .272$; pretest to follow-up: $d = 0.13$, $p = .074$; posttest to follow-up: $d = 0.06$, $p = .269$).

Level and Change Correlations Between Personality Traits and Self-Esteem

With respect to our second research question, we examined the level and change correlations between the personality traits and self-esteem (see Figure 3; for comparison reasons, we plotted the absolute correlations for negative emotionality, corresponding to a correlation with *emotional stability*). As expected, negative emotionality correlated most strongly with self-esteem (pretest *level* correlations averaged across the three groups: $r = -.85$, $p < .001$), followed by extraversion ($r = .51$, $p < .001$), and conscientiousness ($r = .48$, $p < .001$). The pretest level correlations were statistically equivalent across groups (i.e., differences between groups were nonsignificant; see Table 2).

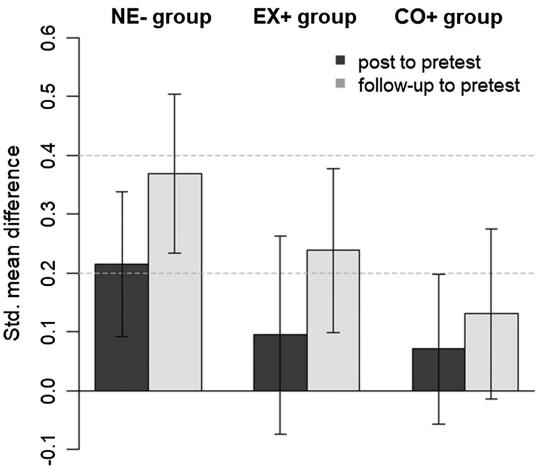
Table 1
Descriptive Statistics and Correlations in the Full Sample

Variable	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11	12
1. NE pretest	2.73	0.66	—											
2. NE posttest	2.65	0.63	.71**	—										
3. NE follow-up	2.63	0.63	.61**	.78**	—									
4. EX pretest	3.22	0.69	−.20**	−.08	−.09	—								
5. EX posttest	3.29	0.61	−.18**	−.31**	−.26**	.79**	—							
6. EX follow-up	3.30	0.64	−.14*	−.24**	−.32**	.80**	.88**	—						
7. CO pretest	3.38	0.69	−.17**	−.05	−.11*	.11**	.03	.03	—					
8. CO postest	3.49	0.63	−.16**	−.29**	−.32**	.14**	.22**	.17**	.73**	—				
9. CO follow-up	3.53	0.60	−.13*	−.25**	−.36**	.13*	.18**	.24**	.72**	.82**	—			
10. SE pretest	3.73	0.69	−.60**	−.40**	−.36**	.36**	.30**	.29**	.27**	.26**	.21**	—		
11. SE posttest	3.85	0.69	−.43**	−.56**	−.52**	.31**	.43**	.39**	.16**	.38**	.35**	.69**	—	
12. SE follow-up	3.93	0.65	−.40**	−.49**	−.60**	.31**	.40**	.43**	.17**	.37**	.40**	.67**	.80**	—

Note. NE = Negative Emotionality; EX = Extraversion; CO = Conscientiousness; SE = self-esteem. Descriptive statistics and correlations are presented for the entire sample, thus the mean-level differences across measurement occasions are smaller than within the change goal groups.
* $p < .05$. ** $p < .01$.

Figure 2

Standardized Factor Means of Self-Esteem Across Time and Intervention Groups



Note. Presented are the standardized factor mean differences between the pretest and posttest or follow-up, respectively. Errors bars represent the 95% confidence interval. NE− = decrease negative emotionality group; CO+ = increase conscientiousness group; EX+ = increase extraversion group.

Because of the large factor correlation between self-esteem and negative emotionality, we tested whether self-esteem could be considered distinct enough from the traits targeted with the intervention. To do so, we used the measurement models at the pretest and compared the model fit of a model with two factors (e.g., negative emotionality and self-esteem) to a model with only one common factor. The Akaike and Bayesian information criteria (AIC and BIC), as well as χ^2-difference tests, supported the distinctness of the constructs in all cases (negative emotionality: $\Delta AIC = 542$, $\Delta BIC = 535$, $\Delta\chi^2 = 157$, $p < .001$; extraversion: $\Delta AIC = 621$, $\Delta BIC = 616$, $\Delta\chi^2 = 623$, $p < .001$; conscientiousness: $\Delta AIC = 734$, $\Delta BIC = 729$, $\Delta\chi^2 = 736$, $p < .001$; positive values indicate that the two-factor model fits the data better).

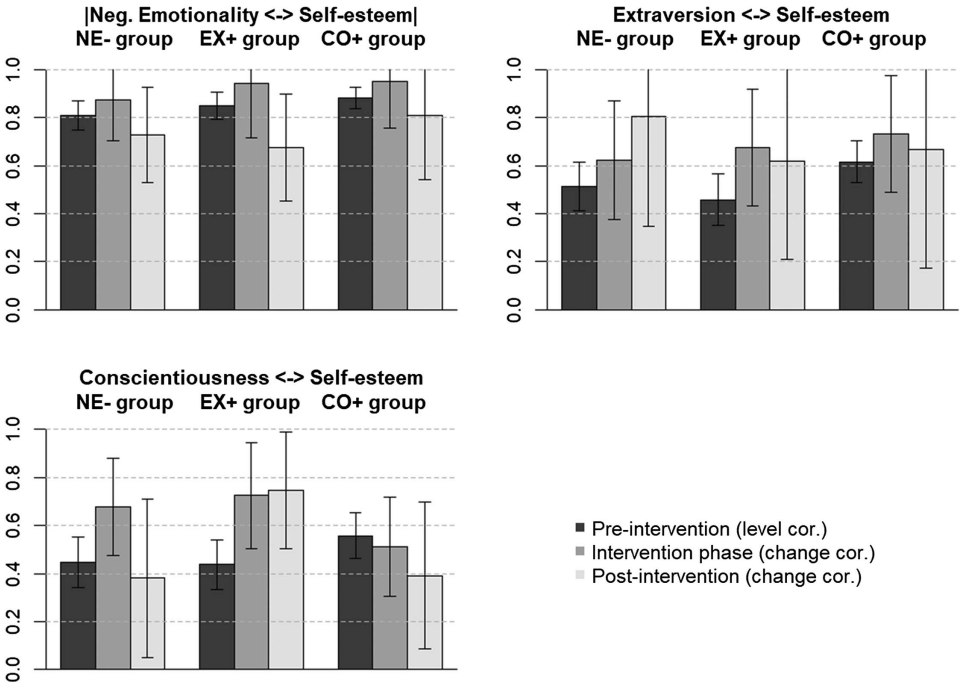
About correlated change, we expected significant *change* correlations between personality traits and self-esteem. The average *intervention phase* change correlation (across the three groups) with self-esteem was $r = -.92$ for negative emotionality, $r = .67$ for extraversion, and $r = .64$ for conscientiousness change (all $p < .001$). Again, emotional stability change showed the strongest associations with self-esteem change.

With respect to our third research question, we explored the potential moderating role of the intervention group and intervention phase. The change correlations for each trait did not differ significantly across groups (i.e., in the corresponding intervention group compared to the other groups) nor to the pretest level correlation (see Table 2). The average *postintervention* (i.e., follow-up) change correlations with self-esteem amounted to $r = -.74$ for negative emotionality (all $p < .001$), $r = .69$ for extraversion (decrease negative emotionality group: $p = .001$; increase extraversion group: $p = .003$; increase conscientiousness group: $p = .008$), and $r = .50$ for conscientiousness (decrease negative emotionality group: $p = .023$; increase extraversion group: $p < .001$; increase conscientiousness group: $p = .012$).

Taken together, these results showed that, on average, participants of the negative emotionality group increased in self-esteem during the coaching intervention, participants from the extraversion group only after a longer time span (i.e., when comparing follow-up and pretest), and participants from the conscientiousness group not at all (Research Question 1). Participants who showed the greatest decrease in negative emotionality, the greatest increase in extraversion, and the greatest increase in conscientiousness also showed the greatest increase in self-esteem (Research Question 2). These

Figure 3

Overview of Correlations Between Personality Traits and Self-Esteem From the Bivariate Latent Change Score Models Across Intervention Groups and Phases



Note. NE− = decrease negative emotionality group; CO+ = increase conscientiousness group; EX+ = increase extraversion group. The bars represent the estimated correlations between the preintervention levels (pretest; black), intervention phase change (posttest; dark gray), and postintervention phase change (follow-up; light gray) in each group. Error bars represent the 95% confidence intervals of the parameter estimates. For negative emotionality, absolute correlations are shown (the actual correlations are negative).

change correlations were similar across intervention groups and phases (Research Question 3). Thus, the links between self-esteem and the personality traits examined seem to remain stable, even if one construct is specifically targeted by coaching activities.

Discussion

The question of how closely changes in different psychological concepts correlate with each other provides basic information about the nature of psychological change. Addressing the recent call for research on intervention-related correlated change processes (Könen & Karbach, 2021), the present study examined correlated change between personality traits and self-esteem using data from a digital coaching intervention targeting personality traits (Stieger et al., 2021). Although traditional analyses typically focus on average group effects and mean-level comparisons, correlated change offers an insightful way to examine individual differences in intraindividual change. The main goal of this study, therefore, was to demonstrate the potential relevance of this unique approach by showing that changes in personality traits through intervention are linked to changes in self-esteem.

Changes in Personality Traits Are Accompanied by Changes in Self-Esteem

The present results make an important contribution to the intervention and coaching literature in three ways. First, after establishing measurement equivalence of the self-esteem measure, we found greater improvement on the average levels of self-esteem, particularly in the group of participants who wanted

Table 2
Significance Testing of the Differences Between the Personality Traits and Self-Esteem Correlations Across Intervention Groups and Phases

Difference	Negative emotionality and self-esteem			Extraversion and self-esteem			Conscientiousness and self-esteem		
	Δr	95% CI	p	Δr	95% CI	p	Δr	95% CI	p
Difference groups									
Pretest level correlation	.06	[−.03, .14]	.203	−.11	[−.24, .03]	.129	.12	[−.01, .24]	.068
Posttest change correlation	.07	[−.17, .31]	.548	.00	[−.35, .34]	.995	−.19	[−.48, .10]	.205
Follow-up change correlation	.02	[−.24, .27]	.906	−.12	[−.69, .45]	.690	−.17	[−.55, .21]	.371
Difference phases									
Posttest change versus level correlation	−.06	[−.25, .12]	.491	.22	[−.09, .52]	.167	−.04	[−.28, .19]	.713
Follow-up change versus level correlation	.08	[−.13, .29]	.446	.16	[−.32, .64]	.511	−.17	[−.48, .15]	.303
Follow-up versus posttest change correlation	.15	[−.09, .38]	.224	−.06	[−.53, .42]	.819	−.12	[−.51, .26]	.534

Note. Difference groups = correlation in the corresponding intervention group minus the average of the other two groups; difference phases = difference between correlations within the corresponding intervention group; Δr = estimated differences between correlations; 95% CI's = 95% confidence interval of difference estimate (standard errors derived by bootstrapping); p = significance value of difference; preintervention phase = cross-sectional *level* correlation at pretest; intervention phase = correlation between pre- to posttest *change* factors; postintervention phase = correlation between posttest to follow-up *change* factors.

to decrease in negative emotionality and partly for the group of participants who wanted to increase in extraversion. That is, as participants made progress toward their desired personality goal, their self-esteem increased. These mean-level findings indicate that an active engagement with one's own personality also may trigger self-evaluation processes, such as how people perceive and evaluate themselves, and thus provide initial evidence for the transfer effects of the personality-intervention efforts. To the best of our knowledge, no research so far has examined changes in self-esteem as an important outcome measure of personality-change interventions. However, although medium-sized effects were observed for mean changes in negative emotionality, extraversion, and conscientiousness (Stieger et al., 2021), the observed changes in self-esteem were of small effect size. Notably, self-esteem levels for the negative emotionality group further increased even after the coaching intervention, indicating that some change processes may take more time than others.

Second, the main goal of the present work was to examine the correspondence in change between personality traits and self-esteem using latent change score models. As a first step, we replicated previous research efforts (Erol & Orth, 2011; Robins et al., 2001) by providing additional support for moderate to strong cross-sectional (initial level) correlations between personality traits and self-esteem. In a clear extension of developmental research on correlated personality change (Olaru & Allemand, 2022; Pfund & Allemand, 2022), we demonstrated substantial correspondence in rates of change between personality traits and self-esteem in coaching research. Specifically, the findings indicate that self-esteem improves when people manage to decrease their negative emotionality and increase their extraversion or conscientiousness. Although the mean-level change in self-esteem results suggests an average increase, the correlated change approach explicitly accounts for individual differences in intraindividual changes and thus for the fact that people often respond and change differently to interventions. The overall picture suggests that the studied processes of change unfold in rather general ways across the intervention and imply transfer effects. It seems that some commonalities between personality traits and self-esteem, such as heritability, malleability, and predictive power (Kandler et al., 2015; Robins et al., 2001), but also being part of a coaching intervention, were responsible, in part, for strong correlated change patterns. The aim of the present work was to show that a targeted change in personality traits is simultaneously accompanied by a change in self-esteem. Future research is needed to examine why traits and self-esteem showed a strong correspondence in change and to investigate general and broad mechanisms underlying the correlated change.

Third, further clarification of the patterns of correlated change by examining the role of the intervention groups and phases (i.e., preintervention phase, intervention phase, and postintervention phase) as potential moderators did not provide significant additional insight. The observed correlated change patterns were similar in magnitude across intervention groups and phases. This finding points to the strong commonality between personality traits and self-esteem, as not only different targets of change or intervention phases might impact the change association. Future intervention work is needed to replicate the stability of (change) associations between traits and self-esteem and to identify the broadly acting mechanisms.

Implications, Limitations, and Future Directions

This study has various implications for intervention and coaching science and consulting practice. Correlated change findings have a potential to inform future intervention and prevention programs aimed at self-improvement and self-change efforts. The finding that changes in personality traits are closely related to changes in self-esteem may be informative for intervention measures; that is, the study provides some evidence that intentional change in personality traits is possible and that such a change may be associated with a broader process of change related to improved perceptions of self-esteem. Overall, the study offers some empirical evidence for a more optimistic attitude toward the saying, "You can't teach an old dog new tricks." Once we understand better which change processes unfold together or in different ways in personality-change intervention, this may help to better understand the range and interplay of interventional outcomes. Given the fact that low self-esteem is considered a vulnerability or risk factor for depression and anxiety (e.g., Sowislo & Orth, 2013; Steiger et al., 2014, 2015), the present findings contribute to intervention efforts to promote self-esteem

(Niveau et al., 2021). Specifically, the findings indicate that changing personality traits with an affective signature (i.e., negative emotionality and extraversion) may be a viable (indirect) pathway to improve self-esteem. Moreover, the knowledge that changes over time on a particular personality trait are associated with a change in self-esteem, or that individuals who tend to change more on certain primary outcomes also tend to change strongly on other secondary or even tertiary outcomes, can be informative for personalizing coaching and consulting efforts (Chapman et al., 2014). Finally, the finding that changes in personality traits are closely related to changes in positive self-evaluation processes may also be informative for self-change or self-improvement efforts. The increase in self-esteem could be because of a positive evaluation process of the personality changes that motivates people to take further steps toward achieving the change goal, to take on new challenges, and likely influences future expectations.

There are several limitations of the present work that deserve attention in future research. First, we focused on correlated change using established self-reports, which leaves open the possibility for issues related to self-report questionnaires, such as social desirability, demand effects, or wishful thinking. Future research may additionally include external observations of self-esteem by significant others (e.g., relatives, friends) as external evaluations of individuals' internal experiences. Second, although the Rosenberg Self-Esteem Scale (Rosenberg, 1965) is the most widely used self-report measure, shortcomings and limitations of the scale, such as item-wording artifacts, are consistently reported (e.g., Gnambs & Schroeders, 2020; Greenberger et al., 2003). For example, recent research has shown that lower cognitive abilities (i.e., reading and reasoning) seem to lead to difficulties in understanding negative, reverse-scored items of the self-esteem measure (Gnambs & Schroeders, 2020). Third, based on this study, it is not possible to determine the directionality and causality of the relationship between personality-trait changes and self-esteem changes. That is, changes in self-esteem could be partly because of changes in self-esteem, but on the other hand, changes in self-esteem may also lead to changes in personality traits. Future experimental intervention research is needed to disentangle the directionality of the effects and to investigate whether affecting self-esteem with an intervention also leads to changes in personality traits. Fourth, like most longitudinal designs, the latent change models require attention to the timing of assessments. The time interval that is needed to accurately capture systematic change and to determine a correlated change is an important aspect in intervention research. Time intervals that are too short or too long about the nature of the phenomenon being studied can produce data that, in some cases, are overly sensitive to measurement errors and carryover effects and, in other cases, are insensitive to variability and change (Hertzog & Nesselroade, 2003). Last, the present sample was restricted to a single country and was largely homogeneous in terms of cultural identity. Future research is needed to examine whether these findings generalize to other contexts, particularly ones with lower socioeconomic status and more diverse samples.

Conclusion

The present study advances our understanding of how changes in personality traits through intervention unfold together or in different ways over time with self-esteem. In particular, participants who took part in a digital coaching intervention to reduce negative emotionality showed significant, albeit small, average increases in their self-esteem, although effects on targeted personality traits reflected medium-sized effects. More importantly, the personality traits of negative emotionality, extraversion, and conscientiousness demonstrated substantial correlated change with self-esteem at a similar level as the cross-sectional associations. These findings show that coaching aimed at reducing negative emotionality and increasing extraversion had an effect on the average level of self-esteem of the participants, especially among those participants who showed the most pronounced personality changes. Although the results showed that average self-esteem continued to develop after the intervention phase, the correlated change results suggest that the associations between self-esteem and personality traits are consistent regardless of the phase (preintervention, intervention, or postintervention). Correlated change is a unique approach to studying individual differences in change that deserves more attention in future research on personality-change interventions and in intervention and coaching science and practice in general.

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