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On the similarity between exchangeable profiles: A psychometric model, analytic strategy, and empirical illustration

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Abstract

Analyses of profile similarity are widespread in personality psychology, but their apparent simplicity masks difficult psychometric and statistical issues. We present a psychometric framework that addresses an important challenge (i.e., profile normativeness) in examinations of dyadic exchangeable profiles. In addition, we present an analytic strategy accounting for non-independence that often arises in analyses of profile similarity, facilitating integrated examinations of variables at dyadic and individual levels. An empirical analysis of personality similarity and relationship quality demonstrates that the model and analytic strategy can reveal novel psychological insights. These are important advances, as previous work has ignored exchangeable profiles and has failed to present an integrated psychometric and statistical framework for profile similarity.

Keywords

Profile similarity; Non-independence; Personality similarity; Relationship satisfaction; Dyadic designs; Measurement; Statistics

1. Introduction

The analysis of profile similarity is intuitively appealing and frequently implemented in many areas of psychology. For example, a personality/social psychologist might study “personality similarity” in relationships by administering a personality trait inventory to two people, obtaining a profile of responses to the inventory for each person. By correlating the two profiles, the researcher can evaluate the degree to which the people have a similar pattern of responses. More specifically, a profile correlation reflects the degree to which the traits that have relatively high scores in one profile are the same traits that have relatively high scores in another profile. A positive correlation indicates that the people have similar patterns of high and low traits, whereas a correlation near zero indicates that they have different patterns of trait scores. As reflected in the correlation, personality similarity might have important implications for the peoples’ feelings of satisfaction in their relationship.

In this paper, we present solutions to two problems that confound examinations of similarity within “exchangeable” profiles. Exchangeable profiles cannot be differentiated in a systematic and conceptually relevant way (Kenny, Kashy, & Cook, 2006). For example,

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researchers might examine roommate pairs in which there is no a priori psychologically-meaningful basis for designating one roommate as “roommate 1” and the other as “roommate 2.” Similarly, they might examine employee pairs in which there are no theory-based social, organizational, or personal ways of differentiating employees within each dyad. The first problem that we address is the lack of a coherent psychometric framework that differentiates similarity into meaningful components that facilitate effective analysis of profile similarity within pairs of exchangeable profiles. The second problem is potential ambiguity about analytic strategies that account for arbitrariness and statistical interdependence that arise in examinations of pairs of exchangeable profiles. We present a new psychometric framework that solves the first problem, and we then present an analytic strategy through which the components of the framework can be examined with appropriate accommodations for arbitrariness and interdependence, thereby solving the second problem. Finally, to demonstrate the applicability and meaning of these solutions, we describe an empirical examination of links between personality similarity and a variety of relational and personal outcomes. This examination demonstrates that the psychometric framework and analytic approach can reveal important new psychological insights that otherwise would have been missed and that – if ignored – would produce incomplete and potentially inaccurate conclusions.

These two problems merit serious attention, for several reasons. First, analyses of profile similarity are widespread in personality, social, developmental, clinical, and organizational psychology (Asendorpf, 2006; Borkenau & Zaltauskas, 2009; Furr, 2009; Furr, Dougherty, Marsh, & Mathias, 2007; Furr & Funder, 2004; Hopwood & Zanarini, 2010; Klimstra, Luyckx, Hale, Goossens, & Meeus, 2010; Leary & Allen, 2011; Letzring & Nofhle, 2010; McCrae & Terracciano, 2006; Sherman, Nave, and Funder, 2012; Robins, Fraley, Roberts, & Trzesniewski, 2001; Samuel & Widiger, 2006; Shoda, Mischel, & Wright, 1994; Westen, Shedler, & Bradley, 2006). With such widespread use, analysis of profile similarity merits a deep understanding of its promises and psychometric pitfalls. Second, although there are indeed substantial and non-intuitive pitfalls associated with profile analysis (Cronbach, 1955; Cronbach & Gleser, 1953; Furr, 2008; Furr, 2010), there is currently no strategy for navigating these pitfalls in the context of “exchangeable” profiles. An informative conceptualization of profile similarity with exchangeable profiles requires a new psychometrically-coherent framework that allows researchers to evaluate potential confounds and to uncover interesting new phenomena. Third, analyzing the similarity of exchangeable profiles raises thorny issues of arbitrariness and statistical interdependence, which have crucial implications for the accuracy of any statistical tests. Statistical models have been developed to handle these issues in some designs, but practical methods of applying these models might be unclear or unfamiliar to many researchers. By addressing these important problems, we hope to open new avenues of important psychological research and to help researchers avoid making incomplete or inaccurate conclusions.

1.1. The challenge and opportunity of normativeness

Profile normativeness is the degree to which a profile matches an average or “normative” profile (Furr, 2008), and it has at least two qualities that complicate analyses of profile similarity. First, most profiles are relatively normative (e.g., any person is likely to have a personality profile at least somewhat similar to another, randomly selected person). Second, normativeness has clear psychological meaning – individuals with normative profiles tend to have desirable traits and to be well-adjusted (e.g., Edwards, 1953; Wood, Gosling, & Potter, 2007; Wood & Wortman, 2012).

These qualities create challenges in the examination of profile similarity. For example, researchers might wonder whether pairs of roommates who are relatively similar to each other tend to be relatively satisfied with their relationships. This question is surprisingly

complex because people with relatively normative profiles tend to be desirable and well-adjusted. Thus, similarity is often confounded with the extent to which the members of the dyad have desirable qualities. Consequently, an association between similarity and satisfaction might simply reflect the fact that well-adjusted people tend to have better relationships, without any salutary effects of actually being similar to one another. Indeed, simple profile similarity indices can be understood as indicating whether both individuals in the relationship are desirable and well-adjusted (Wood & Furr, 2013). Researchers who ignore the role of normativeness in profile similarity risk drawing conclusions that are faulty or that reflect an unnecessarily limited view of their phenomena.

Recent research reveals opportunities for psychological insight that can be gained via a psychometric framework that handles the normativeness challenge (e.g., Biesanz, West, & Millevoi, 2007; Klimstra et al. 2010; Leary & Allen, 2011; Sherman et al., 2012). For example, Sherman, Nave, and Funder (2012) examined behavioral congruence, as reflected in the similarity between one's profile of self-reported personality attributes and one's corresponding profile of behavioral attributes. Congruence initially appeared to be associated with psychological adjustment, but those associations largely disappeared when normativeness was controlled via an appropriate psychometric framework. This approach avoided potentially-misleading artifactual results and offered new insights into the psychological implications of behavioral congruence. Similarly, Biesanz et al. (2007) found that the apparent effects of acquaintanceship on self-other agreement of personality ratings are significantly affected by normativeness. When conducting analyses without accounting for normativeness, they found no association between acquaintanceship and agreement. However, after examining the effects of normativeness, they discovered a deeper story – as participants became more acquainted, they accurately recognized what was distinctive about each other and saw each other as less normative.

1.2. Frameworks for handling normativeness

Fortunately, as these examples show, researchers have begun to recognize the normativeness challenge and to develop solutions appropriate for some designs.¹ The earliest was Cronbach's (1955) work in person perception. This framework was originally articulated for designs in which a perceiver rates multiple targets along a set of traits, with each target rating himself or herself along those traits. Normativeness was reflected in "stereotype accuracy," or the degree to which a judge's perception of the average target (i.e., a profile reflecting the average of the judge's profiles as he/she rated the multiple targets) corresponds with the average target's self-perception (i.e., a profile reflecting the average of the targets' self-perception profiles). Kenny and his colleagues later presented a strategy for a different design often used in dyadic social/personality research (Kenny & Acitelli, 1994; Kenny & Winkust, 2001; Kenny et al., 2006). Their strategy is applicable to person-perception designs in which each perceiver rates only one target, with each target being rated by only one perceiver, or to family research in which each wife is paired with only one husband and vice versa. Using their strategy, researchers obtain indices of similarity that control, to some extent, for stereotype accuracy, as well as indices reflecting the degree to which individuals endorse stereotype profiles.

Building on these approaches, Furr (2008) presented a psychometric model focusing on three concepts relevant in almost any examination of profile similarity. *Overall Similarity* is

¹As a departure from all other strategies for handling normativeness, some strategies avoid profiles altogether. That is, to examine issues such as personality similarity, person-environment fit, judgmental accuracy, or behavioral consistency, some strategies focus on each trait separately, rather than on profiles of traits. For example, the Social Relations Model (Kenny, 1994) operates on one trait at a time, decomposing personality ratings into elements such as consensus and assimilation for each trait. Similarly, Edwards (1994) proposes an alternative to profile similarity which relies on moderated regression, using a single trait at a time.

the degree to which two profiles are similar to each other (with no adjustment for normativeness), computed as the correlation or covariance between two profiles. *Normativeness* is the degree to which an individual profile is like an average profile (e.g., the degree to which a given wife is like the normative or average wife), and it is computed as the correlation or covariance between an individual's profile and a relevant "normative" profile of means. Normativeness is indexed independently for both partners in the dyad (i.e., how normative is partner 1's profile? How normative is partner 2's profile?). *Distinctive Similarity* is a normatively-adjusted index reflecting the degree to which two profiles are uniquely similar to each other, in terms of the ways in which they are "distinct" from the average persons. Biesanz (2010) has recently integrated these concepts into his model for examining personality judgments, applicable to designs in which each perceiver rates multiple targets and each target is rated by multiple perceivers.

1.3. Exchangeable profiles

Unfortunately, existing frameworks for handling normativeness are not applicable to designs that include pairs of exchangeable profiles. Exchangeable profiles cannot be differentiated from each other in a way that is psychologically meaningful (e.g., in terms of same-sex roommates). In contrast, non-exchangeable or distinguishable profiles *can* be differentiated in a systematic and meaningful way. For example, analysis of personality similarity in heterosexual married couples includes pairs of profiles that can be distinguished from each other in a psychologically meaningful way – one is clearly a husband's profile and the other is clearly a wife's (i.e., they are not "exchangeable"). In such cases, there are clearly two categories of profiles (e.g., "criterion" and "judgment"; "male" and "female", "self-rating" and "peer-rating") and a particular set of ratings is misclassified if placed in the other category. Such classifications are not possible with exchangeable profiles, or they entail distinctions that are conceptually irrelevant to the research question (e.g., which participant is taller? Or which participant has an earlier birthday?).

Examinations of exchangeable profiles can arise in many research contexts. Exchangeable profiles might arise in dyadic research in which there is no clear, theoretically meaningful way of differentiating the members of each dyad (e.g., the study of same-sex roommate groups). Similarly, exchangeable profiles can occur in organizational research, where there are no "inherent" dyads, as there are in romantic relationships or parent/child relationships. For example, researchers might examine the association between personality similarity and relational outcomes among all possible pairs of individuals within a fraternity, a set of employees, or other kinds of organizations. In such cases, there might be few or no inherent dyads (i.e., no couples, roommates, or other clear clustering of group members), but researchers could still examine the importance of dyadic similarity for relational outcomes. Exchangeable profiles could also arise in examinations of inter-judge consensus of personality judgment, where several judges rate the same target(s). In such cases, there might be no psychologically-robust way to distinguish among judges.

Examinations of exchangeable profiles encounter the normativeness problem, but existing psychometric frameworks require all profiles to be distinguishable into two types. For example, Furr's (2008) approach requires researchers to identify and examine two normative profiles – one for each "type" of profile (e.g., one representing the normative husband and one representing the normative wife). Such distinctions are psychologically arbitrary for exchangeable profiles, preventing a conceptually grounded identification of separate normative profiles and precluding the efficient use of the existing framework.

There are three potential solutions to the normativeness challenge for exchangeable profiles. One is simply to make arbitrary distinctions between profiles and use the psychometric framework designed for non-exchangeable profiles. For example, a researcher who

examines roommate dyads might randomly select one member of each dyad to be classified as “roommate 1” and the other to be “roommate 2”, generate normative profiles for each “type” of roommate, and use the psychometric decompositions designed for non-exchangeable profiles. This is problematic, in part, because its results (and, consequently, the conclusions drawn from those results) will vary somewhat on the basis of these arbitrary classifications. A second potential solution would be for the researcher to repeat the first solution several times, randomly assigning participants as roommate 1 or roommate 2, conducting the relevant analyses, repeating this process several times, and recording the results each time. Although this begins to handle the arbitrariness problem of the first solution, it is also inefficient, perhaps extremely so. It requires researchers to repeat the entire sequence of analyses (i.e., computing normativeness and similarity indices, and examining all relevant research questions involving those values) many times and then systematically aggregate, summarize, or compare the results of each analysis. Such inefficiency adds complexity to the analytic process and can be avoided through an alternative solution. Thus, a third and preferable solution is to develop a coherent psychometric framework that facilitates a well-grounded and efficient approach to exchangeable profiles, without the need for arbitrary and questionable distinctions.

1.4. Conceptual and psychometric framework for the similarity of exchangeable profiles

The psychometric framework that follows is applicable to exchangeable profiles, and it differentiates profile similarity into several conceptually-meaningful components. It is built upon a single normative profile, which avoids the need for arbitrary distinctions between profiles. This important difference from existing frameworks addresses the first problem confounding the examination of similarity between exchangeable profiles. The framework articulates the similarity between two profiles in terms of four elements that are psychologically meaningful in a range of applications. These components are consistent with those derived from frameworks designed for non-exchangeable profiles (e.g., Furr, 2008; Kenny & Acitelli, 1994), which ensures that similar questions can be addressed effectively across various designs, enhancing productive convergence across studies.

1.5. Conceptual foundation

A framework for profile similarity should have at least two important qualities. First, it should reflect phenomena at multiple psychosocial levels. For example, researchers who study dyadic relationships are interested in qualities of the individuals within each dyad (e.g., personality) and in qualities of the dyad itself (e.g., same-sex or different-sex), as related to important predictors or outcomes (e.g., satisfaction). Similarly, researchers who study consensus among two perceivers of a single target’s personality are interested in qualities of specific perceivers and in qualities of the target judged by both perceivers. Thus, a framework should include individual-level (or perceiver-level) components, as well as dyad-level (or target-level) components. Second, it must separate similarity from normativeness. Although there is no single component or index that reflects “pure” similarity, a framework can represent different facets of similarity.

Integrating both of these qualities, the current framework includes two dyad-level components and an individual-level component, reflecting facets of similarity and normativeness. Dyad-level components are defined separately for each pair of profiles. These include Overall Similarity (i.e., the degree to which two profiles have a similar pattern of scores, without adjustment for normativeness) and Distinctive Similarity (i.e., the degree to which two profiles have a similar pattern of scores, following adjustment for normativeness). Such dyad-level constructs reflect meaningful qualities of each dyad. For example, the study of personality similarity and relationship satisfaction might focus on roommate dyads. Some dyads might include roommates who are relatively similar to each

other, while other dyads might include roommates who are not similar to each other. Researchers might be interested in the possibility that dyads' differences in similarity are associated with dyads' differences in conflict or satisfaction. In contrast, individual-level components are those for which each individual's level or standing can differ from the other member of his/her dyad. In the current framework, Normativeness is an individual-level component because each person has a unique value reflecting the degree to which he or she is like the average person. Normativeness reflects a potentially important quality of a person and might be an important antecedent or consequence of psychosocial processes.

1.6. Components of a profile

The psychometric foundation of the framework begins with decompositions of individual scores and profiles. An individual's profile generally reflects his or her responses to a set of stimuli – e.g., personality trait items, situations, or behavioral items. For example, Table 1 presents six hypothetical personality profiles – one for each roommate, across three pairs of roommate, with each profile reflecting five traits. As illustrated in this Table, profile similarity is meaningful when the variables in the profiles are on the same scale and when each profile includes the same variables.

An individual's score on variable v in profile p (x_{vp}) can be seen as a composite of a normative element and a distinctive element. For exchangeable profiles:

$$x_{vp} = \bar{x}_{v\bullet} + x'_{vp} \quad (1)$$

where $\bar{x}_{v\bullet}$ is the mean score on the variable averaged across all profiles in the sample, and where x'_{vp} is the degree to which the individual's score on the variable deviates from the sample's mean score on the variable (i.e., $x'_{vp} = x_{vp} - \bar{x}_{v\bullet}$). The mean score reflects the sample's normative level of that variable, and the deviation score reflects the individual's "distinctiveness" on the variable. By extension, scores on a variable from two profiles (e.g., from profiles of two individuals) are:

$$x_{v1} = \bar{x}_{v\bullet} + x'_{v1} \quad (2a)$$

$$x_{v2} = \bar{x}_{v\bullet} + x'_{v2} \quad (2b)$$

For example, consider the Neuroticism scores in the first dyad in Table 1. In this dyad, Dave's score is 6 and Adrian's score is 2, and each is the composite of a normative score and a distinctiveness score. Averaged across all six individuals, the sample's normative Neuroticism score is 3. Thus, Dave is (distinctively) 3 points more Neurotic than the normative individual, and Adrian is (distinctively) 1 point less Neurotic than the normative individual.

Because each score is a composite, each profile of scores is a composite of two profiles – a profile of distinctiveness scores (i.e., the individual's distinctive profile) and a profile of normative scores (i.e., the group's normative profile). Thus, each individual's profile in Table 1 arises from a distinctive profile and the normative profile. Fig. 1 illustrates this for two profiles, with the dashed lines reflecting the links between individual's "raw" profiles, their distinctive profiles, and the normative profile.

1.7. The psychometric model of profile similarity and normativeness

Following these decompositions, the similarity between two profiles of scores can be seen as the association between two composites. In this framework, the association between two exchangeable profiles can be decomposed into four terms (see Fig. 1 and Appendix A):

$$\sigma_{x_{v1}x_{v2}} = \sigma_{x'_{v1}x'_{v2}} + \sigma_{x_{v1}\bar{x}_{v\bullet}} + \sigma_{x_{v2}\bar{x}_{v\bullet}} - \sigma_{\bar{x}_{v\bullet}}^2 \quad (3)$$

As discussed earlier, $\sigma_{x_{v1}x_{v2}}$ is Overall Similarity (i.e., the covariance between two profiles of scores), $\sigma_{x'_{v1}x'_{v2}}$ is Distinctive Similarity (i.e., the covariance between two profiles of distinctiveness scores), and $\sigma_{x_{v1}\bar{x}_{v\bullet}}$ and $\sigma_{x_{v2}\bar{x}_{v\bullet}}$ are individual-level components reflecting the Normativeness of the two profiles (i.e., the covariances between each profile and the normative profile). The final term, $\sigma_{\bar{x}_{v\bullet}}^2$ is Normative Variability (i.e., variance of the normative profile, reflecting the differences among the variable means).² Note that Normative Variability is constant across profiles. Thus, although it provides descriptive information about samples, it was not mentioned in the conceptual description of the model, which focused on components that vary across individuals or dyads. In sum, Eq. (3) and Fig. 1 reflect a psychometrically coherent model in which each element is psychologically meaningful in many examinations of exchangeable profiles.

Both individual-level normativeness components in this model (i.e., one for each member of a dyad) are based on the same normative profile. That is, these “individual normativeness” values reflect the degree to which each individual is like the average person in the sample. Again, this reliance upon only a single normative profile differs importantly from previous models of profile similarity (Furr, 2008), but it is fundamental to the nature of exchangeable profiles.

This initial articulation of the framework is based on covariances because they provide the simplest statistical decomposition of relevant concepts (Nunnally & Bernstein, 1994). However, almost all examinations of profile similarity in personality and social psychology are based upon simple Pearson correlations rather than covariances.

Indeed, although covariances or other indices, such as intraclass correlations, have been used to reflect profile similarity (Dilchert, 2007; McCrae & Terracciano, 2006; footnote 2 in Tenney, Turkheimer, & Ottomans, 2009), these types of alternative indices suffer from potential ambiguities (Furr, 2010). Whereas profile correlations are clear reflections of a single facet of profile similarity (i.e., shape similarity), other indices blend multiple facets of profile similarity. Profile covariances, for example, reflect both shape similarity and scatter similarity (i.e., variability). These facets of similarity are conceptually independent, potentially reflecting different psychological phenomena. As such, indices that combine more than one facet confound separable phenomena, and thus they can obscure the psychological meaning of a similarity value (Cohen, 1969; Furr, 2010; Nunnally, 1962). For example, a large covariance can reflect either a large association between profiles or a small association between high-variability profiles.

Thus, in correlational terms, the model is:

$$r_{x_{1v}x_{2v}} = \frac{r_{x'_{1v}x'_{2v}} + r_{x_{1v}\bar{x}_{v\bullet}} + r_{x_{2v}\bar{x}_{v\bullet}} - \sigma_{\bar{x}_{v\bullet}}^2}{\sigma_{x_{1v}}\sigma_{x_{2v}}} \quad (4)$$

²It can be shown that the Normative Variance is identical to the average Normativeness across all profiles in the sample.

where r and σ terms are correlations and standard deviations of the relevant components (e.g., $r_{x'_{1v}x'_{2v}}$ is the correlation between distinctive profiles, and $\sigma_{x'_{1v}}$ and $\sigma_{x'_{2v}}$ are standard deviations of those profiles).

1.8. Illustration

To illustrate the model and the interpretation of its components, consider the similarity and normativeness values in Table 1 (derived from the hypothetical data in the table). For the first pair (i.e., Dave and Adrian), the two individuals are generally similar to each other – the correlation between their raw profiles is substantial, with a positive overall profile similarity correlation of .598 and an overall similarity covariance of .400 (which corresponds with Eq. (3), $.400 = .644 + .233 + .227 - .704$). That is, they have roughly similar patterns of high and low scores in their profiles. For example, both are less Open than Neurotic, Extraverted, Agreeable, and Conscientious, and both are as Agreeable as they are Conscientious. Moreover, Dave and Adrian are quite distinctively similar to each other, as shown by the fact that the correlation between their “distinctive profiles” is .577. For example, both are less Conscientious and less Extraverted than the average individual (as indicated by their negative Distinctive scores on these traits); but more to the point, they are both even further below average in terms of Conscientiousness than in terms of Extraversion. Finally, both Dave and Adrian are at least somewhat normative, as shown by the correlation between each of their raw profiles and the normative profile. Dave is somewhat less normative than Adrian (with normativeness correlations of .166 and .675, respectively), suggesting that he is less like the typical individual than is Adrian.

In contrast, consider the third pair of roommates – Glenn and Ken. These individuals are generally similar to each other (with a large positive overall similarity correlation, .532), and both are highly normative (with large positive normativeness correlations). However, they are *not* distinctively similar to each other; that is, each is distinctive in some ways, but they are distinctive in different ways.

This example begins to illustrate the utility of differentiating similarity, normativeness, and distinctiveness. Both pairs had fairly high overall similarity, but this is only part of the story. Dave and Adrian were similar in general and in terms of their distinctive/non-normative qualities. In contrast, Glenn and Ken were similar in general but not in terms of their distinctive qualities. Moreover, the decomposition revealed the fact that Adrian, Glenn, and Ken are all quite normative but that Dave is much less so. These represent potentially important psychological differences, and they can be observed only through a psychometrically-coherent decomposition of overall similarity.

2. Analytic strategies and empirical illustration

At its most fundamental level, examinations of profile similarity are derived from pairs of profiles, and the second problem in the examination of exchangeable profiles is the difficulty of accounting for the challenges associated with analyses of such data. There are at least two important analytic challenges (Griffin & Gonzalez, 1995; Kenny et al., 2006).

One key analytic challenge is that typical analytic strategies require arbitrary decisions that can produce unreliable results. For example, a question such as “is an individual’s own normativeness associated with a partner’s perception of relational conflict?” would typically require researchers to designate some individuals as “actors” and others as “partners” before correlating normativeness with conflict. Because exchangeable profiles cannot be differentiated meaningfully, such distinctions are arbitrary. Moreover, if such distinctions were made differently (i.e., changing who was designated an actor and who was designated

a partner) among some dyads, then the apparent association between normativeness and “amount of conflict perceived by one’s partner” might change significantly.

The second analytic challenge is that dyadic data often involve interdependence among individuals. For example, the hypothetical data set in Table 1 includes three pairs of roommates, and we might wish to evaluate the association between individuals’ normativeness and their perceptions of conflict with their roommates (e.g., do normative people perceive more or less conflict than non-normative people?). Data from these six individuals likely do not represent six independent observations, violating the key assumption of independence required by simple analytic strategies that treat “individual” as the unit of analysis. Such violations can bias inferential statistics and effect sizes (Kenny et al., 2002).

Fortunately, recent advances address both analytic challenges (e.g., Griffin & Gonzalez, 1995; Kenny et al., 2006; Olsen & Kenny, 2006; Woody & Sadler, 2005). Illustrated in Fig. 2 (Model 5), the Actor–Partner Interdependence Model (APIM; Kenny et al., 2006) is perhaps the most well-known of these. The basic APIM represents associations between two individual-level variables, which are linked separately to each individual in a dyad (e.g., normativeness and perceived conflict). By using statistical models that equate effects across dyad-members and that account for interdependence within dyads, researchers adopting the APIM can obtain results that avoid the challenges that compromise typical analytic strategies. Reflecting this approach, Fig. 2 presents generalized forms of models that can be used to address a variety of relevant questions.

There are at least two statistical approaches that can be used to examine the APIM with exchangeable profiles. The more generalizable approach is a path analysis that imposes equalities upon specific pairs of parameters. This approach can be used to examine the APIM among groups of any size (i.e., not only dyads), and it avoids the need for a “double-entry” data structure that is sometimes viewed as difficult to manage. However, it requires a relatively complex modeling syntax, and its required software is somewhat less available. The second approach is via multilevel modeling, and its advantages and disadvantages are the opposite of the path analytic model’s – its programming is somewhat simpler and it is integrated into software that is more widely available, but it is limited to dyads and requires a double-entry data structure (Griffin & Gonzalez, 1995).

Because the path analytic approach is more generalizable, we emphasize it below. In Table 3, we illustrate the strategy via models written for SAS 9.3, paralleling the generalized models presented in Fig. 2. Although we describe procedures for analyzing this framework via SAS in the text below, we also provide an online Supplemental document with additional details and descriptions of the logic of these analyses, including syntax for conducting analyses via SPSS/AMOS 19.0 and Mplus 6.0. In addition, the Supplemental document describes the multilevel approach through SAS, SPSS, and Mplus, including the necessary double-entry data structure. To explain and illustrate the analytic strategy, we examine personality similarity among real roommates.

2.1. Background on empirical illustration

Researchers have long been interested in associations between personality similarity and relationship-oriented variables (e.g., DeCuyper, de Bolle, & de Fruyt, 2011; Dyrenforth, Kashy, Donnellan, & Lucas, 2010; Gonzaga, Campos, & Bradbury, 2007; Luo & Klohnen, 2005). Much of this work has been conducted with opposite-sex romantic couples and has adopted a profile-based approach to personality similarity. In the current analysis, we examine personality similarity via profile similarity in the context of same-sex non-romantic

roommate dyads. Because we have no conceptual basis for distinguishing the individuals within each dyad, these data reflect exchangeable profiles.

Our psychometric model allows us to disentangle the potential implications of personality similarity and normativeness in terms of important variables. These include relational variables such as perceptions of friendship and conflict among roommates, as well as a dyadic “pairing” variable distinguishing pairs of roommates who chose to live with each other from those who were randomly paired with each other by university housing administration. They also include more individual “personal adjustment” variables such as wanting a transfer from college, feelings of burnout, and self-esteem.

Although these analyses are primarily illustrative and descriptive, several key questions and hypotheses emerge through careful consideration of normativeness, overall similarity, and distinctive similarity. Some questions and hypotheses are univariate in nature, focusing on issues such as interdependence and average levels of key variables. Others involve associations between variables.

Q1: Do roommates have corresponding levels of normativeness? Either through selection or through mutual influence after living together, people with corresponding levels of normativeness might be paired with each other.

Q2: Do roommates have corresponding levels of personal adjustment and, even more interestingly, corresponding perceptions of relational quality?

H1: Based upon analyses of these concepts in other contexts, we expect high levels of normativeness and overall similarity, which itself is affected by normativeness as described earlier. It is less clear what to expect for distinctive similarity, which is generally lower than overall similarity.

H2: We expect normativeness to be associated primarily with the “personal adjustment” outcomes, based upon the known links between normativeness and desirability/adjustment. The desire to transfer from college, the feeling of burnout at college, and self-esteem – are individual and personal in nature, with no necessary link to the roommate relationship.

H3: We expect overall personality similarity to be associated with both “relational” qualities – such as roommate conflict and friendship – and “personal adjustment” outcomes as described above. Considering the former, if overall similarity, as a characteristic of the dyad, has relational implications, then it should be related to relational outcomes such as increased friendship and decreased conflict. Concerning the latter, the fact that overall similarity is confounded with normativeness suggests that it will be related to the same variables that normativeness is related to.

H4: We expect distinctive similarity to be associated only with relational outcomes. Because it is a dyadic characteristic, it should be connected to the relational qualities of the dyad. However, because it is disentangled from normativeness, there is no reason to expect associations between distinctive similarity and personal adjustment.

2.2. Participants and procedures

Approximately 1500 freshmen roommate pairs (or 3000 total students) were invited via email to complete an online survey in 2005. Invited participants were given a week to complete the survey, and were entered into a lottery and given 100 pages of free printing credit following their participation. A total of 1568 freshmen completed the survey, and a total of 896 individuals also had roommates who completed the survey, resulting in 448 roommate dyads. Some participants had missing values on the scales used below, leaving a total of 441 complete dyads used in the analysis. Of these, 339 roommate pairs had been

randomly assigned to live together by the university, while 102 were self-paired (i.e., chose to live together).

2.3. Measures

Personality—To describe their personality characteristics, participants completed the 44-item Big Five Inventory (BFI; John & Srivastava, 1999). These responses are the basis of participants' personality profiles, and thus they are the basis of personality similarity and normativeness indices. Measures for all Big Five traits showed reliability estimates ranging between $\alpha = .80$ and $.90$.

Positive roommate relationship—Participants completed two items measuring the extent to which they felt they had a positive relationship with their roommate. These items were "I would say that overall, my roommate and I fit in well with one another," and "I would say that my roommate and I are friends," and were rated on a five-point scale ranging from 1 (*Strongly disagree*) to 5 (*Strongly agree*) ($\alpha = .91$).

Perceived conflict—Participants also completed two items targeting more negative aspects of the roommate relationship. These items were "My current roommate and I do not get along with one another," measured on a 1 (*Strongly disagree*) to 5 (*Strongly agree*) scale, and "How much do you and your roommate get into conflicts with one another?" which was rated on a five-point scale ranging from 1 (*Not at all*) to 5 (*All the time*) ($\alpha = .72$).

University burnout—Participants rated the two items "I feel emotionally drained from being at UIUC" and "I feel burned out from my UIUC experience" on a five-point scale ranging from 1 (*Strongly disagree*) to 5 (*Strongly agree*). These items were averaged ($\alpha = .86$).

Self-esteem—Participants rated the items "I have high self-esteem" and "I am satisfied with my life" on the same five-point scale. These items were averaged ($\alpha = .76$).

Intent to transfer—Participants rated the item "Do you have any desire to transfer to another university?" on a four-point scale ranging from 1 (*No desire*) to 4 (*A strong desire*), and the item "How likely is it that you will transfer to another university?" on a 5-point scale ranging from 1 (*Not at all likely*) to 5 (*Highly likely*). These items were averaged ($\alpha = .78$).

2.4. Preliminary steps

Before proceeding to substantive analyses of data from exchangeable profiles, there are three preliminary steps. First, we compute the similarity and/or normative components of interest, as described in the previous sections. Again, in most applications of profile similarity in personality psychology, researchers examine correlations rather than covariances. Second and relatedly, profile correlations are z-transformed (i.e., Fisher's transformation) to account for non-normality in Pearson correlations, as shown in the "Zcorr" column of Table 1. These transformed values are the basis of the analyses that follow.

A third important step is to organize the data in a "dyad-level" structure (Kenny et al., 2006), with several crucial points illustrated in Table 2. First, each dyad has its own row. Second, each individual must be designated either as Individual 1 or Individual 2. These designations are arbitrary, but as described earlier, the appropriate analytic strategy handles these arbitrary distinctions, so there is no need to worry about which person in each dyad is designated as Individual 1 or 2. Third, each row contains all information about the

individuals and the dyad, including individual-level components such as normativeness and conflict and dyad-level components such as Overall Similarity and “pairing process.”

2.5. Analysis of interdependence and averages

To examine our core questions and hypotheses, we organize analyses in terms of two broad types of issues. The first includes issues related to the first hypothesis and the first two research questions – issues of interdependence (e.g., the degree to which normative people choose to room together) and mean levels (e.g., average degree of similarity and normativeness). Based upon the logic of path analysis designed for the APIM, these issues can be addressed in separate analyses of each variable, though the models for individual-level variables are slightly different than those for dyad-level variables.

Individual-level variables—Table 3’s Model 1 invokes SAS’s “calis” procedure, which implements path analysis and structural equation modeling (see also Model 1 in Fig. 2). The “method = ml” statement implements maximum likelihood estimation.³ The “Cov” statement estimates the covariance/correlation between roommates’ normativeness values, labeling this “normcorr.” Importantly, the remaining statements impose equality constraints that account for the arbitrariness of the distinction between roommate 1 and roommate 2. The “Variance” and “Mean” statements dictate that the two sets of normativeness values have the same estimated variance (i.e., called “normvar”) and same mean (i.e., called “normmean”) respectively. These constraints are crucial to analysis of exchangeable profiles, and if the profiles truly are exchangeable, then these constraints are conceptually and empirically reasonable.

Interdependence is reflected in correlations estimated by the model, along with a significance test of the correlation. Due to the constraints imposed, these values are intraclass correlations (ICCs, Griffin & Gonzalez, 1995), which range from -1 to $+1$, with more extreme values indicating greater non-independence, or similarity between dyadic partners. A positive value indicates that, in general, dyad-members’ scores on a variable are more similar to each other than to members of other dyads. Negative values, in contrast, indicate that dyad-members’ scores on a variable are generally *less* similar to each other than to members of other dyads.

Addressing the first two research questions, the ICCs reported in Table 4 for Perceived Friendship ($ICC = .545, p < .0001$) and Perceived Conflict ($ICC = .447, p < .0001$) reveal robust interdependence.⁴ This suggests that, when one person views the relationship as being particularly friendly or conflictual, his or her roommate is quite likely to view the relationship in a similar way. The ICCs for the remaining variables are considerably lower, but indicate that roommates have somewhat similar levels of Normativeness, desire to transfer from college, and self-esteem ($ICCs = .111, p's < .05$). There is not significant evidence of roommate similarity in university burnout ($ICC = .080, ns$).

The models estimate the mean of individual-level variables, but the traditional significance test is unlikely to be of great interest for many variables. For example, a sample’s mean normativeness has a lower bound of zero, and it approaches zero only in the very unlikely circumstance that all items have exactly the same mean. Indeed, as expected (H1) and as shown in Table 4, in the roommate data, the mean normativeness is large and significantly greater than zero ($M = .542, p < .0001$).

³Because SAS, AMOS, and Mplus use different default methods of estimation, the syntax in Table 3 and the Supplemental Document uses maximum likelihood estimation to retain consistency across the three programs.

⁴The significance tests of normativeness, overall similarity, and distinctive similarity are based upon Fisher-transformed values. However, the means in Table 4 have been transformed back onto the correlational metric.

Dyad-level variables—Table 3's Model 2 (see also Fig. 2) estimates the means and variances of dyad-level variables such as Overall or Distinctive Similarity, and it is somewhat simpler than the previous model, as each dyad has only a single score for each dyad-level variable, which eliminates the need to impose constraints and to estimate a correlation. Moreover, because scores on dyad-level variables are constant within each pair, there is total interdependence, by definition, on such variables (i.e., $ICC = 1$). Thus, no estimation or test of this is necessary.

Table 4 presents mean values for Overall Similarity and Distinctive Similarity, and results are again consistent with H1. The significant mean level of Overall Similarity suggests that, on average, roommates have similar personality profiles ($M = .307, p < .0001$). However, after controlling for normativeness, Distinctive Similarity indicates only a small (though still significant) degree of similarity in terms of the non-normative aspects of roommates' personalities, as averaged across all pairs of roommates ($M = .051, p < .0001$).

2.6. Analysis of associations among variables

The second set of analyses focuses on questions of association, addressing the remaining hypotheses and research questions (e.g., is normativeness associated with personal adjustment? Is distinctive similarity associated with relational variables such as roommate self-pairing?). Again, there are important differences between the models used for individual-level dependent variables and those used for dyad-level dependent variables.

Individual-level dependent variables—When examining individual-level dependent variables, such as the amount of conflict that an individual perceives with his or her roommate, one or more predictors (e.g., normativeness, partner normativeness) can be used. Models 3–6 (see Fig. 2 and Table 3) address questions regarding personality normativeness or similarity as predictors of individual-level outcomes. Because normativeness is an individual-level variable and similarity is a dyad-level variable, they require slightly different models.

Correlates of normativeness (or other individual-level predictors)—To evaluate whether an outcome is related to an individual's own normativeness or to his/her roommate's normativeness, Models 3 and 4 included Normativeness or Partner Normativeness, respectively, as predictors. Going further, to evaluate a more fully interpersonal effect, Model 5 included both Normativeness and Partner Normativeness as predictors (e.g., the full Actor Partner Interdependence Model, Kenny et al., 2006).

As shown in Table 3 and Fig. 2, these models require several key specifications. Model 3 presents the analysis of "Actor Effects" in predicting one's perceptions of conflict from one's normativeness (i.e., do relatively normative people perceive more or less conflict than less normative people?). In the APIM, this type of association is called an Actor effect because it represents the effect of one's own psychological characteristic (e.g., normativeness) on one's own outcome (e.g., perception of conflict). In this model, the "Lineqs" command includes two regression models that are estimated simultaneously. One equation reflects the prediction of "Individual 1's" conflict (or other individual-level variable) from his or her own normativeness, and the other predicts "Individual 2's" conflict from his or her normativeness. The "Cov" command estimates two correlations – one called "normcorr" reflecting the association between roommates' normativeness values and one called "econcorr" reflecting the association between their (residualized) conflict values. The "Variance" command estimates variances for the four variables in the model – the two roommates' normativeness scores and (residualized) conflict scores. Similarly, the "Mean" statement estimates means for the four variables.

There are several important constraints in this model, which handle the arbitrariness of designating some people as Individual 1 and some as Individual 2. Specifically, the variances and means of corresponding variables are constrained to be equal. For example, the Variance command estimates one variance parameter (“normvar”) for both sets of normativeness scores, and it estimates one variance parameter (“resconvar”) for both residualized conflict scores. Similarly, the Lineqs statement estimates a single slope and a single intercept that are applied to both regression models. Specifically, the “conint” and “act” terms represent an intercept and regression slope to be estimated. The fact that the same terms are used in both Lineqs equations ensures that SAS will estimate only one intercept and one slope based upon the variables within both equations (i.e., based upon all responses from all individuals). In all, Model 3 estimates seven parameters – an intercept value for the outcome, a slope representing the association between the come and predictor, the correlation between roommates’ scores on the residualized outcome, the correlation between roommates’ scores on the predictor, the variance of the residualized outcome, and the variance and mean of the predictor. Again, the equality constraints are crucial for ensuring that this model estimates parameters appropriately for exchangeable dyads.

Models 4 and 5 are very similar to Model 3. Whereas Model 3 estimates actor effects (i.e., the effects of one’s psychological characteristics on one’s own outcomes), Model 4 estimates partner effects (i.e., the effects of one’s psychological characteristics on a partner’s outcomes), and Model 5 represents the full APIM by estimating both effects simultaneously so that they control for each other. These key differences are reflected in the Lineqs commands. For example, in Model 4, Individual 1’s conflict is predicted by Individual 2’s normativeness, and the slope is now referred to as “part” to indicate that it reflects a partner effect. Similarly, in Model 5, Individual 1’s conflict is predicted both by his/her own normativeness and by Individual 2’s normativeness, with slopes labeled correspondingly.

Models 3, 4, and 5 provide insight into the hypothesis that normativeness is associated with “personal adjustment” outcomes (H2), with results generally confirming expectations. Table 5 presents standardized coefficients representing the “act” and “part” parameters in the SAS syntax, and those values reveal that individuals’ Normativeness (and to some degree partners’ normativeness) was robustly associated with their own personal adjustment. Normative people (i.e., individuals with more desirable, well-adjusted, and typical personality profiles) report less desire to transfer from college, less burnout, and greater self-esteem (β s = $-.211$, $.269$, and $-.459$ respectively, all p ’s < $.0001$). Moreover, as shown in Models 4 and 5, individuals with normative roommates tended to report relatively better friendship with their roommate (β ’s = $.080$, p ’s < $.001$) and relatively high self-esteem (β ’s = $.106$, p ’s < $.001$). Note that these normativeness effects have nothing to do with *matching or having similar characteristics with* one’s roommate. We revisit this point later.

Correlates of similarity (or other dyad-level predictors)—To evaluate whether an outcome is related to personality similarity, Model 6 included Overall similarity or Distinctive Similarity as predictors. These analyses begin to provide insight into the hypothesis that overall personality similarity is associated with many or all of the outcomes (H3) and the hypothesis that distinctive similarity is associated only with relational quality (H4). We examine Overall Similarity and Distinctive Similarity separately because the psychometric decomposition (Eqs. (3) and (4), above) differentiates these components; thus, there is no need for analyses in which they further control for each other.

Model 6 requires only slight changes from previous models. Specifically, the Lineqs command includes the dyadic variable (e.g., overall similarity) as a predictor of both individual’s conflict scores, with the intercept and slope (i.e. “bsim”) constrained to be equal across both equations. Because it is a dyadic variable, overall similarity is not included in

the “Cov” statement; however its variance and mean are estimated. Thus, including the correlation and variance of the residualized conflict scores, this model includes a total of six separate parameter estimates.

As shown by the standardized coefficients in the “Model 6” columns of Table 5 (i.e., the standardized “bsim” estimates), results support H3 and H4. Regarding H3, Overall Similarity was associated with all outcomes – the relational and the personal. This seems to suggest that people who are generally similar to their roommates are “better off” in a variety of ways – perceiving more friendship with roommates, experiencing less of a desire to transfer and less burnout, etc. However, applying Model 6 to Distinctive Similarity reveals more nuanced implications and supports H4. Distinctive Similarity was associated only with a relational individual-level outcome – perceived friendship ($\beta = .095, p < .05$). This indicates that roommates who have similar unique characteristics perceive greater friendship with each other. The comparisons of Models 6a and 6b indicate that apparent correlates of roommate similarity can disappear when normativeness is accounted for.

Dyad-level dependent variables—For dyad-level dependent variables, such as whether a roommate pair selected each other or were randomly paired, Models 7 and 8 can be used to evaluate the effects of one or more predictors. As shown in Fig. 2 and Table 3, these models differ from the ones for individual-level outcomes in several ways. Primarily, only one Lineqs statement is required, because only a single regression equation is estimated for a dyad-level outcome. In Model 7 (for individual-level predictors), the slopes for the individual-level predictors (i.e., “bnorm”) are constrained to be equal, as are the individual-level variable’s means and variances. In Model 8 (for a dyad-level predictor), no such constraints are required, because the model does not include individual-level predictors.

Using these models, we examined the association between personality normativeness/similarity and the dyad-level variables “pairing process” (i.e., whether the roommate dyad was formed by the roommates selecting one another, or was randomly formed by the university, coded random = 0, self-paired = 1) and dyad gender (i.e., whether the pair consists of two females or two males, coded males = 0, females = 1). Self-pairing is highly relational, as it reflects a dyad’s familiarity and, presumably, mutual satisfaction. Dyad gender, in contrast, is not necessarily a relational variable. Although we have no hypotheses regarding the link between roommate gender and personality similarity, we hypothesized (H3 and H4) that self-paired roommates would be more similar than roommates who were randomly paired. Thus, for each outcome, we examined separate models for Normativeness, Overall Similarity, and Distinctive Similarity. For such dyad-level outcomes, the effect of Partner Normativeness is identical to Normativeness, so it needs no separate analysis.

As shown in the bottom of Table 5 (Model 7), self-paired roommates were no more or less normative than randomly-paired roommates ($\beta = .006, ns$). Results for similarity were again consistent with expectations (H3 and H4), with self-paired roommates being more similar to each other than are randomly-paired roommates (i.e., significant positive slopes in Model 8a and 8b – β ’s = .098 and .141, respectively, p ’s < .05). It is instructive to consider the difference between overall and distinctive similarity, as distinctive similarity can be roughly considered “similarity after removing normativeness.” Because normativeness did not relate to “pairing process” (Model 7), removing this component distills or strengthens the positive relationship between personality similarity and choosing one’s roommate. Thus, the link between distinctive similarity and “pairing process” was relatively robust, compared to the link between overall similarity (which is confounded with normativeness) and pairing process.

The converse was seen for gender. On the basis of Model 8a, women appear to be more similar to their roommates than men ($r = .173$). However, this appears to be largely due to the fact that women have more normative profiles than men ($r = .132$ from Model 7). Distinctive similarity – where normativeness is removed – now indicates that women roommates are not significantly more similar than male roommates ($r = .072$, ns, from Model 8b).

3. Conclusions

We articulated a new psychometric model for exchangeable profiles, and we presented an analytic strategy handling statistical challenges associated with such data. This addresses two problems that have limited researchers' ability to examine profile similarity with practical efficiency, psychological clarity, psychometric-coherence, and statistical validity. Indeed, our empirical example demonstrates that the proposed approaches can have important implications for psychological theory and application.

3.1. On the examination and meaning of profile similarity, normativeness, and distinctiveness

Our illustrative analyses reveal the potential importance of differentiating Overall Similarity, Distinctive Similarity, and Normativeness in the context of exchangeable profiles. The current psychometric framework produced insights into the connections between personality similarity, relationship quality, and personal adjustment – insights that would have been missed without differentiating similarity and normativeness.

Analyses indicated that Overall Similarity was indiscriminately associated with all outcomes – the relational (e.g., perceived friendship, self-pairing) and the more personal (e.g., experiencing burnout). On one hand, this suggests that being similar to one's roommate has a provocative host of positive consequences. Not only does similarity with one's roommate lead to or reflect increased friendship, which we might expect, but it also seems to have equally strong links to one's desire to transfer to another university and to one's self-esteem! On the other hand, our analyses suggest that the correlations between Overall Similarity in roommates and an individual's university burnout, desire to transfer, and self-esteem were driven more by the fact that Overall Similarity was a proxy for the normativeness (and thus desirability and adjustment) of the individual's own personality profile than by being similar or dissimilar to one's roommate. Clarifying such findings is important for both theory and practice; for instance, by suggesting that efforts to reduce university burnout and increase self-esteem among college students will *not* benefit from developing sophisticated and costly roommate matching systems to increase similarity. As indicated previously, profile normativeness is exceptionally highly linked to profile desirability (Edwards, 1953; Human & Biesanz, 2011; Wood & Wortman, 2012). Because profile normativeness is, in turn, intrinsically linked to Overall Similarity (i.e., Eqs. (3) and (4)), it is difficult to conclude that any of the correlates of Overall Similarity actually indicate anything about the correlates of "similarity" per se.

Indeed, analyses of Distinctive Similarity and Normativeness provided sharper focus and resolved ambiguity about the links between personality similarity, relationship quality, and personal adjustment. As anticipated, Distinctive Similarity was related to relational outcomes such as roommate friendship and was largely unrelated to personal outcomes such as self-esteem and burnout. Also as anticipated, Normativeness showed the opposite pattern of associations, being primarily associated with personal outcomes and less related to relational outcomes. Again, these analyses provide psychological insights that would have been missed without a differentiating similarity and normativeness.

More broadly, examinations of profile similarity should include three or four components. In our experience, Overall Similarity is a useful, though ambiguous, component. Although researchers and readers frequently begin and end their measurement of dyadic similarity with the seemingly intuitive Overall Similarity measure, they might not always appreciate its ambiguity and confounds.

Thus, to make firmer conclusions regarding the role of similarity in some phenomena (such as friendship quality), Distinctive Similarity is usually crucial (e.g., Biesanz et al., 2007; Furr & Funder, 2004; Sherman et al., 2012; No et al., 2008). By removing normativeness, Distinctive Similarity begins to account for many problems that can plague the analysis of profile similarity. Researchers should recognize, however, that Distinctive Similarity is a conservative index of similarity. Reflecting the degree to which two profiles share distinctively high or low scores, Distinctive Similarity will likely be minimal when one or more profiles is relatively non-distinctive. That is, a highly normative profile will not be distinctively similar to any other profile. Thus, Distinctive Similarity is not *the* index of similarity, but rather one important piece of information to consider when examining similarity.

Going further, Normativeness is integral to a fully-informative examination of profile similarity (e.g., Borkenau & Zaltauskas, 2009; Furr et al., 2007; Klimstra et al., 2010). Particularly in terms of understanding individual differences related to profile similarity, Normativeness can reveal new insights that would be missed if analyses ended with Overall Similarity and/or Distinctive Similarity. In this way, Normativeness is not simply a problem, but it is an opportunity for deeper psychological insights.

There are at least two important considerations in interpretation of normativeness. First, any conclusions about the apparent meaning or role of normativeness should be tempered by the fact that it is typically linked to desirability and adjustment (Edwards, 1953; Human & Biesanz, 2011; Wood & Wortman, 2012). For example, consider our finding that normativeness was associated with less burnout and less desire to transfer to another college. One might be tempted to conclude that “fitting in with others” or “being like others” is thus a source of positive outcomes. This might lead to the further conclusion that people should sacrifice their individuality and strive to be like the average person. Such inferences are not clearly valid. An alternative conclusion might be that the normativeness findings reflect adjustment and desirability more than “being like other people.” As a “third variable,” psychological adjustment might be the factor that truly drives one’s burnout and happiness at college; any apparent effects of normativeness might not reflect normativeness per se, but rather reflect one’s adjustment and desirability. To tease apart these effects in most samples, additional data would be required. A second consideration is that, in less typical samples, normativeness might not be “desirable” as typically defined. For example, among prisoners, the normative profile might include a higher level of neuroticism and lower levels of agreeableness and conscientiousness than is found in the typical sample’s normative profile. Such a normative profile might reflect adaptiveness within a prison context, but it would not reflect adjustment and desirability as typically conceptualized. Thus, as these components are examined across a diverse range of samples and contexts, researchers should carefully consider the meaning of normativeness with regard to their particular samples and contexts.

3.2. Applications

The framework outlined in the current paper can be applied directly to a wide range of important psychological questions across domains of psychology. There are many dyadic and relational designs that, like the current example, involve pairs of exchangeable profiles. The current framework would be applicable to all such research. For example, the framework can also be usefully applied to many examinations of inter-judge consensus of

interpersonal perceptions. If each “target” person is rated by acquaintances who are not distinguishable on the basis of a relational role or any other characteristic that is central to the theoretical question, then the acquaintances are exchangeable and the current framework is appropriate. Similarly, organizational psychologists might be interested in shared perceptions of a work environment (in terms of profiles of environmental characteristics), as related to the productivity of co-workers. Again, if those co-workers are not distinguishable on the basis of a theoretically-relevant variable, then the current framework for exchangeable profiles could be used to examine the nature and implications of normativeness and co-worker similarity in environmental perceptions. Yet another potential application is with observational or experience sampling studies of behavioral or emotional stability/variability. For example, clinical psychologists might ask participants to rate their experience of symptoms (e.g., via a profile of symptoms of Borderline Personality Disorder) at multiple occasions. Researchers might be unable to distinguish between pairs of situations, precluding them from assuming that one participant’s “situation 1” is equivalent to another participant’s “situation 1.” For such “exchangeable symptom profiles” studies, researchers could apply the model in this paper, obtaining indices of overall symptom stability, distinctive symptom stability, and symptom normativeness.

These examples do not exhaust the potential applications of the framework. Rather, they illustrate a few questions for which the current framework would be applicable and informative. More broadly, the framework is applicable to any design in which: (a) multiple variables are measured in multiple contexts, at multiple times, by multiple sources, or within pairs of participants, (b) those contexts, sources, or participants are not distinguishable on the basis of a psychologically-meaningful or relevant variable, and (c) researchers are interested in questions of similarity, stability, consistency, agreement, coherence, fit, or another similar concept.

The analytic framework can also be expanded for psychological questions even more complex than those addressed in the current examples. For example, we could conduct multi-group path analyses to examine the possibility that randomly-paired roommates differed from self-paired roommates in terms of the magnitude of actor effects (e.g., the effect of one’s normativeness on one’s desire to transfer or on one’s perceptions of conflict). Such models are more complex, but are manageable within some programs. For example, SAS’s proc calis can accommodate such questions, by using: (a) “group” statements to estimate parameters separately for each group, and (b) “simtests” statements to test the difference between groups’ parameters. A full discussion of various expansions is beyond the scope of the current work, but such expansions can offer insights into a host of important intrapersonal and interpersonal questions.

Going even further, the psychometric framework and analytic strategy can be extended beyond dyads. For example, organizational researchers might study multi-person work groups (e.g., organizational departments), hoping to determine whether productive work-teams are composed of employees who are similar to each other or who are highly normative. In such an examination, researchers can calculate similarity among all possible pairs of employees within each work group (i.e., through Eqs. (3) and (4)). They can then adjust the relevant Models in Table 3 to apply to groups with more than two members. For example, the Model 9 in Fig. 2 and Table 3 reflects the APIM applicable in triads. The triadic model includes the same number of estimated parameters as the dyadic model, it simply requires a larger number of equality constraints to ensure that effects are equal across all three individuals in the triads. Of course, the triadic model can be extended to handle groups of any size.

3.3. Choices and limitations

The current paper's psychometric model and analytic strategy are articulated for designs and data common in personality psychology, reflecting choices that might be particularly relevant for that field. Some of these choices merit additional comment.

We emphasize profile similarity in terms of simple correlations between profiles, but other indices of similarity have been used. The most likely alternatives are covariances (Dilchert, 2007), double-entry intraclass correlations (McCrae & Terracciano, 2006), and D^2 (Robins et al., 2001). Unfortunately, each alternative is affected by several elements of similarity that are conceptually and (usually) empirically separable. Thus, they can obscure the psychological meaning of similarity (Cohen, 1969; Furr, 2010; Nunnally, 1962). For example, small intraclass correlation between two profiles might indicate that two profiles have different shapes, or have similar shapes but different degrees of variability, or have similar shapes and similar variability but different means, or some other combination of elements.

Due to such ambiguity, we see little value in these alternatives. For researchers interested in multiple elements of profile similarity (i.e., shape, mean levels, variability), we recommend examining each element independently (Furr, 2010). For example, if one suspects that both shape similarity and mean differences between profiles are important, then we recommend examining two indices of similarity – a profile correlation reflecting shape similarity clearly and a mean difference index reflecting mean (dis)similarity clearly. Rather than using a single index that might provide no clear information about either element of similarity, a “differentiated” approach provides clear information about both elements. Moreover, there is little evidence that these alternative indices offer any empirical advantage over the simpler profile correlation, at least for wide-ranging personality trait profiles (Furr, 2010). Indeed, we re-analyzed our roommate data using profile covariances, finding the same basic pattern of results. Similarly, Tenney et al. (2009) examined the link between personality similarity and “liking” using both profile correlations and profile covariances, finding the same pattern of findings (footnote 2).

Another important point is that the current psychometric model is based upon normativeness as reflected by a profile of means. This choice is based upon three points. First, it is consistent with other models of profile similarity (Cronbach, 1955; Furr, 2008; Kenny & Winquist, 2001). Second, by using means derived from a given sample of participants, analysis of those participants' profile similarity will be fully and precisely decomposed (see Eqs. (3) and (4)). Third, for many variables in personality and social psychology, the mean is a reasonable reflection of a “typical” individual. However, there are at least two alternatives to consider. One alternative is a profile of means from a larger sample. For example, Biesanz and Human (2010) examined profile similarity among approximately 500 participants, but they used a normative profile from a similar but larger sample of more than 1100 participants. Such a profile might reflect the typical individual in a highly generalized sense, but it will likely produce a pattern of findings very similar to those produced by using a sample's own normative profile (we would be surprised if the correlation between the two sets of normativeness values was lower than .95). Another alternative would be required when the mean is a poor indicator of “the typical person.” For example, some pathology-oriented variables might be highly skewed, with the mean being quite unrepresentative of many people. In such cases, researchers might consider using a profile of medians or even modes to represent normativeness. Although the psychometric decomposition would not follow precisely Eqs. (3) and (4), above, the psychological meaning of normativeness and distinctiveness would likely remain valid.

4. Summary

The current paper extends methodological insights concerning profile analysis in the context of exchangeable profiles. The psychometric framework reflects a coherent model for differentiating similarity, normativeness, and distinctiveness. Similarly, the analytic strategy reflects appropriate concern for the statistical complexities often associated with profile similarity. Importantly, our empirical results reiterate other recent findings reflecting the importance of considering normativeness when examining profile similarity. As recent studies have shown – and as we have shown here – failure to account for normativeness can lead researchers to miss meaningful psychological findings or important alternative explanations and qualifications of their conclusions. Researchers interested in profile similarity with exchangeable profiles can use the framework and analytic strategy with the knowledge that their analyses are psychometrically coherent and can reveal new psychological insights.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Appendix A

A.1. Derivation of the psychometric framework

Nunnally and Bernstein (1994, p. 171) show that the covariance between composite variables is the sum of the covariances between components of those composites. Thus, the covariance between one profile of scores that are composites of normative and distinctive values (i.e., $x_{i1} = \bar{x}_{i\bullet} + x'_{i1}$) and another profile of scores that are composites of normative and (a different set of) distinctive values (i.e., $x_{i2} = \bar{x}_{i\bullet} + x'_{i2}$) can be decomposed initially as:

$$\sigma_{x_{i1}x_{i2}} = \sigma_{x'_{i1}x'_{i2}} + \sigma_{x'_{i1}\bar{x}_{i\bullet}} + \sigma_{\bar{x}_{i2}x'_{i\bullet}} + \sigma_{\bar{x}_{i2}\bar{x}_{i\bullet}}$$

This final term in this equation can be expressed as a variance, thus:

$$\sigma_{x_{i1}x_{i2}} = \sigma_{x'_{i1}x'_{i2}} + \sigma_{x'_{i1}\bar{x}_{i\bullet}} + \sigma_{\bar{x}_{i2}x'_{i\bullet}} + \sigma_{\bar{x}_{i\bullet}}^2 \quad (A1)$$

As implied in Eqs. (2a) and (2b), each distinctive score can be seen as a composite, with $x'_{i1} = x_{i1} - \bar{x}_{i\bullet}$ and $x'_{i2} = x_{i2} - \bar{x}_{i\bullet}$. Considering this and the psychometric point raised by Nunnally and Bernstein, two of the covariances Eq. (A1) can be expanded, producing:

$$\sigma_{x_{i1}x_{i2}} = \sigma_{x'_{i1}x'_{i2}} + \left(\sigma_{x_{i1}\bar{x}_{i\bullet}} - \sigma_{\bar{x}_{i\bullet}\bar{x}_{i\bullet}} \right) + \left(\sigma_{\bar{x}_{i2}x_{i\bullet}} - \sigma_{\bar{x}_{i\bullet}\bar{x}_{i\bullet}} \right) + \sigma_{\bar{x}_{i\bullet}}^2$$

Again, two of these terms reflect variances, thus:

$$\sigma_{x_{i1}x_{i2}} = \sigma_{x'_{i1}x'_{i2}} + \left(\sigma_{x_{i1}x_{i\bullet}} - \sigma_{x_{i\bullet}}^2 \right) + \left(\sigma_{x_{i2}x_{i\bullet}} - \sigma_{x_{i\bullet}}^2 \right) + \sigma_{x_{i\bullet}}^2$$

This can be simplified to produce Eq. (3):

$$\sigma_{x_{i1}x_{i2}} = \sigma_{x'_{i1}x'_{i2}} + \sigma_{x_{i1}x_{i\bullet}} + \sigma_{x_{i2}x_{i\bullet}} - \sigma_{x_{i\bullet}}^2$$

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Fig. 1.
Illustrations of the framework for similarity of exchangeable profiles.

Fig. 2.

The Actor-Partner Interdependence Model (APIM) and Relevant Variations (Model Syntax in Table 3). *Notes.* Model numbers refer to model syntax in Table 3. X and Y variables are predictors and outcomes, respectively. Variables with a subscript (e.g., X_1) are individual-level variables, with the subscripting noting the individual. Variables without a subscript are dyad-level or triad-level variables. The labels in bold represent parameters to be estimated in a path analysis of the data. When two variables are associated with the same parameter, the parameter is estimated but it is constrained to be equal across the two variables. Thus, Models 5 and 9 include eight parameters each, Models 3 and 4 include seven parameters each, Models 6 and 7 include six parameters each, and Model 8 includes five parameters.

Table 1

Example data with exchangeable profiles.

PAIR 1			Dave	Adrian				
Trait	Dave	Adrian	Dist	Dist	Index	Covar	Corr	Zcorr
Neur	6	2	3.00	−1.00	Overall Sim =	.400	.598	.690
Ext	2	2	−1.17	−1.17	Dist Sim =	.644	.577	.658
Open	1	1	−1.33	−1.33	Dave Norm =	.233	.166	.168
Agree	3	2	−1.17	−2.17	Adrian Norm =	.227	.675	.820
Consc	<u>3</u>	<u>2</u>	<u>− 1.67</u>	<u>− 2.67</u>				
M	3	1.8	−.47	−1.67	Dave's Perc conflict	5		
SD	1.67	.40	1.74	.64	Adrian's Perc conflict	4		
PAIR 2			James	Kirk				
Trait	James	Kirk	Dist	Dist	Index	Covar	corr	Zcorr
Neur	3	1	.00	−2.00	Overall Sim =	1.000	.466	.505
Ext	3	3	−.17	−.17	Dist Sim =	.084	.126	.127
Open	2	5	−.33	2.67	James Norm =	.987	.980	2.289
Agree	<u>5</u>	<u>6</u>	.83	1.83	Kirk Norm =	.633	.422	.450
Consc	<u>5</u>	<u>5</u>	<u>.33</u>	<u>.33</u>				
M	3.6	4	.13	.53	James' Perc conflict	3		
SD	1.20	1.79	.41	1.62	Kirk's Perc conflict	4		
PAIR 3			Glenn	Ken				
Trait	Glenn	Ken	Dist	Dist	Index	Covar	corr	Zcorr
Neur	5	1	2.00	−2.00	Overall Sim =	1.200	.532	.593
Ext	6	3	2.83	−.17	Dist Sim =	−.242	−.219	−.223
Open	3	2	.67	−.33	Glenn Norm =	.633	.689	.846
Agree	5	4	.83	−.17	Ken Norm =	1.513	.876	1.358
Consc	<u>6</u>	<u>7</u>	<u>1.33</u>	<u>2.33</u>				
M	5	3.4	1.53	−.07	Glenn's Perc Conflict	2		
SD	1.10	2.06	.80	1.38	Ken's Perc conflict	1		
Normative								
Profile								
Trait	Mean							
Neur	3.00							
Ext	3.17							
Open	2.33							
Agree	4.17							
Consc	<u>4.67</u>							
M	3.47							
SD	.84							
Variance of normative profile = .704								

Variance of normative profile = .704

Table 2

Dyad-level structure for path analysis of profile similarity/normativeness data in Table 1.

Dyad	Indiv 1	Indiv 1	Indiv 2	Indiv 2	Ovl	Dist
	Norm	Conf	Norm	Conf	Sim	Sim
1	.168	5	.820	4	.690	.658
2	2.289	3	.450	4	.505	.127
3	.846	2	1.358	1	.593	-.223

Table 3

Syntax for path analysis via SAS 9.3.

Model Description	Syntax
Interdependence and/or Mean levels	
Model 1: Individual-level variable	proc calis method = ml; Cov ilnorm i2norm = normcorr; Variance ilnorm = normvar, i2norm = normvar; Mean ilnorm = normmean, i2norm = normmean;
Model 2: Dyad-level variables	proc calis method = ml; Variance ovlsim = osimvar; Mean ovlsim = osimmean;
<u>Associations</u>	
Model 3: Actor effects on individual-level outcomes	proc calis method = ml; Lineqs ilconflict = conint Intercept + act ilnorm + eilcon, i2conflict = conint Intercept + act i2norm + ei2con; Cov ilnorm i2norm = normcorr, eilcon ei2con = resconcorr; Variance ilnorm = normvar, i2norm = normvar, eilcon = econvar, ei2con = econvar; Mean ilnorm = normmean, i2norm = normmean;
Model 4: Partner effects on individual-level outcomes	proc calis method = ml; Lineqs ilconflict = conint Intercept + part i2norm + eilcon, i2conflict = conint Intercept + part ilnorm + ei2con; Cov ilnorm i2norm = normcorr, eilcon ei2con = resconcorr; Variance ilnorm = normvar, i2norm = normvar, eilcon = econvar, ei2con = econvar; Mean ilnorm = normmean, i2norm = normmean;
Model 5: Actor and partner effects on individual-level outcomes (Full APIM)	proc calis method = ml; Lineqs ilconflict = conint Intercept + part ilnorm + part i2norm + eilcon, i2conflict = conint Intercept + part ilnorm + act i2norm + ei2con; Cov ilnorm i2norm = normcorr, eilcon ei2con = resconcorr; Variance ilnorm = normvar, i2norm = normvar, eilcon = econvar, ei2con = econvar; Mean ilnorm = normmean, i2norm = normmean;
Model 6: Dyad-level effects on individual-level outcomes	proc calis method = ml; Lineqs ilconflict = conint Intercept + bsim ovlsim + eilcon, i2conflict = conint Intercept + bsim ovlsim + ei2con; Cov eilcon ei2con = resconcorr; Variance ovlsim = osimvar, eilcon = econvar, ei2con = econvar; Mean ovlsim = ovlsimmean;
Model 7: Individual-level effects on dyad- level outcomes	proc calis method = ml; Lineqs dmutual = mutint Intercept + bnorm ilnorm + bnorm i2norm + emut; Cov ilnorm i2norm = normcorr; Variance ilnorm = normvar, i2norm = normvar, emut = evarmut; Mean ilnorm = normmean, i2norm = normmean;
Model 8: Dyad-level effects on dyad-level outcomes	proc calis method = ml; Lineqs dmutual = mutint Intercept + bsim ovlsim + emut; Variance ovlsim = osimvar, emut = emutvar; Mean ovlsim = osimmean;
Model 9: Full APIM with a triadic group	proc calis method = ml; Lineqs ilconflict = conint Intercept + act ilnorm + part i2norm + part i3norm + eilcon, i2conflict = conint Intercept + part ilnorm + act i2norm + part i3norm + ei2con, i3conflict = conint Intercept + part ilnorm + part i2norm + act i3norm + ei3con; Cov ilnorm i2norm i3norm = normcorr, eilcon ei2con ei3con = resconcorr; Variance ilnorm = normvar, i2norm = normvar, i3norm = normvar, eilcon = econvar, ei2con = econvar, ei3con = econvar; Mean ilnorm = normmean, i2norm = normmean, i3norm = normmean;

Table 4

Intraclass correlations, means, and variances of personality similarity data.

Variable	ICC	<i>t</i>	<i>p</i>	Mean	<i>t</i>	<i>p</i>	Var	<i>t</i>	<i>p</i>
<i>Individual-level (Model 1)</i>									
Normativeness ^a	.130	2.777	<.01	.542	49.871	<.0001	.115	20.801	<.0001
Friendship	.545	16.239	<.0001	3.811	72.519	<.0001	1.573	18.422	<.0001
Conflict	.447	11.729	<.0001	1.700	48.377	<.0001	.750	19.148	<.0001
Want transfer	.130	2.770	<.01	1.421	54.724	<.0001	.525	20.802	<.0001
Burnout	.080	1.683	NS	2.464	61.306	<.0001	1.316	20.910	<.0001
Self-esteem	.111	2.361	<.05	3.860	118.500	<.0001	.840	20.847	<.0001
<i>Dyad-level (Model 2)</i>									
Overall Sim ^a				.307	22.923	<.0001	.084	14.832	<.0001
Distinctive Sim ^a				.051	4.224	<.0001	.065	14.832	<.0001
Pairing process				.231	11.493	<.0001	.178	14.832	<.0001
Dyad gender				.592	25.230	<.0001	.242	14.832	<.0001

Note. Models are presented in Table 3 and Figure 2.

Dyad pairing coded: 0 = random, 1 = self-paired. Dyad gender coded: 0 = male, 1 = female. N = 441 dyads, 882 individuals.

^aSignificance tests are based on Fisher-transformed values, but means have been transformed back onto the correlational metric.

Table 5

Associations between similarity/normativeness and criterion variables.

Dependent variable	Models and predictors					
	Model 3	Model 4	Model 5		Model 6a	Model 6b
		Partner		Partner	Overall	Dist
	Norm	Norm	Norm	Norm	Sim	Sim
<i>Individual-level dependent variables</i>						
Want transfer	-.211 ***	-.015	-.211 ***	-.014	-.122 ***	.000
Burnout	-.269 ***	-.044	-.268 ***	-.024	-.126 ***	.023
Self-esteem	.459 ***	.188 ***	.444 ***	.106 ***	.264 ***	-.020
Friendship	.017	.080 **	.065 *	.109 ***	.144 ***	.095 *
Conflict	-.048	-.039	-.069 *	-.062†	-.097 *	-.041
	Model 7				Model 8a	Model 8b
<i>Dyad-level dependent variables</i>						
Pairing process	.006				.098 *	.141 **
Gender	.132 ***				.173 ***	.072

Note. Models are presented in Table 3. Dyad pairing coded: 0 = random, 1 = self-paired. Dyad gender coded: 0 = male, 1 = female. Values are standardized path coefficients (slopes). $N = 441$ dyads, 882 individuals.

*
 $p < .05$.

**
 $p < .01$.

 $p < .001$.

 $p < .0001$.