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Person-Oriented Approaches within a Multi-Level Perspective

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Abstract: I propose that empirical psychology should study individual characteristics at *both* the person and the population level because both exclusively person-oriented analyses and exclusively population-oriented analyses are seriously limited. Multi-level regression models are well suited for this task because they simultaneously estimate within-person and between-person parameters, and do not require many assessments within persons, but can nevertheless easily model complex within-person relations. I illustrate application of such models with a three-level model of the intraindividual change of relationship-specific interpersonal conflict during an important life transition.

Keywords: person-oriented analysis, multi-level model, social relationships, development, longitudinal

Person-oriented (or person-centered) approaches in psychology focus on psychologically meaningful *patterns* of individual characteristics of persons, their variation across situations, their dynamics over time, and important life outcomes *within a person* (see Asendorpf, 2014, for a recent overview). Variable-oriented approaches isolate psychologically meaningful characteristics on which individuals reliably differ (traits), and study their correlational structure, their consistency across situations, their stability and change over time, and their predictive validity for important life outcomes. Because variable-oriented approaches focus on interindividual differences in one or few variables whereas person-oriented approaches focus on intraindividual differences (patterns) of a few or many variables, the term "variable-oriented" makes sense.

However, "variable-oriented" seems to me a suboptimal description of the second approach because most empirical person-oriented studies include variables too, even in the case of single-case studies; what is different in this case is only that variation is within a person, not across persons. More adequate seem to me terms such as "population-oriented" because variable-oriented approaches focus on characteristics of populations. If the population changes within which a person is studied from a variable-oriented perspective, the characteristics of that person very likely change even if the person remains the same from a person-oriented perspective because most person characteristics are measured relative to their distribution in the population.

Also, the pair "person- versus population-oriented" explicitly describes the fact that the two approaches refer to two different levels of analysis and generalization: (a) the level of persons where results apply to this person, not necessarily to other persons of the same population, and (b) the level of the population where results apply to this population, not necessarily to most or even any person in the population (e. g., the mean of a trait in a population may not characterize anyone in the population).

This paper makes two key propositions. First, empirical psychology should study individual characteristics at *both* levels because an exclusively person-oriented analysis is silent about the extent to which the results apply only to this person, some other persons, or all persons in the population, and because an exclusively population-oriented analysis is silent about the extent to which the results apply to any specific person in the population. Second, multi-level regression models are well suited for this task because they simultaneously estimate within-person and between-person parameters, and do not require many assessments within persons, but can nevertheless easily model

complex within-person relations.

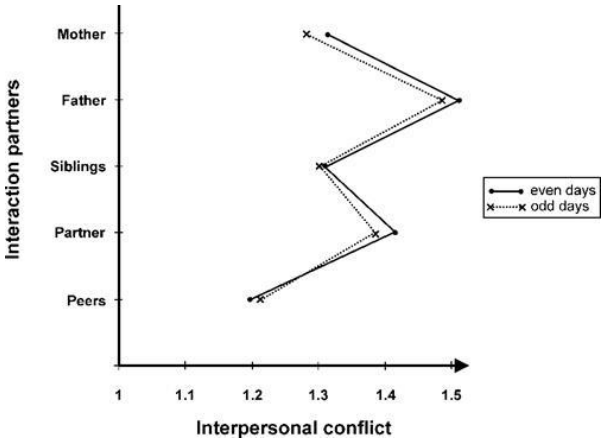

Figure 1. Profiles of interpersonal conflict by interaction partner reported by one student on odd and even days in a three-week diary (reprinted from Asendorpf, 2014, Fig. 2a, with permission by the American Psychological Association).

Limited Utility of Person-Oriented Results

Consider the two profiles depicted in Figure 1 that are based on diary data obtained from a Berlin undergraduate student (Asendorpf & Wilpers, 1998). The student was asked to report over a period of three weeks any lengthy or emotionally significant social interaction and to rate each interaction on various scales including a scale for reporting the degree of interpersonal conflict with the interaction partner. Ratings were averaged for interactions with the same type of interaction partner, separately for odd and even days of the diary. The resulting cross-situational profiles suggest stable tendencies to have more conflict in interactions with the father and the romantic partner than with the mother, the siblings, and peers. Because of their consistency, the profiles describe a reliable person characteristic that is best captured by the mean of the two profiles.

What does this mean profile tell us about the uniqueness of the student in terms of interpersonal conflict? Nothing - unless we know what the profiles of other students look like. In fact, the mean of the two profiles in Figure 1 is identical with the average profile of all participants in the Asendorpf and Wilpers (1998) study. Therefore, the profiles of the student in Figure 1 can be interpreted as average in every respect. If we were to guess how the student's profile might look without having observed this student (but a sufficiently large sample of other students), the average of the two profiles in Figure 1 is the best bet because it maximizes accuracy by relying on stereotype accuracy (Cronbach, 1955), that is, on knowledge about the average profile in the sample. Without a comparison with other students, the profiles obtained for the target student provide little insight into the student's unique interpersonal conflicts.

A result obtained by exclusively person-oriented analysis, without reference to a comparison group of other persons, is similarly limited as the result for a clinical group without comparison to a control group. Exclusively person-oriented single-case studies are useful in the context of biography or historiometry (see Simonton, 1998, for a nice example of the lagged influence of personal and political stress on the mental and physical health of "crazy" British King George III). But whenever we want to generalize beyond a particular individual to other members of a population (kings, politicians, ordinary people etc.), we additionally need population-oriented analyses.

Limited Utility of Population-Oriented Results

Population-oriented results most often rely on averages across persons, and therefore it can be misleading to interpret population-oriented results in terms of patterns within individual persons which are, or should be, the focus of psychological research. A classic example is the correlation between angriness and happiness (population level) versus the correlation between being angry and being happy (person level). In diary studies where participants report the intensity of emotions in particular situations (see already Epstein, 1983), angriness (the average report of being angry across all situations) and happiness (the average report of being happy across all situations) correlate only slightly negatively because of interindividual differences in the overall tendency to report intense emotions (some "unemotional" participants report both low angriness and low happiness, others report both high angriness and high happiness). In contrast, being angry and being happy correlate strongly negatively across situations within persons, because situations where one experiences mixed angry-happy emotions are rare. It would be misleading to infer from a correlation at the higher level (sample of participants) the same correlation at the lower level (sample of situations within participants).

The correlations can even have a different sign. For example, Cacioppo et al. (1992) measured students' physiological arousal and facial expressions of fear in multiple situations and reported a positive correlation between students' average frequency of skin conductance responses at the population level, but a negative correlation between skin responses and fear expressions across situations within most students (i.e., at the person level). After correction for attenuation, correlations at the higher level can be expected to be identical with those at the lower level only if the condition of ergodicity is met, which is rarely the case in psychology (see Molenaar, 2004, and Molenaar & Campbell, 2009).

Ergodicity requires that the intraindividual pattern is sta-

tionary across time and that the intraindividual pattern is the same for all individuals in the sample. Consider again the example illustrated in Figure 1. Ergodicity requires that the pattern of conflict is stationary (stable across time) and identical for all persons. Whereas most (but not all) students showed a highly stable pattern when odd and even days were compared, the patterns varied strongly. In fact, only a subsample reported their highest conflict with the father; others reported highest conflict with the mother, the partner, or a sibling.

More generally, ergodicity requires the absence of interindividual differences in the intraindividual patterns such that it would suffice to study one individual as a representative of the population. Ebbinghaus (1885) studied his own memory processes because he thought that his memory would be representative for all humans, but his student Stern (1911) recognized the ubiquitous nature of interindividual differences, and for the first time clearly distinguished between correlations within and between persons. If ergodicity applies to more complex intraindividual patterns at all, it is extremely rare. Therefore, it is necessary to study *both* the intraindividual and the interindividual variation of psychological mechanisms in order to understand the causal processes underlying them.

Multi-Level Analysis

Multi-level analysis offers statistical tools for a simultaneous analysis of person- and population-oriented effects. This approach is increasingly used in longitudinal studies of personality change and in diary studies of emotional states and social behavior although its potential for the person-centered perspective has been rarely recognized (but, see Asendorpf, 2014).

First, for each person a linear regression is fitted to the person's data. For example, time may be scaled from the beginning of a diary study to its end, and reports of interpersonal conflict may be regressed on time (describing linear change), any other function of time such as time squared (describing quadratic change), or both simultaneously. The person-specific intercepts and slopes are the Level 1 parameters of the model. Interindividual differences in these parameters are then regressed at Level 2 on stable person characteristics such as age, sex, or personality. For example, one might assume that agreeableness would predict a low intercept in conflict, and little change in life transitions when interpersonal relationships are challenged such as leaving one's family of origin, becoming a parent, or separation from a partner.

The regression at Level 1 constitutes the person-oriented part of the model, the regressions at Level 2 constitute its population-oriented part. Although the two levels could be separately analyzed with ordinary regressions, multi-level models use information about both levels for estimating the parameters by weighting them according to their fit to the assumed linear model (empirical Bayes estimates; see e. g. Raudenbush & Bryk, 2002). The advantage is that the standard errors of the estimates are smaller but it should be noted that if the multi-level model does not adequately describe the data, bias is introduced.

A main advantage of using multi-level models is that intra- and interindividual effects are explicitly modeled which prevents confusion in the interpretation of the findings. Interindividual effects are modeled as cross-level moderations of intraindividual effects which helps interpreting more complex effects such as moderation of the change in interpersonal conflicts by a personality trait.

Two levels are the mimimum for analyzing data from both a person- and a population-oriented perspective. Such two-level models can be easily expanded to three-level models that introduce a second person-oriented level, resulting in richer person-oriented information. For example, the diary data on interpersonal conflict can be analyzed with a three-level model. The lowest level (time) and the highest level (persons) remain the same but an intermediate second level is introduced where personal relationships are the units of analysis. Thus, moderation of the person-specific intercepts and slopes of interpersonal conflict by relationship can be analyzed (e.g., is the mean conflict with mother higher than the mean conflict with father, and does the conflict with father increase more or less than the conflict with mother)?

At Level 3, moderation of the Level 1 and the Level 2 effects can be studied (e.g., is the increase of conflict related to agreeableness [Level 3 moderation of Level 1 effect], and is increase of conflict with father relative to conflict with mother related to the participant's agreeableness? [Level 3 moderation of Level 2 effect]). Note that the Level 2 effects are based on contrasts between relationships *within persons* and therefore provide information from a person-oriented perspective. Only at Level 3 are population-oriented effects estimated.

Empirical Example: Three-Level Model of Interpersonal Conflict

The following example illustrates the application of such a three-level model to interpersonal conflict data. Because long-term trends in interpersonal conflict are expected to be very small within a three-week diary, I do not describe an application of a three-level model to these diary data. Instead, I apply the model to longer-term trends in the same participants obtained over the first 18 months at the university, with assessments of relationship-specific interpersonal conflict every three months (see Asendorpf & Wilpers, 1998, 2000).

Method

Participants and Design

When students of Humboldt University, Berlin, enrolled a few weeks before their first term opened, they were personally contacted and asked to participate in a longitudinal study on students' social relationships. Only students below 23 years of age were included. During the second week of their first term, 173 females and 64 males participated in the first session (see Asendorpf & Wilpers, 1998, for more details). Because of the smaller male sample, the study was repeated one year later with a second sample of 75 males. Because the results for the two male samples were virtually identical with regard to all major variables, the two male samples were pooled, resulting in a more balanced study with regard to subjects' sex (173 females, 139 males; see Asendorpf & Wilpers, 2000).

Students' social relationships were assessed every three months over a period of 18 months (7 assessments; the first took part in the second week of the first term). In addition, the present analysis includes only the first assessment of personality (which was also later assessed every 6 months). The sample for the present analysis consists of those 163 heterosexual participants who participated in the first and the last assessment. An attrition analysis showed that this longitudinal sample was not different from the drop-outs in terms of the Big Five personality traits and the social network characteristics except for significantly higher conscientiousness. Thus, the results underestimate effects of conscientiousness.

Measures

Personality. The *Big Five* factors of personality were assessed in the second week of the first term by the German version of the NEO-FFI by Costa and McCrae (Borkenau & Ostendorf, 1993).

Social relationships. Students' social relationships were assessed every three months with an ego-centered social network approach. In the first assessment, subjects were asked to list all persons that were currently personally important to them. To minimize errors of omission, we asked them to check 17 categories of relationships; all listed persons were identified by their initials, relationship category, sex, age, and relationship duration. Also, the quality of the subject's relationship with each person during the last 3 months was rated scalewise on 8 Likert scales. The present analysis uses the categories *mother*, *father*, *sibling*, *partner* (married, engaged, or serious relationship), peers (any person aged 18-27 years, excluding siblings and partner), *OTHER* (all other relationships); peers were categorized as either *old peers* (relationship began before the first term) or *new peers* (relationship began after the start of the first term). Of the relationship quality ratings, only the rating of *conflict* is considered here (5-point scale 1-5, from "never" to "nearly at every encounter").

In the following 6 assessments, the participants received an outprint of their last questionnaire excluding the ratings of relationship quality. They were asked to delete those persons that they did not consider important any more, to check the data of the remaining persons for correctness, and to add new persons that were currently important to them. Subsequently, they rated the revised list of persons scalewise on the 8 scales for relationship quality since the last assessment.

Data Analysis

On average, the participants reported 63.18 different relationships, with 3.72 assessments for each relationship, resulting in a total of 38,293 assessments of 10,299 relationships. That only 3.72 reports of conflict were available on average for each relationship was due to ending of relationships, starting of new relationships, and missing assessment points between the first and the last assessment. The data have a nested structure, with time points nested in relationships which were in turn nested in individuals. It was modeled as a three-level random effects linear regression model. Level 1 represents time points, Level 2 relationships, and Level 3 individuals.

For each of the 10,299 relationships, a linear regression line was fitted to the available conflict ratings. Missing values at Level 1 present no problems for multi-level linear regression models because regression lines are fitted to all available data points. Differences in the intercept and the slope of these regression lines across the relationships were modeled at Level 2, again within each individual. Finally, personality differences in the Level 2 intercepts and slopes were modeled at Level 3.

In multi-level regression models, the intercept refers to units of analysis with zeros at all levels. Time was centered at the first assessment and scaled in years such that the Level 1 intercept refers to conflict at the first assessment, and the slope refers to the change in conflict per year. The relationships at Level 2 were dummy-coded for the relationship categories mother, father, sibling, partner, old peers, new peers such that the Level 2 intercept of an individual refers to the average conflict of this individual across OTHER relationships of the individual at the first assessment (because OTHER was coded as zero in all dummy variables). The slope of a relationship category refers to the difference between the conflict in the relationships of this category of the individual and the conflict in OTHER relationships of the individual (e. g., the difference between conflict with mother and average conflict in OTHER relationships, or between the average conflict with all new peers versus OTHER relationships). Note that the dummy variables contrast relationship categories within individuals. The five personality dimensions were grand-mean centered such that the Level 3 intercept refers to the average conflict at the first assessment in OTHER relationships across all individuals, and the slopes to the average change of conflict in OTHER relationships resulting from a one point increase

in the personality trait (e. g., the extraversion slope for the Level 2 slope for mother refers to the extent to which the change in conflict per year in the conflict with mother changes relative to the change in OTHER relationships if extraversion is one point higher).

In terms of the multi-level regression equations, the equations read as follows (here I use the notations provided by the software HLM 7 that was used for the analyses; Raudenbush, Bryk, Cheong, Congdon, & du Toit, 2011):

Level-1 Model

CONFLICT = P0 + P1*(YEARS AT UNIVERSITY) + e

Level-2 Model

P0 = B00 + B01*(MOTHER) + B02*(FATHER) + B03*(SIBLING) + B04*(PARTNER) + B05*(OLD PEERS) + B06*(NEW PEERS) + r0

P1 = B10 + B11*(MOTHER) + B12*(FATHER) + B13*(SIBLING) + B14*(PARTNER) + B15*(OLD PEERS) + B16*(NEW PEERS) + r1

Level-3 Model

B00 = G000 + G001(NEUR) + G002(EXTR) + G003(OPEN) + G004(AGREE) + G005(CONSC) + u00

B01 = G010 + G011(NEUR) + G012(EXTR) + G013(OPEN) + G014(AGREE) + G015(CONSC) + u01

B02 = G020 + G021(NEUR) + G022(EXTR) + G023(OPEN) + G024(AGREE) + G025(CONSC) + u02

B03 = G030 + G031(NEUR) + G032(EXTR) + G033(OPEN) + G034(AGREE) + G035(CONSC) + u03

B04 = G040 + G041(NEUR) + G042(EXTR) + G043(OPEN) + G044(AGREE) + G045(CONSC) + u04

B05 = G050 + G051(NEUR) + G052(EXTR) + G053(OPEN) + G054(AGREE) + G055(CONSC) + u05

B06 = G060 + G061(NEUR) + G062(EXTR) + G063(OPEN) + G064(AGREE) + G065(CONSC) + u06

B10 = G100 + G101(NEUR) + G102(EXTR) + G103(OPEN) + G104(AGREE) + G105(CONSC) + u10

B11 = G110 + G111(NEUR) + G112(EXTR) + G113(OPEN) + G114(AGREE) + G115(CONSC) + u11

B12 = G120 + G121(NEUR) + G122(EXTR) + G123(OPEN) + G124(AGREE) + G125(CONSC) + u12

B13 = G130 + G131(NEUR) + G132(EXTR) + G133(OPEN) + G134(AGREE) + G135(CONSC) + u13

B14 = G140 + G141(NEUR) + G142(EXTR) + G143(OPEN) + G144(AGREE) + G145(CONSC) + u14

B15 = G150 + G151(NEUR) + G152(EXTR) + G153(OPEN) + G154(AGREE) + G155(CONSC) + u15

B16 = G160 + G161(NEUR) + G162(EXTR) + G163(OPEN) + G164(AGREE) + G165(CONSC) + u16

The Pi, Bij and Gijk are unstandardized regression coefficients for the intercepts and slopes.

This approach of dummy-coding the more meaningful relationship categories assigns a key role to the remaining OTHER relationships because it is the standard to which all other relationship categories are compared. For example, the significance of the change in conflict with the mother refers to the difference between the change in conflict with mother and the change in conflict with OTHER relationships. Nevertheless it is possible to compare any two relationship categories with one another, or define more complex contrasts between more than two categories, by testing appropriate Level 2 contrasts between the dummy variables. Similarly, differences between the intercepts or slopes of two or more personality traits can be tested by appropriate Level 3 contrasts.

Results

A model without any predictors showed that 41.9% of the variance in the conflict ratings were due to differences at Level 2 (relationships), and an additional 14.0% to differences between individuals (both variance components were highly significant, $p < .001$). Adding years at the university as a predictor at Level 1 increased the explained Level 1 variance by 11%, adding the dummy-coded relationships at Level 2 increased the explained Level 2 variance by 24%, and adding the personality scales at Level 3 increased the explained Level 3 variance by 13% (in each case, $p < .001$). The effect of time spent at the university and its moderation by relationship category and the Big Five personality traits are presented in Table 1.

The Level 3 intercepts provide overall information across individuals for the initial level and change of conflict in relationships by relationship category. Thus, the average initial conflict in OTHER relationships was 1.543 on the 1 - 5 point scale, and increased marginally by 0.042 points per year at university. Initial conflict with mother was 1.136 points higher, thus 2.679, and significantly changed by 0.042 – 0.106 = -0.064 points per year. Therefore, the estimated average conflict with mother after 18 months at university was 2.679 - 1.5·0.064 = 2.583. Table 1 indicates that compared to OTHER relationships, conflict was initially higher with members of one's family of origin and the partner, slightly higher with pre-university peers, and lower with new peers. Conflict with mother decreased, and conflict with the partner and with new peers increased.

These overall trends are moderated by personality; note that each effect of a Big Five trait is controlled for the effects of the other four traits, so that the personality effects are unique effects. Table 1 suggests that initial conflict in all non-peer relationships was uniquely and positively related to neuroticism (for OTHER 0.217, for mother 0.217 + 0.171, etc.) whereas this relation was significantly less marked in peer relationships (e.g., for new peers only 0.217 – 0.165 = 0.052). Furthermore, neuroticism was uniquely related to a decrease of conflict in OTHER relationships (-0.100) and an increase in the relationship with the father (-0.100 + 0.280 = 0.180). Agreeableness was initially uniquely negatively related to conflict in all relationships,

Table 1
Effect of Time at University on Conflict and its Moderation by Relationship Category and Personality

	Level 1 Intercept P0					Level 1 Slope P1				
Effect		*b*	*SE*	*t*	*p*		*b*	*SE*	*t*	*p*
Other relationships	B00					B10				
- Level 3 intercept	G000	1.543	0.031	49.50	.000	G100	0.042	0.024	1.72	.087
- Neuroticism	G001	0.217	0.055	3.92	.000	G101	-0.100	0.040	-2.52	.013
- Extraversion	G002	0.098	0.060	1.62	.107	G102	-0.081	0.060	-1.35	.178
- Openness	G003	0.112	0.063	1.79	.076	G103	-0.058	0.048	-1.19	.235
- Agreeableness	G004	-0.116	0.051	-2.25	.026	G104	0.056	0.055	1.02	.308
- Conscientiousness	G005	-0.084	0.051	-1.64	.102	G105	0.032	0.038	0.83	.407
Mother	B01					B11				
- Level 3 intercept	G010	1.136	0.075	15.12	.000	G110	-0.106	0.046	-2.32	.022
- Neuroticism	G011	0.171	0.122	1.40	.164	G111	0.046	0.090	0.51	.612
- Extraversion	G012	0.309	0.163	1.87	.060	G112	-0.118	0.095	-1.25	.215
- Openness	G013	-0.216	0.151	-1.43	.155	G113	0.050	0.086	0.57	.567
- Agreeableness	G014	-0.381	0.147	-2.58	.011	G114	0.090	0.090	1.00	.321
- Conscientiousness	G015	-0.183	0.128	-1.43	.156	G115	0.084	0.077	1.10	.274
Father	B02					B12				
- Level 3 intercept	G020	1.070	0.074	14.50	.000	G120	-0.050	0.050	-1.01	.316
- Neuroticism	G021	-0.024	0.116	-0.21	.834	G121	0.280	0.078	3.34	.001
- Extraversion	G022	0.143	0.156	0.92	.361	G122	0.132	0.098	1.35	.179
- Openness	G023	-0.107	0.127	-0.84	.403	G123	0.038	0.092	0.41	.683
- Agreeableness	G024	-0.171	0.176	-0.97	.333	G124	0.066	0.107	0.62	.534
- Conscientiousness	G025	-0.034	0.116	-0.30	.769	G125	0.115	0.080	1.43	.154
Sibling	B03					B13				
- Level 3 intercept	G030	0.788	0.069	11.41	.000	G130	-0.073	0.049	-1.49	.138
- Neuroticism	G031	0.002	0.115	0.01	.989	G131	0.042	0.080	0.53	.599
- Extraversion	G032	0.300	0.138	2.17	.031	G132	-0.121	0.103	-1.18	.242
- Openness	G033	-0.357	0.126	-2.83	.005	G133	0.126	0.092	1.37	.173
- Agreeableness	G034	-0.258	0.160	-1.61	.109	G134	-0.031	0.107	-0.29	.772
- Conscientiousness	G035	0.216	0.113	1.92	.057	G135	-0.037	0.085	-0.44	.662
Partner	B04					B14				
- Level 3 intercept	G040	0.794	0.124	6.41	.000	G140	0.458	0.143	3.21	.002
- Neuroticism	G041	0.014	0.289	0.05	.961	G141	0.141	0.235	0.60	.548
- Extraversion	G042	0.127	0.243	0.52	.603	G142	-0.017	0.284	-0.06	.951
- Openness	G043	-0.088	0.254	-0.35	.730	G143	-0.012	0.258	-0.05	.962
- Agreeableness	G044	0.630	0.276	2.28	.024	G144	-0.768	0.309	-2.48	.014
- Conscientiousness	G045	-0.094	0.232	-0.41	.686	G145	-0.014	0.242	-0.06	.955
Old peers	B05					B15				
- Level 3 intercept	G050	0.144	0.029	4.99	.000	G150	-0.022	0.024	-0.91	.365
- Neuroticism	G051	-0.102	0.050	-2.02	.045	G151	0.127	0.046	2.77	.006
- Extraversion	G052	-0.135	0.062	-2.17	.032	G152	0.143	0.064	2.22	.028
- Openness	G053	-0.022	0.057	-0.39	.698	G153	-0.009	0.054	-0.16	.874
- Agreeableness	G054	0.010	0.056	0.18	.855	G154	-0.056	0.057	-0.98	.328
- Conscientiousness	G055	-0.031	0.041	-0.75	.453	G155	-0.016	0.039	-0.42	.676
New peers	B06					B16				
- Level 3 intercept	G060	-0.165	0.031	-5.31	.000	G160	0.129	0.029	4.49	.000
- Neuroticism	G061	-0.144	0.049	-2.93	.004	G161	0.119	0.044	2.68	.008
- Extraversion	G062	-0.085	0.055	-1.55	.124	G162	0.120	0.060	1.99	.049
- Openness	G063	-0.148	0.058	-2.54	.012	G163	0.097	0.051	1.91	.058
- Agreeableness	G064	-0.044	0.054	-0.83	.410	G164	-0.044	0.055	-0.76	.447
- Conscientiousness	G065	0.017	0.048	0.36	.720	G165	-0.001	0.045	-0.02	.985

Note. Reported are unstandardized regression coefficients *b* with standard error *SE* and t-test for significance with *df*=157.

and this negative relation did not significantly change, except for the partner where it was initially positively related to conflict (0.630 - 0.116 = 0.514), with decreasing strength (-0.768 + 0.056 = -0.712). Thus, after one year, agreeableness was estimated to be already negatively related to conflict with the partner. The findings for partner should be considered with caution because partner relationships were relatively rare, particularly at the first assessment (only 23% of the participants reported a partner) whereas all other relationship categories were much more frequent.

A problem of the present analyses is that the Level 1 intercepts (conflict at the first assessment) are estimated not only for relationships present at this time but also for relationships starting later (most new peer relationships and most partner relationships). If a positive (or negative) linear change is estimated for such relationships, the intercept is lower (or higher) than the actual rating at the beginning of the relationship because it is extrapolated backwards to the first assessment. Therefore the results for the initial level of the relationships have to be considered with caution, particularly for the partner and new peers. Alternatively, one could use relationship duration as the time scale but this might introduce even stronger biases because conflicts before entering the university would be estimated on the basis of conflicts after entering university. Another approach is using the onset of each relationship as an additional predictor at Level 2 such that the Level 2 and Level 3 effects are controlled for onset; including this control variable did however only slightly change the results reported in Table 1.

Discussion

The present example of a three-level analysis of relationship change during an important life transition illustrates how rich person-oriented data on relationship dynamics can be combined with population-oriented data on personality traits. The person-oriented part in this example concerned the first two levels of analysis: conflict level and change by relationship category. Interindividual differences in the indices resulting from these data were explained to some extent by personality traits.

As in all empirical analyses of psychological data, measurement issues are of utmost importance when it comes to the question to which extent the results are informative about person characteristics and/or about characteristics of the population (see Asendorpf, 2014, for an extensive discussion). For example, an individual profile based on absolute measures such as raw points in multiple IQ subtests or time spent with particular activities is independent of other individuals, whereas a profile based on IQ scores or *z*-scores is dependent on the normative sample for the IQ test or the sample used for standardization. In both cases, the profiles may be considered "idiographic" although they are based on "nomothetic" information in the second case (see Asendorpf, 2014, for an extensive discussion).

Of similar importance in multi-level analysis is *centering* of the data at the various levels. Consider again the three-level model described here. Time was centered at the beginning of the observation; this was psychologically meaningful because the zero point marked the beginning of a developmental transition. Time could be grand-mean centered such that zero represents the average of all observations, but in this case the intercepts of the Level 1 regressions would be less clearly interpretable because zero would deviate somewhat from the midpoint of the observation interval of 18 months due to missing assessments. Also, time could be centered within each relationship or each individual which would even more hinder interpretation of the zero point and the intercepts. Different interpretations of the results due to different centering of the Level 2 data (zero point represents OTHER category versus average relationship) were already discussed above.

The empirical example described in this paper can be extended into many different directions. Instead of time, any relationship quality could serve as the Level 1 predictor. For example, emotional closeness could serve as the Level 1 predictor for conflict. In this case, the Level 1 slope describes how conflict is related to emotional closeness across time within each relationship. The resulting relations could be averaged within various relationship categories at Level 2, and these category-specific within-individual relations could be explained by stable characteristics of the participants including personality. In all such cases, the results provide information about interindividual differences in within-person processes.

The approach chosen in the present example was a three-level model where intraindividual patterns of conflict across relationship categories made up Level 2, and interindividual differences in these patterns made up Level 3. Alternatively one could use a *multivariate* two-level model with time at Level 1 where the Level 1 equation describes changes of conflict patterns across time; these patterns would be represented by dummy variables that code relationship category (see Hox, 2010, chapter 10). The changes in the dummy variables would be assumed to vary across individuals who constitute Level 2. This would, however, require that the averages of conflict within relationship category would be computed category by category before the multi-level model is applied, losing the information about how reliable the average is. Thus, the peer conflict score of an individual which was based on two peers would have the same weight as the peer conflict score of an individual based on 20 peers. In contrast, the three-level model described here weights the conflict data according to their reliability at Level 2. This advantage would only be lost if each relationship category would include only one relationship (e. g., a study of relationships with mother, father, sibling of most similar age, partner, and best friend). The three-level model better captures the fact that there can be

multiple relationships of the same type.

A great advantage of multi-level regression models is that a high number of units of analysis is required only at the highest level (in the present case: individuals) because significance tests refer to this level. At least 50 units are required for the highest level (Hox, 2012; Raudenbush & Bryk, 2002) but at lower levels even two units are sufficient if the data at this level are reliably assessed (e. g., in research on couples; see Kenny, Kashy, & Cook, 2006). In contrast, other person-oriented methods such as intraindividual time series analysis (e. g., Molenaar, Sinclair, Rovine, Ram, & Corneal, 2009) require many assessments at the lowest level (time) that conventional longitudinal studies and most diary studies do not provide. Multi-level regression models are a flexible tool for person-oriented research that can be applied to a wide array of study designs.

Last but not least, application of multi-level analysis helps us think more clearly about interindividual versus intraindividual effects and their underlying psychological mechanisms. Psychologists unfamiliar with multi-level analysis often confuse psychological mechanisms at different levels when they interpret their data. Referring again to the examples in the introduction, the low negative correlation between angriness and happiness in diary studies (Epstein, 1983) may be misinterpreted in terms of many mixed-emotion situations. Or from the positive correlation between students' average frequency of skin conductance responses and their average expression of fear across different situations (Cacioppo et al., 1992), it may be wrongly concluded that the more one increases the frequency of skin conductance responses with a stress induction procedure, the more fear will be shown. Framing these studies in terms of a multi-level data structure is extremely helpful to avoid such mistakes based on a confusion between levels of analysis.

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