MIXTURE MODELS FOR INTRAPERSONAL DATA

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MODEL-BASED CLUSTERING METHODS: THE IDEA OF MIXTURE MODELING

Variable-oriented methods: e.g., regression and path models, ANOVA
Investigating (often linear) associations between the variables

Model-based clustering methods: mixture modeling
Identification of subgroups of individuals based on the certain model parameters

Person-oriented methods – e.g., clustering methods
Classification of individuals into subgroups based on pattern similarity
In mixture-modeling, C is the latent categorical variable including k classes (the number of latent groups, e.g., McLachlan & Peel, 2000).

**EXAMPLES OF DIFFERENT KINDS OF MIXTURE MODELS**

<table>
<thead>
<tr>
<th></th>
<th>Latent categorical variable C + observed variables continuous</th>
<th>Latent categorical variable C + Observed variables categorical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross-sectional models</td>
<td>* Latent profile analysis (LPA)</td>
<td>* Latent class analysis (LCA)</td>
</tr>
<tr>
<td></td>
<td>* Factor mixture modeling (FMA), mixture factor modeling (MFA), regression mixture modeling (RMM)</td>
<td></td>
</tr>
<tr>
<td>Longitudinal models</td>
<td>* Latent profile analysis (LPA)</td>
<td>* Latent transition analysis (LTA) (in LTA, observed variables can also be continuous)</td>
</tr>
<tr>
<td></td>
<td>* Factor mixture modeling (FMA), mixture factor modeling (MFA)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>* Growth mixture modeling (GMM)</td>
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<tr>
<td></td>
<td>* Regression mixture modeling (RMM)</td>
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</tbody>
</table>

⇒ All these models can also be to generalized in multilevel mixture modeling
⇒ Also multigroup mixture modeling is possible

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THE STEPS OF MIXTURE MODELING

Building a mixture model is similar to the traditional structural equation modeling.

The distinguishable stages in modeling are:

- a) specification of the model
- b) checking the identifiability of the model
- c) estimation of the model
- d) testing and evaluating overall fit of the model, and
- e) doing diagnostics of parameters of the model.

If the model fits the data poorly, parameters are non-significant, or the model needs some modification, it is possible to re-specify the model or to test alternative models. In this case, the process is repeated through the stages a-e.

Choice of the within class "overall" model is critical: what is overall model and based on which parameters latent groups are searched?

Model a: Uncorrelated latent profile analysis (LPA)

Model b: Correlated latent profile analysis

Model c: Mixture factor model

Model d: Factor mixture model
Next, I present one application of mixture modeling.

Entire reference of the paper is:


Also statistical equations and Mplus scripts are presented in the paper.
According to the emotion transmission paradigm, emotions within families – particularly negative ones – tend to spread and affect the family atmosphere and the interaction between family members (e.g., Almeida et al., 1999; Larson & Almeida, 1999).

Although it has been suggested that some children are more vulnerable to environmental effects than others due to their temperamental features (Belsky & Pluess, 2009), the role of a child’s temperament in emotion transmission has thus far not been examined.

The present study investigated the extent to which the negative daily emotions of fathers and children are transmitted in the father-child dyad, and the extent to which children’s temperamental negative emotionality influences these associations.

The notion that some individuals are more prone to emotion transmission than others (Larson & Almeida, 1999; Repetti & Wood, 1997) has prompted the need for a person-oriented approach to emotion transmission between partners.

Previous studies using a person-oriented approach have typically focused on examining different groups of individuals that differ in the pattern of values they show in relation to some criteria variables (Bergman & Magnusson, 1991; Bergman et al., 2003).

The present study expands previous person-oriented research by focusing on identifying patterns of transmission between dyads of partners rather than patterns of individual characteristics. From the methodological point of view, our study is one of the first to apply person-oriented analysis to examine transactional patterns between partners within dyads over several days.
PARTICIPANTS AND MEASURES

- Participants
  - 149 children from grade 1
  - 116 fathers
  ⇒ Parental questionnaire in grade 1 fall
  ⇒ Parental daily diary during seven days in grade 1 fall
- Measures
  - mother-rated children’s temperamental negative emotionality (questionnaire, alpha = .84)
  - children’s daily negative emotions, filled by a parent (average alpha = .78)
  - fathers’ reports of their own daily negative emotions (average alpha = .82)

Analysis strategy

- In the present study, we used both variable-oriented and person-oriented approaches to examine our research questions.
  ⇒ One objective was to compare the results of the person-oriented and variable-oriented analyses to see whether these analyses produced similar results and whether the person-oriented analyses provided a complementary understanding of the emotion transmission in father-child dyads
- All analyses were conducted using multilevel modelling in which the variation in children’s and fathers’ negative emotions was divided into between- and within-person variations.
ANALYSIS STRATEGY:
A variable-oriented approach to emotion transmission in the family (see Figure 1)

1. First, the prospective change model (Larson & Almeida, 1999) was utilized to examine the extent to which fathers’ emotions on a given day would predict changes in their children’s emotions from a given day to the next day, and vice versa.

2. Second, the prospective change model with a random slope was utilized to investigate the extent to which there is variation between father-child dyads in the strength of emotion transmission from fathers to children and, if so, whether children’s temperamental negative emotionality predict this variation, and individual differences in the overall emotion levels of children and their fathers.
ANALYSIS STRATEGY: A person-oriented approach to emotion transmission in the family (Figure 2)

- We used multilevel regression mixture analysis (Muthén & Asparouhov, 2009; Asparouhov & Muthén, 2008) to capture unobserved heterogeneity in emotion transmission from fathers to children by a categorical latent variable, that is, latent class.
- By estimating a between-level class variable on the basis of within-level emotion transmission, it was possible to examine whether there were naturally occurring homogeneous patterns of day-to-day interactions that differed according to the emotion transmission from fathers to children.
- The typicality of certain patterns of day-to-day interaction to the individual child-father dyad was predicted at the between-level by the child’s level of temperamental negative emotionality using multinomial logistic regression.

PERSON-ORIENTED APPROACH: naturally occurring homogeneous patterns of day-to-day interactions and predicting patterns with child’s negative emotionality (Figure 2)

⇒ Searching daily patterns of emotion transmission from fathers to children (within-level analysis)
⇒ Are there differences between individuals in the typicality of daily emotion transmission patterns?
⇒ Does child’s negative emotionality predict typicality of these patterns?
**ANALYSIS STRATEGY**

- All the analyses were carried out using the Mplus statistical package (Version 7.0; L.K. Muthén & Muthén, 1998–2015).
- Using the missing data method in models allowed all observations in the dataset to be used to estimate the parameters in the models.
- Because some of the variables were initially skewed, the parameters of the models were estimated using the MLR estimator. Scripts of Mplus input code for the analyses are presented as Appendix.

**RESULTS: Variable-oriented Approach to Emotion Transmission**

- Results of variable-oriented analyses with prospective change multilevel modeling showed, first, that emotions were, on average, not significantly transmitted in a father-child interaction (p > .05).
- However, the results of prospective change models with a random slope revealed that there was statistically significant variation between father-child dyads in the strength of emotion transmission from fathers to children (unstandardized estimate = .097, s.e. = .021, p < .001).
- In turn, there was no variation between father-child dyads in emotion transmission from children to their fathers (p > .05).
- Finally, because variation between father-child dyads in emotion transmission from fathers to children was found, children’s temperamentally negative emotionality was added to the model as a between-level variable in order to predict this variation, as well as variation in the level of children’s and fathers’ negative emotions (see Figure 3 and 4)
RESULTS: Person-oriented approach to emotion transmission

Four daily patterns of emotion transmission from fathers to children were identified using multilevel regression mixture analysis.

Table 2: Model Fit Indices and Entropy for Regression Mixture Models and Tests for Different Numbers of Latent Classes (N = 1018 days)

<table>
<thead>
<tr>
<th>Number of Classes</th>
<th>Log Likelihood</th>
<th>BIC*</th>
<th>BLRT</th>
<th>Entropy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-1387.715</td>
<td>3245.501</td>
<td>p &lt; .001</td>
<td>955</td>
</tr>
<tr>
<td>2</td>
<td>-1522.624</td>
<td>3162.504</td>
<td>p &lt; .001</td>
<td>955</td>
</tr>
<tr>
<td>3</td>
<td>-1520.727</td>
<td>3164.896</td>
<td>p &lt; .001</td>
<td>378</td>
</tr>
<tr>
<td>4</td>
<td>-1495.886</td>
<td>3140.837</td>
<td>p &lt; .001</td>
<td>825</td>
</tr>
<tr>
<td>5</td>
<td>-1513.348</td>
<td>3262.307</td>
<td>p &lt; .001</td>
<td>846</td>
</tr>
</tbody>
</table>

Note: BIC* = Sample-size adjusted Bayesian Information Criterion. The smaller the BIC value, the better the fit of the model. BLRT = Bootstrapped Likelihood Ratio Test of TR (compares solutions with different numbers of latent classes; significant values (p < .05) indicate that the k-1 class model has to be rejected in favor of a model with at least k classes). Entropy values range from 0 to 1, with values close to 1 indicating greater clarity in classification.

Table 3: The Results of the Final Four-Class Cluster Solution: Standardized Estimates for the Regression from Fathers’ Emotions (T2) to Children’s Emotions (T3) (β3), and Estimated Class Probabilities and Class Sizes (n of Days) for Each Latent Class

<table>
<thead>
<tr>
<th>Class</th>
<th>Standardized Estimate</th>
<th>Probability</th>
<th>n of Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1: low transmission</td>
<td>.815</td>
<td>&lt; .001</td>
<td>.832</td>
</tr>
<tr>
<td>Class 2: high transmission</td>
<td>.671</td>
<td>&lt; .001</td>
<td>.839</td>
</tr>
<tr>
<td>Class 3: moderate transmission</td>
<td>.963</td>
<td>&lt; .001</td>
<td>.839</td>
</tr>
<tr>
<td>Class 4: reverse transmission</td>
<td>.651</td>
<td>.207</td>
<td>.207</td>
</tr>
</tbody>
</table>

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RESULTS: Child’s negative emotionality as a predictor of typicality of daily patterns of emotion transmission from fathers to children

- The higher the child’s level of temperamental negative emotionality, the more typical it was for the father-child dyad to show a pattern of strong emotion transmission rather than a pattern of no emotion transmission.
- Furthermore, the higher the child’s level of temperamental negative emotionality, the marginally more typical it was to display a pattern of strong emotion transmission as compared to a pattern of reversed transmission.

<table>
<thead>
<tr>
<th>Class</th>
<th>Estimate (logit coefficient)</th>
<th>SE</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 4: strong transmission</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>vs. 1 (moderate transmission)</td>
<td>0.699</td>
<td>0.709</td>
<td>0.549</td>
</tr>
<tr>
<td>vs. 2 (no transmission)</td>
<td>2.081</td>
<td>0.722</td>
<td>0.000</td>
</tr>
<tr>
<td>vs. 3 (reversed transmission)</td>
<td>1.509</td>
<td>0.816</td>
<td>0.059</td>
</tr>
<tr>
<td>Class 3: reversed transmission</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>vs. 1 (moderate transmission)</td>
<td>-0.670</td>
<td>0.694</td>
<td>0.534</td>
</tr>
<tr>
<td>vs. 2 (no transmission)</td>
<td>0.432</td>
<td>0.590</td>
<td>0.591</td>
</tr>
<tr>
<td>Class 2: no transmission</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>vs. 1 (moderate transmission)</td>
<td>-1.103</td>
<td>0.572</td>
<td>0.031</td>
</tr>
</tbody>
</table>

DISCUSSION

- Overall, the present study provided new insights into individual differences in the process of emotion transmission between first-grade children and their fathers.
- From a methodological point of view, the results highlight the fact that failing to take into account individual differences in emotion transmission may mask some interesting results concerning day-to-day parent-child interactions.
- The results of the present study showed that, although at the entire sample level, fathers’ negative emotions were not transmitted to their children, there were individual differences in emotion transmission. Moreover, we were able to identify qualitatively different patterns of father-child interactions; patterns in which fathers’ negative emotions were not only transmitted to their children’s negative emotions but also, in some cases, to decreased levels of negative emotions.