Capturing Change Within Change: Exploring Maternal Trajectory Heterogeneity and Its Longitudinal Predictions of Children's Cognitive and Socio-Emotional Development Using the KIT Database

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Background and Significance

The major advantage of longitudinal data is in its ability to capture how observed variables change over time. By applying growth modeling, researchers can estimate developmental trajectories and investigate how specific trajectory parameters affect distal outcomes. When combined with finite mixture modeling, researchers can uncover distinct sub-populations behind the data. This approach allows for the identification of different trajectory profiles and the examination of their conditional effects on distal variables. While this finite mixture model-based structural equation modeling framework maximizes the theoretical and practical value of longitudinal datasets, it involves highly complex statistical estimation procedures. Researchers face numerous preliminary decisions regarding model selection, specification, and data requirements; inappropriate choices can easily lead to biased estimates or distorted conclusions.

Research Methods

Using the 3-month-cohort data from the Kids in Taiwan National Longitudinal Study (KIT), this study examines the growth trajectories of maternal depression from childbirth to preschool age. It aims to identify distinct latent subgroups of mothers and explore how these heterogeneous trajectories conditionally influence and predict children's cognitive and socio-emotional

development.

The sample consists of more than three thousand kids whose mothers served as the primary respondents. Maternal depression was assessed across seven waves (at ages 3, 6, 12, 18, 24, 36, and 48 months) using a 4-point Likert-type scale item: *"Over the past 3 months, did the child's mother feel sad, depressed, gloomy, or unhappy?"* Children's cognitive and socio-emotional development scores, calculated using Item Response Theory (IRT), were included as distal outcomes.

To analyze the trajectories of maternal depression, the study first applied a conventional Latent Growth Model (LGM). To explore latent heterogeneity, three distinct mixture modeling approaches were utilized and compared:

- GBTM (Group-Based Trajectory Model)
- LCGM (Latent Class Growth Model)
- GMM (Growth Mixture Model)

These models define the distinct maternal depression profiles within each sub-population to evaluate their subsequent impacts on child development.

Results

Homogeneous Trajectories: When assuming a single, homogeneous population (not accounting for subgroups), the overall trajectory of maternal depression exhibited a curvilinear U-shaped pattern—initially high, gradually declining, and then rising again over time. Notably, child gender acted as a predictor; the curvature (rate of change acceleration) was significantly higher for mothers of boys than mothers of girls.

Heterogeneous Trajectories: When allowing for subgroups, all three mixture models consistently identified three primary latent classes. However, the specific shapes and paths of the trajectories varied considerably across GBTM, LCGM, and GMM, demonstrating that the choice of statistical model heavily influences the estimation of latent trajectories.

Conditional Predictions: Within the three heterogeneous subgroups, different trajectory parameters (such as initial status and rate of change) significantly predicted children’s cognitive and socio-emotional outcomes. Furthermore, the predictive power of these parameters was moderated by both the mother’s trajectory group membership and the child's gender, underscoring the critical importance of group-specific predictive analysis.

Methodological Mitigation: Because latent class analysis is prone to classification errors and shifts in classification membership when predicting distal outcomes, this study explicitly compared models with and without the BCH adjustment method. The results illustrate the empirical differences and potential risks associated with omitting such advanced corrections in high-level modeling.

Conclusion and Contribution

This study demonstrates how researchers can empirically implement an analysis strategy that captures "change within change" using empirical longitudinal data. By integrating longitudinal growth modeling with statistical heterogeneity paradigms, this paper highlights the divergent results produced by different model selections and error-correction strategies. Ultimately, these findings offer valuable theoretical insights into early childhood intervention and provide a concrete methodological reference for researchers working with large-scale longitudinal databases.