Assessing the longitudinal course of depression and economic integration of south-east Asian refugees: an application of latent growth curve analysis

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ABSTRACT *This paper has both methodological and substantive application for mental-health researchers. Methodologically, it presents the latent growth curve (LGC) technique within a structural equation modelling (SEM) framework as a powerful tool to analyse change in depressive symptoms and potential correlates of such changes. The rationale for LGC analysis and subsequent elaboration of this statistical approach are presented. The limitations of traditional analytical methods are also addressed. Substantively, the paper considers socio-contextual factors as correlates of change in symptoms, and examines the dynamic systematic relationship with the degree of economic integration of south-east Asian immigrants in Canada over time. Using the LGC technique, this study also investigated how the longitudinal course of sub-clinical depression places individuals at risk for developing full-blown major depression. The LGC results provided strong evidence for the reciprocal influence between economic integration and subclinical depression of immigrants. The initial level of economic integration negatively influenced the rate of change in subclinical depression whereas the initial level of sub-clinical depression negatively influenced the rate of change in economic integration. Both initial level and the rate of change in subclinical depression placed individuals at risk for full-blown major depression. However, traditional auto-regressive models were not capable of revealing these dynamic associations. Thus, an investigation of within-individual change in symptoms and potential correlates of such changes is necessary to understand the process that results in full-blown mental disorder.*

Key words: south-east Asian refugees, depression, growth curves

A prodromal build-up of symptoms may span years before the onset of full-blown mental disorder (Judd, 1994; Murphy et al., 1989; Rueter et al., 1999; Eaton et al., 1995, 1997). The prodromal build-up of symptoms is a within-individual clinical process that may differ qualitatively between individuals, placing them at varying risk for full-blown mental disorders. Furthermore, inter-individual differences in prodromal build-up of symptoms may stem from differences in sociocontextual factors. Investigation of within-individual change in symptoms and potential correlates of such changes is necessary to understand the process that results in full-blown mental disorder (Karney and Bradbury, 1995; Rueter et al., 1999). In the case of

immigrants, inter-individual differences in prodromal build-up of symptoms and subsequent onset of full-blown disorder may stem from pre-migrant and/or post-migrant stressful experiences.

Traditional analytical approaches often used in psychiatric research studying social factors that influence psychopathology are insensitive to within-individual changes of symptoms over time. In particular, regression methods, mean comparisons, and repeated measures Manovas are not sensitive to within-individual changes over time and, consequently, entail several related limitations. The lack of focus on within-individual changes could result in incomplete and/or potentially inaccurate conclusions concerning the development of symptoms or disorders, but also their antecedents and sequelae (Rogosa et al., 1982; Karney and Bradbury, 1995).

The present paper has both methodological and substantive purposes for mental health researchers. Methodologically, it will present the latent growth curve (LGC) technique within a structural equation modelling (SEM) framework as a powerful tool to analyse change. The limitations of traditional methods will also be addressed. This paper considers socio-contextual factors in this process and will examine the dynamic systematic relationship between degree of economic integration of SE Asian immigrants in Canada across time, and the longitudinal course of subclinical depression placing them at risk for developing full-blown major depression.

Background

Past research demonstrates that the initial time of settlement and integration into a new socioeconomic environment is a stressful experience for immigrants and refugees (DeVoretz, 1995). Socioeconomic integration includes acquisition of a new language and practices, and establishment of stable economic and employment conditions, representing stressful activities for immigrants and refugees in several ways:

- First, difficulties in gaining access to banking facilities, credit cards, purchases, insurance, emergency funds, and securing stable employment can be stressful, because very often these goals exceed the immigrants' initial capacities to obtain them.
- Second, lack of economic integration reflects a maladaptation to the labour market and is a proxy for poor employment status – underemployment, in particular. Research suggests that performing a low-status job that is incongruous with one's prior education and skill level would create a mental health risk (Lin, 1986; Beiser et al., 1993).
- Third, at the same time, the lack of economic integration directly increases the economic hardship of immigrants, leaving them deprived of some basic necessities, and more likely to experience stressful day-to-day living. Poverty is thought to jeopardize mental health by generating depressive feelings, such as frustration, hopelessness, and powerlessness (Conger, Patterson and Ge, 1995).

Psychosocial stress associated with a failure in socioeconomic integration may contribute to maladaptive psychological functioning and symptom development and, in turn, to the onset of mental disorders (Beiser et

al., 1996). However, an accurate portrayal of this process must take into consideration that both the degree of economic integration and the level of depressive symptoms of immigrants may change over time. Noticeably lacking is psychiatric research focusing on the dynamic association between trajectories of economic integration of immigrants and trajectories of depressive symptoms.

Some methodological concerns

The need to preserve the continuity of change

Traditional regressive methods and mean comparisons are not capable of preserving the continuity of change. Instead, regression techniques examining change over time use only two measurements of an outcome variable at a time, incorporating very little information about change over time (Rogosa, 1982). Taking two time points uses only two discrete snapshots linked by the incremental change of a continuous process (Karney and Bradbury, 1995). The traditional regression method for analysing change in psychiatric research typically includes regressing the final measurement of symptoms on predictors after controlling for the initial level of symptoms. This is known as 'residualized scores' or autoregression (or cross-lagged models in the SEM framework) because covariates are used to predict residualized scores of the final measurement after removing the effect of initial measurement. This method entails several limitations. First, the non-dynamic nature of these models views psychopathology as a status rather than a process that unfolds over time (Coyne and Downy, 1991). Second, when individual change follows a non-linear trajectory, regression methods are unlikely to reveal intricacies of such change (Willet and Sayer, 1994). Moreover, 'Ignoring the continuous nature of change process, traditional methods prevent empirical researchers from entertaining a richer, broader spectrum of research questions, questions that deal with the nature of individual development' (Willet, 1988, p. 347). Research questions with regard to the nature of change in psychiatric research – prodromal development of symptoms, in particular – requires researchers to view change as a continuous process using more than two time points, because the build-up of symptoms is a clinical process that may be non-linear and that has to be estimated with more than two time points. Moreover, this process may be systematically associated with sociocontextual and developmental processes.

The need to investigate different growth parameters

Individual-specific growth parameters can capture different facets of a multifaceted process of symptom build-up. These parameters include not only the intensity or severity (level) and but also the amount of growth or decline (rate of change) in symptoms over time. For example, the developmental course of an already depressed individual who has experienced a sharp increase in symptom level from 'moderate' to 'very high' is qualitatively different from the developmental course of a mentally healthy individual who has experienced the same amount of increase in the level of depressive symptoms from 'zero' to a 'moderate level' over the same period of time. Although the aforementioned two trajectories have the same amount of change, they have important differences; specifically, involvement of different symptom levels (intensities). Traditional methods are not sensitive enough to capture this difference and to distinguish the difference between these two courses of development, although these courses may have different sequelae and also different antecedents (Rueter et al., 1999; Karney and Bradbury, 1995).

Development of depressive disorder may not simply correspond to the severe end of a continuum of depressive symptoms (Beiser et al., 1994). 'The causal structure for initiation, prolongation, and exacerbation (of prodromal build-up of symptoms) are not well understood' (Eaton et al., 1995). That is, to understand and investigate the full course of the prodromal build-up of symptoms, all the facets of change (for example, both intensity and the shape/rate of change) have to be taken into account. In examining the full course of the development of symptoms in psychiatric research, several growth parameters may be independent predictors of risk for developing full-blown mental disorder (Eaton et al., 1995; Judd, 1994). It is important to understand relative contributions of different growth parameters of symptoms (for example, level and rate of change) to the risk for developing disorder (Rueter et al., 1999; Eaton et al., 1995; Judd, 1994). On the other hand, the intensity level and rate of change may be independently affected by different socio-contextual factors, such as pre-migration trauma and/or post-migration stress in the case of immigrants and refugees. It is important to understand which sociocontextual factors (for example, pre-migration trauma) may lead some individuals to have higher intensity levels than others and which factors (for example, post-migration

stress) may lead some individuals to have higher rates of change in symptoms over time than others.

The need to incorporate growth parameters either as predictors or outcomes in the same model

It is important to test simultaneously the influence of antecedents on the developmental course of symptoms and the relationship between the developmental course and the onset of subsequent full-blown disorders. This would enable the researcher to disentangle direct and indirect effects among all the variables. Traditional regression and Manova methods are unable to include all growth parameters (for example, the level and change) in the model simultaneously, both as independent outcomes of sociocontextual factors and predictors of later full-blown disorders.

The need to incorporate time-varying predictors

Predictors of change in symptoms such as stressful economic integration of immigrants may themselves be a process specified as a time-varying variable (Hinton et al., 1997; Beiser and Hove, 2001). As in the case of change in psychiatric symptoms, all aspects of change in predictors are important for understanding the associations with various aspects of change in symptoms. It is the differences in within-individual change in socio-contextual predictors across individuals that may result in the differences in within-individual change in psychiatric symptoms across individuals. Thus, a proper analysis should relate differences in growth parameters (for example, rate of change) of sociocontextual variables across individuals to differences in growth parameters of mental health variables across individuals. Such an analysis would provide a richer and deeper understanding about the dynamic relationship between time-varying sociocontextual factors and mental health than traditional methods. However, the traditional regression and Manova methods are not flexible enough to entertain time-varying predictors, preserving their continuous nature. This is an important drawback for mental health research because sociocontextual factors, such as the influence of life stressors and life satisfaction on mental health, are constantly changing.

The latent growth curve (LGC) technique within a structural equation modelling (SEM) framework fulfils the above needs in analysing change. It provides an estimation of individual change parameters as well as their differences across individuals, and systematically

relates these differences to the differences in time-invariant and/or time-varying predictors and in sequelae across individuals. The LCG capitalizes on the availability of data by taking into account both means and variance covariances. The SEM framework also provides a flexible approach to specifying random errors of measurements and their covariances. Moreover, as psychiatric research data sets become more and more complex with the addition of new waves of data and time-varying variables, the need for such a technique to analyse change is heightened.

Although a LGC approach within the SEM framework addresses several methodological issues related to the analysis of change, several potential limitations exist. First, although LGC provides estimates of individual specific growth parameters and examines systematic associations between growth parameters and other correlates, SEM is similar to traditional regression analysis in that the strength and nature of such associations are assumed to be the same for all individuals. Similarly, although the magnitude of growth parameters can differ across individuals, growth shapes (for example, linear) are assumed to be the same for all individuals. Realistically it is possible that individual differences in growth shape and associations between growth parameters and covariates exist. Second, unlike in traditional regression analysis, regression parameters in SEM models should be interpreted acknowledging that some of the error terms in the model are allowed to correlate. However, extreme caution should be used when error terms are correlated in that such correlations should be theoretically or methodologically meaningful. Third, the statistical assumptions regarding distributional characteristics of the variables used in SEM are more restrictive. Specifically, SEM assumes univariate and multivariate normality of the variables. However, use of appropriate data matrices (for example, polychoric correlations) and appropriate fit indices (for example, the Satorra-Bentler scaled chi-square) to evaluate models effectively reduces influences due to deviations from multivariate normality. Moreover, study populations may be heterogeneous resulting in subpopulations requiring the use of multi-group SEM analyses. Finally, there are various fit indices available to evaluate SEM models. Those indices appropriate for any given model must be identified depending on factors such as sample size, number of variables, and deviation from distributional assumptions.

Study hypotheses

Taking into account the aforementioned methodological concerns, in accordance with the theoretical associations between economic integration, subclinical depressive symptoms, and major depressive disorder, we developed the following hypotheses:

1. Initial level of economic integration negatively influences initial level of subclinical depression.
2. The rate of change in economic integration negatively influences the rate of change in subclinical depression.
3. Initial level of economic integration negatively influences the rate of change in subclinical depression.
4. Initial level of subclinical depression negatively influences the rate of change in economic integration.
5. Both the initial level and the rate of change in subclinical depression place individuals at risk for developing full-blown major depression.

Study background, samples and measures

Between 1979 and 1981, Canada admitted 60,000 south-east Asian refugees, about 5,000 of whom resettled in Vancouver, British Columbia. In 1981, the co-author (MB) initiated the Centre for Addiction and Mental Health/University of Toronto Department of Psychiatry Refugee Resettlement Project (RRP), a 10-year longitudinal study of the psychological, economic and social adaptation of these survivors of war, persecution, flight and refugee camp internment. Because Canada's confidentiality laws prohibited the federal Department of Employment and Immigration's release of refugee names and addresses, the RRP investigators could not identify a population universe from which to draw a sample. The alternative sampling strategy chosen was a combination of key informant and probability sampling techniques suggested by Mendenhall and Schaeffer (1971) and described in more detail elsewhere (Beiser and Fleming, 1986; Beiser, 1999).

In advance of the initial survey, RRP staff developed a structured interview schedule containing information about sociodemographic characteristics, pre-migration and post-migration stressors, employment and marital history, language fluency, time perspective, and psychiatric symptoms. Using standard translation and back-translation guidelines (Brislin et

al., 1973), Cantonese, Vietnamese, and Laotian versions of the survey were then constructed. Bilingual Chinese, Vietnamese and Laotians, many of them refugees themselves, were recruited to act as RRP interviewers and received intensive training in the administration of structured questionnaires.

The RRP sample: 1981, 1983, 1991

The study began in 1981, with a survey of 1,348 adults. Sampling was stratified so as to include approximately equal numbers of ethnic Chinese and non-Chinese, as well as equal proportions of privately and government-sponsored refugees (Beiser and Fleming, 1986; Beiser, 1999). The demographic profile of the sample approximated the federal government figures describing the total population of refugees who came to Vancouver in 1979 and 1980. When the study began, the refugees had been in Canada an average of 16 months. After receiving a complete explanation of the study's objectives and procedures, each person chosen for the sample was asked to sign a written informed consent. Ninety-five per cent agreed to participate.

In 1983, the study team succeeded in locating and re-interviewing 1,169 persons, 87% of the original sample. Six-hundred-and-forty-eight members of the original sample participated in a third wave of the survey in 1991. Forty refugees who took part in the third survey had not participated in the second wave. Data for the current study derive from the 608 cases with complete records for all three waves of data collection.

Although the loss of about half the original sample is disappointing, it is important to view this loss in context. Retention rates in the RRP are twice as high as those reported by others (Lewis et al., 1988; Burwel et al., 1986) who have attempted to follow highly mobile southeast Asian refugees over a period of years. More importantly, according to the results of formal statistical testing, sample attrition gave rise to a negligible amount of bias.¹ There was a slight mental health trend: the least mentally healthy in 1983 were the most likely to agree to a 1991 reinterview. This finding

has one important implication: since psychiatric disorders tend to be persistent conditions, 1991 data may overestimate the amount of refugee psychopathology (Edwards, 1994).

There were more males (57.3%) than females in the final sample. Ages ranged from 26 to 88 years, with a mean of 41 years. About 80% of the study participants were married. Most (71.7%) had been continuously employed over the five years prior to the 1991 interview. Of the total sample, 43% were ethnic Chinese from Vietnam, with the rest either ethnic Vietnamese or Laotians.

Measurement

The mental health measures used in the present report are the individual probabilities of satisfying criteria for a diagnosis of sub-clinical depressive disorder and major depressive disorder. These measures were created by applying grade of membership analysis to a symptom inventory of 45 items covering depression, anxiety, and somatization. The inventory, appearing in the mental health section of each of the three RRP surveys contained items from the CES-D (Radloff, 1977), the DIS (Robins et al., 1981), the Senegal Health scales (Beiser, 1985; Beiser et al., 1986). This inventory also contained culturally based idioms of distress derived from the Vietnamese Depression Scale (Kinzie et al., 1982) and from key-informant interviews for the RRP study.

Grade of membership (GOM), a form of multivariate cluster analysis, describes symptom clusters as prototypes with fuzzy boundaries. A previous publication, detailing the application of GOM to RRP data, identified an empirically derived symptom cluster closely resembling the DSM-III-R description of major depressive disorder, a similar cluster with less intense complaints that seemed to describe subclinical depressive disorder, and a relatively asymptomatic cluster. The report also described the construct validity and cross-cultural invariance of the syndromes (Beiser et al., 1994). When GOM was used to analyse

¹ The investigative team used a two-stage estimation procedure proposed by Heckman (1979) to examine possible selection bias due to sample attrition. In stage one, a probit model was constructed to estimate the propensity to remain in the follow-up survey. The results of the probit models indicated that at wave two, only being married was significantly associated with lower probabilities of attrition. At wave three, younger age at immigration, being married, and higher levels of initial English proficiency were significantly associated with lower probabilities of attrition. In stage two, a correction factor, so-called the hazard rate (the inverse Mill's ratio) was computed for each observation based on the probit estimates. The hazard rate was then entered as an explanatory variable in multivariate models for selected outcome variables, including depression. The results indicated that the correction factor was not significant and had no substantial influence on the parameter estimates of other variables in the models.

mental health data pooled from the three longitudinal surveys, remarkably similar symptom clusters emerged. Consistent with the results of the GOM analysis performed on one wave of data, three waves of symptom information produced a cluster closely approximating DSM-III-R major depressive disorder, another describing subclinical depression, and a third describing an asymptomatic state. After identifying item clusters, the GOM program assigns each respondent in each wave a statistical value, g_{ik} , that indicates the probability that he or she belongs to each of the typologies identified; g_{ik} values vary between 0 and 1.0. A score of 1.0 on major depressive disorder would signify 100% probability that the respondent was one of psychiatry's elusive 'classic cases'. The higher the g_{ik} , the more likely it is that an individual best fits the prototype described by each of the symptom clusters. Thus, like a psychiatric diagnosis, assignment to a particular category, whether a category which describes psychiatric disorder or relative lack of symptoms, is based on the probability of best fit, and not on the assumption that the fit will be perfect. By calculating the average g_{ik} for each survey wave, it is possible to estimate prevalence.

At each wave of the survey (in 1981, 1983 and 1991), interviewers enquired about the study subject's employment status and the involvement in other financial activities. Economic integration was measured by counting successful economic activities they were involved in (1 = yes, 0 = no) including regular employment, life insurance, house insurance, checking account, instant teller, savings account, stocks, real estate, bonds, RRSP, and credit card. During each of three interview waves, respondents rated their English-language proficiency on a three-point scale (1 = none, 2 = little, 3 = good).

Latent growth curve (LGC) modelling

Although latent growth curve modelling is gaining popularity in some disciplines, to our knowledge it has not often been employed in psychiatric research. Growth curve estimation begins by describing change over time for each individual in the study (Wickrama et al., 1997). Conceptually, this is done by fitting a regression line (a growth curve) linking the outcome variable (final measurement of symptoms) to time for each individual in the study. The individual regression prediction equations can then be summarized to obtain an average intercept and average slope for all individuals, each with

a variance. The goal is then to use theoretically driven covariates to explain why some individuals have higher initial levels (intercepts) than others, and why some have greater rates of change (steeper slopes).

Practically, the process of estimating the growth curves for each individual p ($p = 1, 2 \dots n$), is done by writing and then estimating equations linking the observed scores at each time point in time (y_{t1} , y_{t2} , and y_{t3}) to time (t_1 , t_2 , and t_3) using two parameters, an intercept (level) π_0 and a slope (rate of change) π_1 as expressed in these equations:

$$\begin{aligned} y_{1p} &= 1 * \pi_{0p} + t_1 * \pi_{1p} + \epsilon_{11} \\ y_{2p} &= 1 * \pi_{0p} + t_2 * \pi_{1p} + \epsilon_{22} \\ y_{3p} &= 1 * \pi_{0p} + t_3 * \pi_{1p} + \epsilon_{33} \end{aligned}$$

For each individual, equations link subclinical symptom measurements in 1981, 1983 and 1991 to time using an intercept π_0 and a slope π_1 .

(In the above equations ϵ_{11} , ϵ_{22} , and ϵ_{33} are the residuals at each point in time and are assumed to be normally distributed with zero means.)

These three equations correspond to a SEM model with latent and observed measurements as shown in the right part of Figure 1. In the structural equation framework, π_0 and π_1 can be considered as two latent variables measured by three observed indicators y_{t1} , y_{t2} , and y_{t3} . The coefficients of π_0 in three equations (these are always 1) are equal to factor loadings of three indicators (measurements) for 'level' latent variable. The coefficients of π_1 for three equations (t_1 , t_2 , and t_3) are equal to factor loadings of three measurements for 'rate of change' latent variables. If t_1 , t_2 , and t_3 are 0, 1 and 2 respectively, change would be a linear increase across three time points and the level (intercept) is defined by measurement of y at first time point, the point at which factor loading is equal to 0. (If time intervals are not equal, appropriate factor loading should be given proportionate to unequal time intervals.) Alternatively, as shown in Figure 2, for a linear increase (rate of change π_1), appropriate loadings can also be -2 , -1 , 0. Then the level (intercept π_0) is defined by the final measurement of y because the factor loading equal to 0 corresponds to the final measurement. The form of change may not always be linear; it may be quadratic, or otherwise. Then appropriate loadings for slope (rate of change π_1) would be different. For example, appropriate loadings for a quadratic term with four time points would be 0, 1, 4, and 9. The form of change may

be based on theory, prior research, or exploratory modelling (Willet and Sayer, 1994).

Individual trajectories (level and rate of change) are expected to be different from individual to individual. For a sample of n individuals, there will be as many as n different rates of change over time and n different levels of symptoms. Although each individual trajectory

varies in level and rate of change, they can be aggregated so that, for the whole sample, there is an average level (mean of π_0) with a variance, and an average rate of change (mean of π_1), also with a variance. The mean and variance of the level parameter identify the overall average of the individual-specific levels and variability of levels (dispersion) across individuals. The mean for

Figure 1A. An illustration of a latent growth curve of Y and covariate X .

Figure 1B. Changes in sub-clinical depression (GOM Scores) from 1981 to 1991 for randomly selected 10 refugees (dotted line represents the sample average).

the rate of change describes the average overall change in symptoms of individuals over time while the population variance for the change parameter reflects differences in the rate of change across individuals. Significant variances in the growth parameters show the heterogeneity of the individual-specific trajectory population. This is the variability that predictors of change should explain in the analysis of change.

Thus, in addition to the simple description of change, growth curve modelling allows us to explain systematic inter-individual differences in both the level and rate of change for symptoms. When the change parameter (for example, rate of change in symptoms) covaries significantly with a predictor variable (for example, economic integration), differences in rate of change in symptoms across individuals are said to be systematic (Willet and Sayer, 1994). Thus, the symptom growth parameters of individuals (π_{0p} or π_{1p}) can be represented by the following equations using economic integration as a predictor variable:

1. For level of p^{th} individual: $\pi_{0p} = \alpha_{\pi_{0p}} + \beta_1 (\text{economic int}) + \zeta_1$
2. For rate of change of p^{th} individual: $\pi_{1p} = \beta_{\pi_{1p}} + \zeta_2$ (economic int) + ζ_2 ζ_1 and ζ_2 are residual error terms.

In the above equations, $\alpha_{\pi_{0p}}$ and $\alpha_{\pi_{1p}}$ are intercepts of the prediction equations, β_1 and β_2 are path coefficients linking change parameters of symptoms and predictor variables, and ζ_1 and ζ_2 are disturbances. More importantly, if the predictor variable is time-varying, growth trajectories can also be estimated for the predictor variables, and growth parameters of the predictor variable (covariate) can be used as predictors. Then, two possible equations predicting symptom growth parameters for the p^{th} person are as follows:

$$(\text{level of symptoms})_p = \alpha_{\pi_{0p}} + \beta_1 (\text{level of economic int})_p + \zeta_1$$

and

$$(\text{rate of change in symptoms})_p = \alpha_{\pi_{1p}} + \beta_2 (\text{rate of change in economic int})_p + \zeta_2$$

or

$$(\text{rate of change in symptoms})_p = \alpha_{\pi_{1p}} + \beta_1 (\text{level of economic int})_p + \beta_2 (\text{rate of change in economic int})_p + \zeta_2$$

Results

Development of subclinical depressive symptoms

We examined change in subclinical depression for a randomly selected group of 10 immigrants over time. As shown in Figure 1B, the average rate of change over time for these 10 individuals appeared to be constant (indicating the absence of an increasing or a decreasing trend in subclinical depression over time). However, there appeared to be substantial variances in the individual initial levels (1981) and rates of change (slope) of subclinical depression, indicating that subclinical depression probably increased for some immigrants, decreased for others, and remained relatively constant for some from 1981 through 1991.

In order to investigate these individual changes systematically, a univariate latent growth curve model was estimated for subclinical depression from 1981 to 1991 using a structural equation model with latent variables (Joreskog and Sorbom, 1993). A latent growth curve model with the growth parameters (level and slope) represented by two latent variables (π_0 and π_1) is shown in Figure 1. The initial level is defined by the measurement in 1981. However, the latent variable corresponding to rate of change in the present analysis is defined by giving appropriate loadings (0, 1 and 4) for a linear change taking into account measurement time-points (1981, 1983 and 1991).

Table 1 presents the estimates of growth parameters of univariate latent growth curves (LGC) for economic integration and subclinical depression. The latent growth curve model for subclinical depression with three measurements showed a respectable fit with the data. The fit index of the model (adjusted goodness of fit index) was excellent (0.99). Thus, in this model the linear form of the slope for changes in subclinical depressive symptoms was shown to have a very good fit with the data. The average initial level of subclinical depression in 1981 (mean of π_0) was 0.14, and significant variance for the initial level (0.36, $t = 6.56$) indicates substantial differences among refugees in their initial level of subclinical depressive symptoms (g_{ik} scores). The average rate of change (mean of π_1) is not significant (-0.01 , $t = -0.89$). That is, subclinical depression did not show any shift in overall mean score among refugees. Nevertheless, significant variation among refugees in rates of change in subclinical depression (variance = 0.03, $t = 3.51$) indicated that subclinical depression probably increased for some refugees, decreased for others, and remained relatively

Table 1. Estimates for univariate growth curves for economic integration and subclinical depression

	Initial level		Rate of change			
	Mean	Variance	Mean	Variance	chi-square(df)	AGFI
Economic integration	2.41* (18.73)	0.40* (8.13)	0.32* (28.00)	0.02* (2.73)	1.90 (3)	0.98
Subclinical depression	0.14* (3.60)	0.36* (6.56)	-0.01 (-.89)	0.03* (3.51)	2.04 (3)	0.99

* $p < 0.05$.

constant for some from 1981 through 1991. The correlation between rate of change in depression and the initial level of depression (-0.64 , $t = -3.84$) indicates that refugees who had a higher initial level of depressive symptoms in 1981 experienced lower levels in rate of change in depressive symptoms from 1981 through 1991 than the refugees who had a lower initial level of depressive symptoms in 1981.

The latent growth curve model for economic integration with three measurements showed a respectable fit with the data. The fit index of the model (adjusted goodness of fit index) was excellent (0.99). Thus, in this model the linear form of the slope for changes in economic integration was shown to have a very good fit with the data. The average initial level of economic integration in 1981 (mean of π_0) was 2.41, and significant variance for the initial level (0.40, $t = 8.13$) indicates substantial differences among refugees in their initial level of economic integration. The average rate of change (mean of π_1) is positive and significant (0.32, $t = 28.00$). That is, on average, economic integration showed an increase among refugees. However, there was significant variation among refugees in rates of change in economic integration (variance = 0.02, $t = 2.73$).

The model in Figure 2 contains LGCs for both economic integration and subclinical depression. This model addresses study hypotheses 1 through 5, which predicted that growth parameters of economic integration would be systematically associated with the growth parameters of subclinical depression which in turn would contribute to major depression. According to the model in Figure 2, and contrary to our expectations, the initial level of economic integration is positively associated with the initial level of subclinical depression (0.22, $t = 2.57$) showing that economically integrated

immigrants experienced higher levels of subclinical depression initially. However, the initial level of economic integration negatively influences the rate of change in subclinical depression (-0.31 , $t = -3.94$) showing an increasing beneficial influence of the initial economic integration on depression over time. Reciprocally, the initial level of subclinical depression has a marginal negative influence on rate of change in economic integration. More importantly, there was support for the expectation that the rate of change in economic integration negatively influences the rate of change in subclinical depression (-0.46 , $t = -2.46$). Parameters of change in symptoms are also independently related to risk for subsequent full-blown mental disorder; both the initial level (1981) and the rate of change (1981 through 1991) in subclinical depression independently contributed to subsequent full-blown major depression in 1991 (0.58, $t = 4.81$ and 0.80, $t = 4.62$, respectively). Growth parameters of subclinical depression explain 41% of variance in major depression in 1991. The fit index of the model (AGFI) is 0.98. Thus, this model shows a very good fit to the data.

The model in Figure 3 includes controls for background characteristics: gender, age and English language proficiency in 1981. Gender (female) negatively influences initial level of economic integration (-0.10 , $t = -2.50$) and English ability (-0.22 , $t = -6.28$). Age directly influences the initial level of depressive symptoms (-0.19 , $t = -3.39$). As expected, English language skills positively influence initial level of economic integration (0.50, $t = 9.92$). More importantly, although the level of language proficiency (1981) has a positive influence on the initial subclinical depression level (1981), it significantly hinders the growth in depressive symptoms from 1981 through 1991 (-0.24 , $t = -2.42$). In this

Figure 2. Association between trajectories of economic integration and sub-clinical depression, and subsequent major depression.

Figure 3. The process model for the development of major depression.

Figure 4. Cross-lagged model for economic integration and sub-clinical depression.

comprehensive model with background controls, the positive association observed between the level of economic integration and subclinical depression (Figure 2) became non-significant, indicating that the previously observed association is spurious due to the common influence of English language skills on both variables. The influences of the initial levels of economic integration and subclinical depression in 1981 on rates of change in subclinical depression and in economic integration from 1981 to 1991, respectively, were significant. This model supports the contention that trajectories of economic integration and depressive symptoms are interlocking, and prodromal build-up of depressive symptoms precedes the onset of major depression.

Autoregressive models

We estimated autoregressive models using economic integration and subclinical depression variables of the same data (Lorenz et al., 1994). The measures in 1981 and 1991 were used for this analysis. Figure 4 presents the result of the autoregressive model. This model fits the data perfectly. Stability coefficients of economic integration and subclinical depression between 1981 and 1991 were 0.24 and 0.10, respectively. The cross-lagged paths were of great interest. As discussed previously, these paths represent the influence of one variable on the residualized change score of the other. Economic inte-

gration (1981) had no significant influence on the residualized change score of subclinical depression in 1991 (after controlling for subclinical depression in 1981). Similarly, subclinical depression (1981) had no significant influence on the residualized change score of economic integration 1991 (after controlling for economic integration in 1981). These findings regarding predicting change in attributes are not consistent with the findings of latent growth curve analysis.

Figure 5 presents the autoregressive model with the same background variables (English language proficiency, gender, and age) and major depression as the final outcome. The model fits the data well: chi-square = 27.70 with 15 degrees of freedom; AGFI = 0.98. In contrast to the results of growth curve analysis, English language proficiency influences change in economic integration (residualized change) and not the change in subclinical depression from 1981 to 1991 (as was the case in the LGC model). Although the autoregressive model demonstrated that the level of subclinical depression (1991) contributes to major depression, it was unable to show that absolute change in subclinical depression contributes to subsequent major depression. Explained variance of major depression was 16% in this model, as compared to 41% in the latent growth curve model.

Figure 5. Auto-regressive process model predicting major depression.

Discussion

Latent growth curve analysis and autoregressive analysis provided inconsistent results with regard to predicting change. This is because the two approaches interpret change differently. The predicted 'change' (residualized score) in autoregression is not unique to the individual. The 'residualized score' is the difference between final level and 'the influence of the initial level' (adjustment for the initial level). This influence is determined by the stability coefficient obtained from the regression of final level on initial level (autoregression). The stability coefficient in autoregression is common to all individuals, although the influence of initial level may be different for different individuals. Thus, the estimated 'residual score' is not explicitly unique to the individual. However, in growth-curve analysis, individual-specific absolute change is estimated and the predictors explain the variability of such changes.

If the stability coefficient is high (in previous analysis, stability coefficients for economic integration and subclinical depression were comparatively low) it prevents additional predictors from entering into the equation in traditional regression (Lorenz et al., in press; Stoolmiller and Bank, 1995; Patterson, 1992). This problem is pronounced in research focuses on sociocontextual predictors of mental health because

they are often distal causes. The stability of the level of symptoms is highly sensitive to maintaining the rank order of the individuals over time. If the rank order of symptom levels between two measurement points is maintained, even after a change, the stability of the symptom levels over time is very high. This makes it extremely difficult for other predictors, such as socio-contextual factors, to enter into the regression equation as significant predictors of change in symptoms, although change may be attributable to those predictors (Stoolmiller and Bank, 1995). However, use of initial status of symptoms as a predictor of final status is substantively meaningful in psychiatric research. The history of prior symptoms and episodes may be strongly related to current status due to recurrence and/or residual effects of past occurrences (Depue and Monore, 1986). Thus, analytical methods should be capable of disentangling and incorporating effects of both prior status and additional predictors, avoiding unnecessary competition between the two. The LGC approach allows this.

If unique individual change is computed avoiding stability between initial and final levels, the forced competition between initial level and additional predictors can be minimized when predicting individual change in symptoms. In another traditional method used to analyse change, 'difference score'

regression, individual changes (difference scores) are directly computed taking the difference between final and initial level. Difference scores are unique to individuals and are regressed on predictors. Regression of the difference score is free from the forced competition between initial status and additional predictors found in residual score regression. However, difference scores suffer from low reliability, especially if levels are not precisely measured (Karney and Bradbury, 1995). In LGC modelling, instead of using 'difference score', individual specific change is estimated using more than two measurements with the consideration of measurement error. Thus, the reliability concern for estimated individual change is low.

Regression methods, including autoregression, take into account only the variance-covariance structure and ignore the mean structure of the data. On the other hand, repeated measures Manova method takes into account only the mean structure of data, which corresponds to aggregate level information. This method does not explicitly estimate individual changes nor take into account variances corresponding to individual differences (Duncan and Duncan, 1994). A proper analysis of change should capitalize on the availability of data both by using means, which correspond to aggregate level information, and variances, which correspond to differences across individuals (Duncan and Duncan, 1994). In addition, the LGC approach allows the researcher to preserve the continuity of the variable between all the measurement occasions. It also allows use of growth parameters either as predictors or outcomes in the same model.

The other objective of our study was to test several substantive hypotheses related to economic integration, subclinical depression and major depression among south-east Asian refugees. In contrast to our first hypothesis, the initial level of economic integration is positively associated with the initial level of subclinical depression in both LGC and autoregressive models without controlling for background variables. This influence disappeared when the model controlled for initial level of English proficiency. This indicates that the association between initial level of economic integration and subclinical depression is spurious due to the influence of English proficiency. Although initial level of English proficiency enhanced refugees' ability to integrate economically, it also raised the level of depression. This may be due to the fact that refugees who have a higher initial level of English proficiency

came from higher social stratum in their countries and had become frustrated in their new socioeconomic environment. Both gender (female) and age were associated negatively with English ability. Gender negatively influenced initial level of economic integration whereas age negatively influenced initial level of subclinical depression. Younger refugees had higher levels of subclinical depression than older refugees at the initial level.

In general, the results of the LGC analysis support all the hypotheses with regard to change in subclinical depression and economic integration. The rate of change in economic integration negatively influenced the rate of change in subclinical depression.

This dynamic association over time strongly supports the contention that psychosocial stress associated with failure in economic integration may contribute to maladaptive psychological functioning and contemporaneous symptom development – dynamic association or interlocking trajectories between trajectories of economic integration and subclinical depression.

The results of LGC also support the hypothesis that initial level of economic integration negatively influences the rate of change in subclinical depression. Results also support the hypothesis that initial level of subclinical depression negatively influences the rate of change in economic integration. These provide strong evidence for the reciprocal influence between economic integration and subclinical depression. Moreover, the influence of initial level of one variable on the rate of change in the other variable indicates an interaction effect between time and the former influencing the latter. That is, the influence of lack of initial economic integration of refugees on depression may be weak in early years but increases over time. Similarly, the influence of lack of initial subclinical depression of refugees on economic integration also increases over time.

More importantly, results showed that both the initial level and the rate of change in subclinical depression place individuals at risk for developing full-blown major depression. That is, development of depressive disorder may not simply correspond to the severe end of a continuum of depressive symptoms (Beiser et al., 1994). Instead, both the level (severity) and individual change (change or build-up of symptoms) may be independent potential predictors of risk for developing full-blown disorder.

In general, the results of LGC analysis emphasize that an investigation of within-individual change in symptoms and potential correlates of such changes is necessary to understand the processes that result in full-blown mental disorder.

References

- Beiser M (1985) A study of depression among traditional Africans, urban North Americans and Southeast Asian refugees. In Kleinman A, Good BJ (eds) *Culture and Depression*. Berkeley: University of California Press, pp. 272–98.
- Beiser M (1999) Strangers at the gate: the 'boat people's' first ten years in Canada. Toronto: University of Toronto Press.
- Beiser M, Cargo M, Woodbury MA (1994) A comparison of psychiatric disorder in different cultures: depressive typologies in Southeast Asian refugees and residential Canadians. *International Journal of Methods in Psychiatric Research* 4: 157–72.
- Beiser M, Flemming JAE (1986) Measuring psychiatric disorder among Southeast Asian refugees. *Psychological Medicine* 16: 627–39.
- Beiser M, Hou F (2001) Language acquisition, unemployment and depressive disorder among Southeast Asian refugees: a 10-year study. *Social Science and Medicine* 1–14.
- Beiser M, Johnson PJ, Turner RJ (1993) Unemployment, underemployment and depressive affect among Southeast Asian refugees. *Psychological Medicine* 23: 731–43.
- Brislin RW, Lonner WJ, Thorndike RM (1978) *Cross-Cultural Research Methods*. New York: John Wiley & Sons.
- Canadian Task Force on Mental Health Issues Affecting Immigrants and Refugees (1988) *After the Door Has Been Opened*. Ottawa: Secretary of State, Multiculturalism and Health and Welfare Canada.
- Conger RD, Patterson GR, Ge, X. (1995) It takes two to replicate: a mediational model for the impact of parent's stress on adolescent adjustment. *Child Development* 66: 80–97.
- Coyne JC, Downey G (1991) Social factors and psychopathology: stress, social support, and coping process. *Annual Review of Psychology* 42: 401–25.
- DeVoretz D (1995) Diminishing returns: the economics of immigration policy. Toronto: University of Toronto Press.
- Duncan SC, Duncan TE (1994) Modeling incomplete longitudinal substance use data latent variable growth curve methodology. *Multivariate Behavior Research* 29: 313–38.
- Eaton WW, Badawa M, Melton B (1995) Prodromes and precursors: epidemiological data for primary prevention of disorders with slow onset. *American Journal of Psychiatry* 152: 967–72.
- Edwards PG (1994) Southeast Asian Refugees in Canada: Gender Differences in Adaptation and Mental Health. Wilfred Laurier University, Waterloo, unpublished thesis.
- Judd LL (1994) Clinical characteristics of subsyndromal symptomatic depression. In *International Academy of Biomedical Drug Research* 9: 67–74.
- Karney BR, Bradbury TN (1995) Assessing longitudinal change in marriage: an introduction to the analysis of growth curves. *Journal of Marriage and the Family* 57: 1091–108.
- Kinze JD, Manson SM, Vinh DT, Nolan NT, Anh B, Pho TN (1982) Cultural aspects of psychiatric treatment with Indochinese refugees. *American Journal of Social Psychiatry* 14: 105–11.
- Lin LM (1986) Psychopathology and social disruption in refugees. In Williams CC, Westermeyer J (eds) *Refugee Mental Health in Resettlement Countries*. Washington DC: Hemisphere Publishing Corp.
- Lorenz, Frederick O, Wickrama HAS, Rand D Conger (in press) Modeling continuity and change in family relations with panel. In Conger RD, Lorenz FO, Wickrama KAS (eds.) (in press) *Continuity and Change in Family Relations: Theory, Methods, and Empirical Findings*. Hillsdale NJ: Erlbaum.
- Murphy JM, Sobol AM, Oliver DC, Monson RR, Leighton AH, Pratt LA (1989) Prodromes of depression and anxiety: The Stirling County study. *British Journal of Psychiatry* 155: 490–5.
- Patterson GR, Reid JB, Dishion TJ (1992) *A Social Interactional Approach-antisocial Boys*. Eugene: Oregon Social Learning Center.
- Radloff L (1997) The CES-D scale: a self-report depression scale for research in the general population. *Applied Psychological Measurement* 1: 388–401.
- Robins LN, Helzer JE, Weissman MM, Orvaschel H, Greenberg E, Burke JD, Regler DA (1984) Lifetime prevalence of specific psychiatric disorders in three sites. *Archives of General Psychiatry* 41: 949–58.
- Rogosa DR, Brand D, Zimowski M (1982) A growth curve approach to the measurement of change. *Psychological Bulletin* 90: 726–48.
- Rueter MA, Scaramella L, Wallace LE, Conger RD (1998) First onset of depressive or anxiety disorders predicted by the longitudinal course of internalizing symptoms and parent-adolescent conflict. *Archives of General Psychiatry* 56: 726–39.
- Stoolmiller M, Bank L (1995) Autoregressive effects in structural equation models: we see some problems. In JM Gottman (ed.) *The Analysis of Change*. Mahwah NJ: Lawrence Erlbaum.
- Wickrama KAS, Conger RD, Lorenz FO (1998) Parental education in adolescent self-reported physical health. *Journal of Marriage and the Family* 60: 967–78.
- Willet JB (1988) Questions and answers in the measurement of change. In EZ Rothkopf (ed.) *Review of Research in Education*. Vol.15. Washington DC: American Educational Research Association, pp. 345–422.

Willet JB, Sayer AG (1994) Using covariance structure analysis to detect correlates and predictors of individual change over time. *Psychology Bulletin* 116: 363–81.

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