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Models of Change and Continuity in Romantic Experiences

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The development of romantic relationships commonly begins in adolescence and continues to unfold over the life course. Over the course of time, a romantic relationship may take on new characteristics, acquire new meaning, and serve new functions (Furman & Collins, 2009). For example, the attachment and caregiving behavioral systems typically become more salient as the relationship develops (Furman & Wehner, 1994).

Of particular importance are the formative experiences and developmental processes that occur during emerging adulthood. The salience of romantic relationships increases across these years, rivaling and sometimes surpassing those with parents and eclipsing those with friends (Laursen & Williams, 1997). Many emerging adults face decisions about long-term commitment, including cohabitation and marriage.

Not only do particular romantic relationships change and develop but also changes can occur across relationships. Emerging adulthood is often a time of exploration, and many persons during this period have a series of different romantic relationships. As relationship experiences accumulate, patterned styles of interacting with romantic partners may emerge or change (Laursen & Jensen-Campbell, 1999). These developmental processes are complicated and multiple in nature. One of the key questions social scientists face is how best to capture the changes and development that occur in romantic relationships and experiences in emerging adulthood.

Over the last two decades, statisticians have developed a range of different statistical procedures to analyze change and development. Traditionally, autoregressive models were the method of choice with longitudinal data. Latent growth curve models are commonly used today, and growth mixture modeling, trait-state-error models, and other complex models have emerged as promising techniques. Many excellent papers and books describe the details of these statistical techniques and the mathematical underpinnings of procedures available for modeling longitudinal data. This proliferation of methods may foster confusion about which analytic model is most appropriate for which type of research question. Few papers have addressed differences in how the various models conceptualize and measure change; most are devoted to describing statistical rather than conceptual differences (Bollen & Curran, 2004; Ferrer & McArdle, 2003; Grimm, 2007; Ram & Grimm, 2007).

Understanding how the statistical models conceptualize change is particularly important in the study of emerging adults' romantic relationships, because the nature of romantic development and change during this period is likely to vary depending on the aspect of the relationship under consideration. *Stochastic* processes of change, which emphasize the variable or random element of change over time, differ from *deterministic* processes of change, which describe the steady unfolding of a continuous process. Stochastic change arises when a variable is influenced by proximal factors that are themselves in the midst of change. For example, one's current relationship satisfaction may be influenced by recent exchanges with one's romantic partner. In this way, satisfaction is influenced more strongly by current or recent events than by the general course of prior events. In contrast, deterministic processes unfold in a consistent, developmentally driven fashion. For example, the quality of accumulated interactions with one's romantic partners may shape one's perceived competence in future romantic relationships. As experiences accumulate, the course of development becomes increasingly determined, unfolding with regularity in timing and direction. The nature of development from adolescence into emerging adulthood can vary in other ways as well. Some constructs may be more trait-like and unchanging during this time. Still other constructs may demonstrate multiple patterns of growth.

In this chapter we discuss the conceptual underpinning of statistical models of change. It is not intended to be a statistical primer. We assume some familiarity with the statistical models and provide just an overview of each technique. Instead, we focus on the underlying conceptualization of change within each type of model (e.g., stochastic vs. deterministic) and their relative strengths and weaknesses as applied to the study of romantic relationships. We demonstrate the use of these models with examples from an ongoing research project on emerging adults' romantic relationships, summarizing issues relevant to model selection and interpretation. The chapter is designed to guide investigators in the selection of analytic models that best capture the nature of development in emerging adults' romantic relationships.

PROJECT STAR

Project STAR is an ongoing longitudinal investigation of close relationships and psychosocial adjustment during adolescence and emerging adulthood. An ethnically diverse community sample of 200 10th-grade adolescents (100 male, 100 female) was recruited from the Denver metropolitan area. Participants completed interviews and provided observational and self-report questionnaire data about themselves and their close relationships. Similar data were collected from participants' parents, friends, and romantic partners. In this chapter, we describe data collected over the first five time points: when the participants were in the 10th, 11th, and 12th grades; one year post-high school; and 2.5 years post-high school.

At Time 1, 55% reported having a romantic relationship of at least one month's duration during the last year; at subsequent times, between 69% and 75% reported having a romantic relationship during the last year. The average length of these relationships was 5.8 months at Time 1 and increased to 16 months by Time 5. At Time 2, 11.5% of participants reported dating the same romantic partner as at Time 1; 20.5% of those at Time 2 were dating the same partner at Time 3, 23.5% were dating the same partner at Times 3 and 4, and 20.5% were dating the same person at Times 4 and 5. At Time 1, participants had had an average number of 3.1 relationships, whereas by Time 5, the average had risen to 8.6. A more complete description of the participants in this ongoing investigation is provided in Furman, Low, and Ho (2009).

In this chapter we focus on the development of romantic relationship satisfaction and perceptions of romantic competence. *Romantic relationship satisfaction* was assessed using the 6-item Quality of Marriage Index (QMI; Norton, 1983), which was adapted to apply to noncommitted, as well as committed relationships. *Perceived romantic competence* was assessed with a subscale of the Self-Perception Profile for Adolescents (SPP-A; Harter, 1988). This subscale consists of five items designed to assess emerging adults' perceptions of their own competence and appeal in romantic situations.

We selected romantic relationship satisfaction and perceived romantic competence to demonstrate differences in stochastic and deterministic processes and the implications of these differences for modeling change. We expected romantic relationship satisfaction would be more stochastic than deterministic in nature, because it should be influenced by one's partner and because romantic experiences related to satisfaction are likely to differ from one partner to the next. We expected romantic competence would be more deterministic than stochastic in nature, because levels of competence are not expected to fluctuate over the course of development. Instead, as experiences accumulate, perceived romantic competence is expected to gradually increase. As we demonstrate, differences between the change processes of these variables have important implications for the selection of statistical models.

MODELS OF CHANGE

In the rest of the chapter, we provide an overview of various models that are available for examining change, describe the research questions these models address, and illustrate each model using the relationship satisfaction and romantic competence variables. We begin with an autoregressive cross-lagged panel model. Because this model predicts the current level of a variable from a previous time point, we anticipate that it will be particularly useful for modeling stochastic change. Next, we add latent intercept and growth variables to create a latent growth curve model. Because this model implies an underlying, continuous trajectory of development, it is expected to improve the modeling of deterministic change. The third model is a growth mixture model, which identifies multiple trajectories of change. In this model, change is modeled deterministically, but individuals may differ in the trajectory of change that they follow. Finally, we present a technique for identifying the stable and time-dependent change processes that may occur together within a variable. This trait-state-error model partitions variance within a construct into trait-like (e.g., deterministic), state-like (e.g., stochastic), and error components.

Autoregressive Cross-Lagged Model

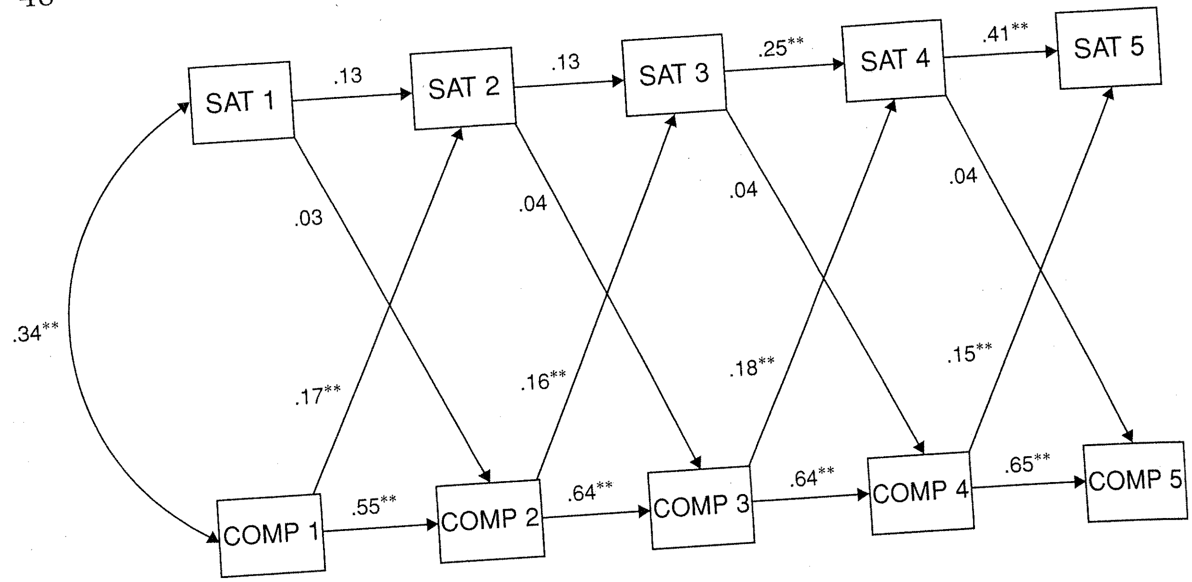
Overview

The first model is an autoregressive cross-lagged model (see Kline, 2004 for a technical description). In autoregressive cross-lagged models, the level of the variable of interest is directly predicted by levels of that variable and of different variables in relation to the previous time point. In the autoregressive portion of the model, the relatedness of a single variable over time is modeled by regressing the value at any given time point (T) on the value of the *same* variable at the previous time point (T-1). For example, in Figure 4.1 the level of romantic relationship satisfaction at the second time point is regressed on the level of romantic relationship satisfaction at the previous time point (T-1). In the cross-lagged portion of the model, the level of one variable at a given time point (T) is predicted by the level of the *other* variable at the previous time point (T-1). For example, the level of romantic relationship satisfaction at the second time point is regressed on the level of perceived romantic competence at Time 1. Cross-lagged regressions are often modeled in both directions (e.g., earlier satisfaction predicting later competence as well as earlier competence predicting later satisfaction), capturing the potential effect of one variable on another.

Research Questions

We identified three research questions that can be addressed with this autoregressive cross-lagged model:

1) What is the concurrent association between the two variables at Time 1?
2) What is the stability of romantic relationship satisfaction and perceived romantic competence over time? To what extent do earlier levels predict later levels?



Model Fit	
X^2 (33)	76.99
CFI	0.92
RMSEA	0.08
AIC	6874.58

Variance Accounted For			
	R^2		R^2
SAT 2	.06	COMP 2	.31
SAT 3	.06	COMP 3	.43
SAT 4	.13	COMP 4	.43
SAT 5	.24	COMP 5	.45

Figure 4.1. Autoregressive cross-lagged model of romantic competence and satisfaction. Parameters are standardized ($^{**}p < .01$; $^{*}p < .05$). Error terms (not shown) are correlated within time. SAT = relationship satisfaction; COMP = romantic competence.

3) Do earlier levels of romantic relationship satisfaction predict later levels of perceived romantic competence? Do earlier levels of perceived romantic competence predict later levels of romantic relationship satisfaction?

Data Illustration

The model depicted in Figure 4.1 provided a good fit to the data. We turn first to the question of the initial correlation between romantic relationship satisfaction and perceived romantic competence. The findings indicate a moderate positive association between romantic relationship satisfaction and perceived romantic competence at age 16. The second research question concerns the stability of each construct. The autoregressive paths between time-adjacent competence scores were all statistically significant for perceived romantic competence, and the latter two paths were statistically significant for romantic relationship satisfaction. Across ages 16 to 23, there was considerable consistency in perceived romantic competence. From ages 16 to 18 there was little consistency in romantic relationship satisfaction, although stability increased between ages 18 and 23. The third research question concerns the association between romantic relationship satisfaction and perceived romantic competence over time. The cross-lagged paths from perceived romantic competence to romantic relationship satisfaction were statistically significant, but the paths from satisfaction to competence were not.

Summary

The autoregressive model seems to be an appropriate model for describing the associations over time between romantic relationship satisfaction and perceived romantic competence. The two variables are associated with each other at Time 1, and they become increasingly stable over time. The significant cross-lags could indicate that perceived romantic competence has temporal precedence over romantic relationship satisfaction.

For the sake of simplicity, we constrained the cross-lagged parameters to be equal over time in this model, but this constraint is not required. That is, change does not have to occur smoothly or unfold in a consistent fashion. Instead, change can occur unevenly, with times of stability and instability and with periods when variables are strongly or weakly predictive. For example, less stability and less predictive power might be expected during an important developmental transition.

The autoregressive model is not without limitations. First, variables at the preceding time are assumed to be the primary determinant of the variables at the next time. Usually a direct link between the values of a particular variable at different times is only provided at directly adjacent time points (Curran & Bollen, 2001). Thus, the model assumes no direct effect between variables at Time 1 and variables at Time 3. Any effect that variables at Time 1 have on variables at Time 3 is mediated by the Time 2 variables. This assumption may be overly stringent and may lead to models with unnecessarily poor fit. Fortunately, this situation is easily remedied by allowing direct paths between nonadjacent time points. Second, the autoregressive portion of the model may be useful in determining the relative predictability of scores based on previous levels (e.g., stability), but the model does not capture the potential growth (or mean-level change) of the variable over time (Ferrer & McArdle, 2003). For example, the model indicates that competence at Time 1 predicts competence at Time 2, but it does not indicate whether competence increases or decreases from one time point to the next.

Latent Growth Curve Model

The increasing popularity of growth curve modeling over the last two decades is evident in the literature. Technical descriptions of this modeling technique are provided elsewhere (see Duncan, Duncan, Strycker, Li, & Alpert, 1999). To remain consistent in our illustrations, we present a bivariate latent growth curve (LGC) model, but other variations of this model exist (e.g., univariate models, models with time-varying covariates, and models with time-invariant covariates).

Overview of the Model

Change modeled within the LGC approach is considered to be deterministic because it represents a stable developmental process or trajectory that continuously unfolds over time. Individual trajectories of development may vary in terms of the intercept, which typically represents the initial level of a variable. Trajectories may also vary in slope, which represents the direction and degree of change. Importantly, the developmental process that is characterized by the trajectory theoretically occurs independently of previous levels. Once an individual begins to develop along a certain trajectory, that developmental process is expected to continue to unfold in a relatively predictable fashion.

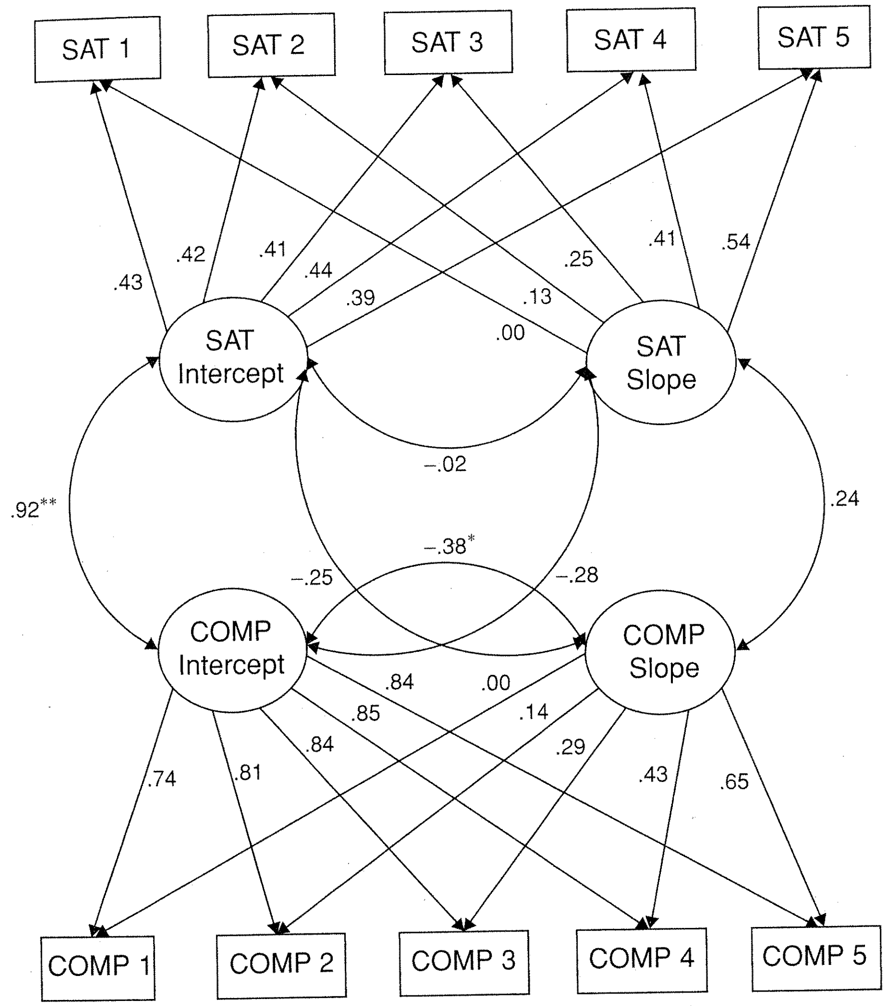
Growth curve modeling requires repeated measures of a variable for at least three time points. From the observed measures, a latent slope factor is estimated. The factor loadings from each observed time point to the latent slope variable are specified so as to describe a particular pattern of growth, such as linear or quadratic. A latent intercept factor also is estimated and is typically used as the starting point of the growth curve. Finally, the association between the initial level of a construct and the slope of growth in the construct can be examined by estimating the covariance between these latent variables. For example, emerging adults with initial high levels of romantic relationship satisfaction (intercept) may experience greater increases in satisfaction over time (slope).

Research Questions

An LGC model can address the following research questions:

1) What pattern of growth best fits the observed data? Specifically, does growth in romantic relationship satisfaction and in perceived relationship competence proceed in a linear fashion (or quadratic, exponential, etc.)?
2) How much of the variation in romantic relationship satisfaction and perceived relationship competence can be accounted for by these trajectories?
3) Do individuals differ in romantic relationship satisfaction and perceived relationship competence at the onset of the study?
4) Do individuals differ in the rate of growth in romantic relationship satisfaction and perceived relationship competence?
5) How are early levels of a construct related to the growth of the construct? In the current model, is the initial level of romantic relationship satisfaction related to the growth of satisfaction? Is the initial level of perceived relationship competence related to the growth of competence?

By combining two univariate models into a single bivariate LGC model (as seen in Figure 4.2), development within a system of variables may be examined.



Model Fit	
X^2 (40)	77.89
CFI	0.93
RMSEA	0.07
AIC	6861.49

Variance Accounted For			
	R^2		R^2
SAT 1	.18	COMP 1	.55
SAT 2	.19	COMP 2	.59
SAT 3	.23	COMP 3	.60
SAT 4	.36	COMP 4	.63
SAT 5	.44	COMP 5	.72

Figure 4.2. Bivariate latent growth curve of romantic competence and satisfaction. Parameters are standardized (**$p < .01$; *$p < .05$). Error terms (not shown) are correlated within time. SAT = relationship satisfaction; COMP = romantic competence.

Change in both variables is conceptualized as unfolding simultaneously along continuous trajectories. A latent slope and intercept factor are estimated for each variable. In addition, the intercepts and slopes of each variable can be allowed to covary. In this way, several additional research questions may be explored:

6) Is the initial level of romantic relationship satisfaction related to the initial level of perceived relationship competence?

7) Is the growth of romantic relationship satisfaction related to the growth of perceived relationship competence?
8) Is the initial level of romantic relationship satisfaction related to the growth of perceived relationship competence? Is the initial level of perceived relationship competence related to the growth of romantic relationship satisfaction?

Data Illustration

The bivariate LGC model is depicted in Figure 4.2. To address the first research question regarding the pattern of growth, we examined the means for the latent slope variables. The latent slope means for perceived romantic competence and romantic relationship satisfaction were positive, suggesting linear growth over time. We also examined a quadratic growth factor for both variables (not depicted in Figure 4.2), but these models did not fit the data.

Next, we examined the amount of variance accounted for by each trajectory (see the R^2 values in Figure 4.2). Modeling perceived romantic competence as a latent trajectory accounted for 55% to 72% of the variance in the five romantic competence manifest variables. The latent romantic relationship satisfaction trajectory accounted for only 18% to 44% of the variance in observed satisfaction scores. This finding is consistent with assertions about the deterministic nature of perceived romantic competence and the stochastic nature of romantic relationship satisfaction. A comparison of the growth curve model and the previous autoregressive model indicates that the addition of latent trajectories to the manifest variables increases the amount of variance accounted for in perceived romantic competence and romantic relationship satisfaction (compare R^2 values in Figure 4.1 and in Figure 4.2). This suggests that there is some merit in representing change in these variables during adolescence and emerging adulthood as a developmental trajectory.

The third and fourth research questions concern individual variation in the initial level and growth of perceived romantic competence and romantic relationship satisfaction. For perceived romantic competence, we found significant variance in both the intercept and the slope, indicating that late adolescents varied in their initial level of romantic relationship competence and that there was considerable variation in the rate of change in competence across the transition into emerging adulthood. This was not the case for romantic relationship satisfaction, for which intercept and slope were fairly uniform. The absence of variation in the trajectories for romantic relationship satisfaction may be because the variable is primarily stochastic in nature. Usually, if there is no significant variance in growth parameters, there is nothing to be explained, and no further tests are needed (Karney & Bradbury, 1995). For purposes of illustration, we went ahead and specified the bivariate growth curve models anyway.

The final three research questions pertain to the associations between perceived romantic competence and romantic relationship satisfaction intercepts and slopes. We found that the intercept for romantic competence was positively related to the intercept for relationship satisfaction, suggesting that the two variables were moderately correlated at the outset of the study and replicating results from the autoregressive cross-lagged model. Other covariances between the variables' latent variables did not reach statistical significance.

Summary

The bivariate LGC model revealed positive linear growth in both romantic competence and relationship satisfaction. Emerging adults varied significantly in initial levels and rate of growth in romantic competence; initial levels of these variables also were related.

Important advantages of the LGC model over the autoregressive cross-lagged model are its ability to describe patterns of growth and to identify interindividual differences in growth. The LGC model is also capable of linking the initial level of a construct to the rate of growth in the same or in a different construct. This is an important feature, as development within one variable can be interpreted within the context of related variables that are also undergoing developmental change.

Despite these advantages, several limitations of the LGC model are apparent. For example, the LGC model does not provide an estimate of a variable's stability over time. In addition, it assumes that a significant proportion of the change or development is deterministic in nature and can be described in terms of an underlying trajectory. Change that occurs abruptly or inconsistently, as a result of a "turning point" or sudden transition to a new developmental stage, may be difficult to capture. Moreover, the LGC model assumes that a single pattern of change (linear, quadratic, or cubic) describes all individuals. However, if some individuals follow a linear trajectory and others follow a quadratic trajectory, the model may not fully capture the development of the variable.

Additionally, the relationship between two variables is only examined in terms of the associations between their intercepts and slopes. The association between slopes is summarized by a single covariance coefficient aggregated across all time points, and thus the model cannot identify time-varying associations. If, for example, the relation between growth in satisfaction and in romantic competence was strong only at Time 3 and 4, this pattern would not be evident in the bivariate LGC model. In this regard, the bivariate LGC model is not sensitive to potential differences in the interrelations between variables at different time points, which is an advantage of the cross-lagged model. Moreover, although the association between intercepts and slopes is a powerful tool for detecting long-term trends, LGC analyses preclude inferences about whether change in one variable leads to subsequent changes in the other.

Finally, although including latent trajectories increased the proportion of variance accounted for in both competence and satisfaction, it is important to note that this effect was not uniform; the increment in explained variance was greater for competence than for satisfaction, suggesting that the development of competence may be more deterministic than the development of satisfaction. In fact, a follow-up analysis revealed significant autoregressive paths across two time points for perceived romantic competence (e.g., Time 1 predicting Time 3). However, the stability of romantic relationship satisfaction over two time points was low, suggesting that there may not be a smooth and predictable trajectory underlying changes in satisfaction. These findings are consistent with the idea that romantic competence is more deterministic in nature, whereas satisfaction is more stochastic in nature.

Growth Mixture Model

Overview of the Model

In contrast to the bivariate growth curve model in which individuals progress along a single trajectory, growth mixture modeling (GMM) assumes that the population contains groups that differ in their developmental trajectories (Nagin, 1999). The procedure is designed to identify the optimal number of groups and describe the trajectories of each. Importantly, each trajectory does not need to conform to the same pattern of growth. As in the bivariate LGC, change processes in GMM are assumed to occur deterministically.

Research Questions

GMM addresses many of the same questions as the bivariate LGC model, but the ability to identify groups with distinct developmental trajectories gives rise to some new research questions:

1) What are the different patterns of growth in perceived romantic competence? What are the different patterns of growth in romantic relationship satisfaction?
2) What proportion of individuals follows each trajectory?
3) What is the link between an individual's trajectory of perceived romantic competence and trajectory of romantic relationship satisfaction?

Data Illustration

In regard to the first research question, we found four distinct trajectories of perceived romantic competence (see Figure 4.3). Just as significant variance was found in the latent intercept in the bivariate LGC, each of these four trajectories represents a unique starting point for a particular group of individuals. Those in the first trajectory had the lowest level of romantic competence,

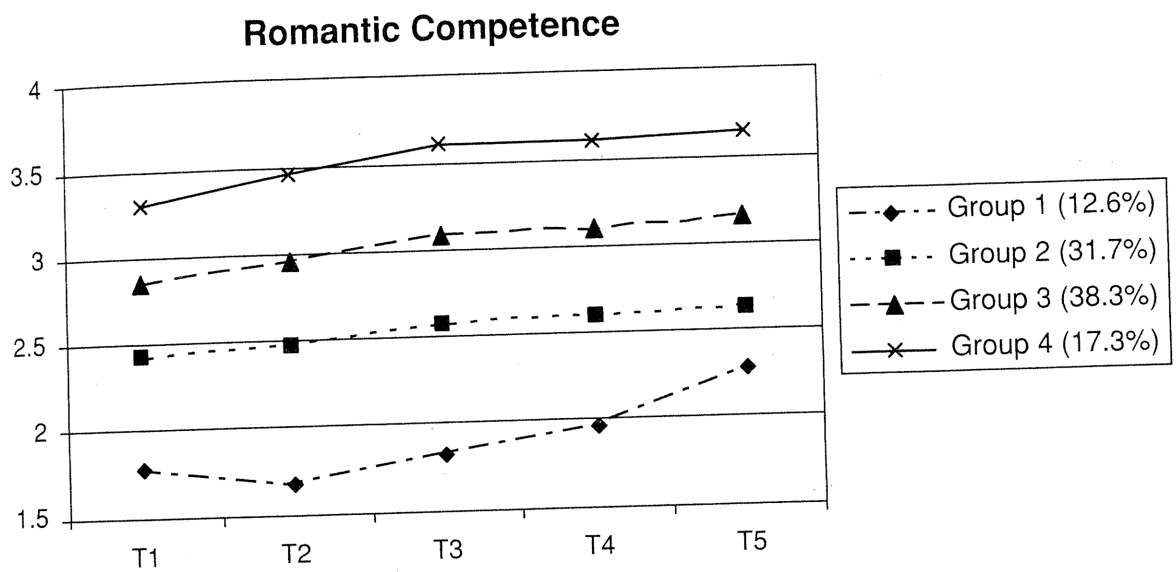


Figure 4.3. Trajectories of four growth mixture groups for romantic competence.

and each subsequent group had increasingly higher scores, initially and over time. The trajectory of the first group was quadratic, with most of the change coming during emerging adulthood, whereas the other three groups exhibited linear patterns of growth. There were two distinct satisfaction trajectories (see Figure 4.4). Individuals in the low satisfaction group displayed no growth over time, whereas those in the high satisfaction group displayed linear growth.

The second research question asked about the proportion of individuals who followed each trajectory (see Figures 4.3 and 4.4). In terms of perceived romantic competence, most individuals followed one of the two middle trajectories (e.g., Group 2 or Group 3). Relatively few individuals (12.6%) followed the lowest trajectory of perceived romantic competence. In terms of romantic relationship satisfaction, the proportion of individuals was similar in the

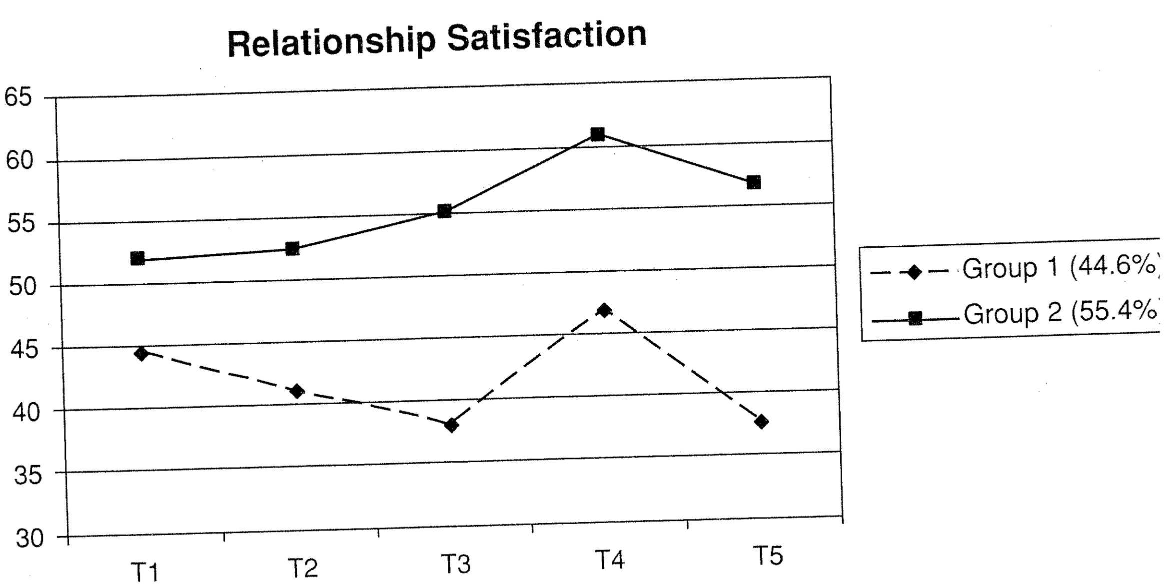


Figure 4.4. Trajectories of two growth mixture groups for relationship satisfaction.

high and low trajectories, with somewhat more than half following the low satisfaction trajectory.

The third research question investigated the link between trajectories of perceived romantic competence and romantic relationship satisfaction. As part of the estimation procedure, we calculated a probability of group membership for each individual for each trajectory. For example, an individual with consistently high perceived competence scores over time would have a high probability of membership in Group 4 and a correspondingly low probability of membership in Group 1. The probability of group membership for each perceived romantic competence trajectory can then be correlated with the probability of group membership for each romantic relationship satisfaction trajectory. This analysis revealed that the two sets of trajectories were related to each other. Individuals in the highest perceived romantic competence group also were the most likely to be in the high romantic relationship satisfaction group ($r = .39$), whereas those in the lowest perceived romantic competence group were the least likely to be in the high romantic relationship satisfaction group ($r = -.32$).

Summary

One of the primary advantages of growth mixture modeling is that it does not assume a single pattern of growth. Development in romantic competence unfolded for some emerging adults in linear fashion and for others in quadratic fashion. Similarly, one group of emerging adults displayed no growth in relationship satisfaction, whereas other groups displayed linear growth. Thus, differences in the rate and shape of development were evident across individuals.

Relatedly, it is possible for a variable that initially appears stochastic to be better represented with several different (deterministic) trajectories. For example, in the case of satisfaction, the low magnitude of the autoregressive paths in the autoregressive cross-lagged model suggested stochastic change. However, the present model identified two distinct trajectories, one that was increasing in satisfaction over time and one that was decreasing. The presence of these opposite trends within the data may have obscured the nature of the changes in satisfaction.

It is important to note that the groups are identified empirically. When complex patterns of growth are identified in the data, one is left with the challenge of providing a theoretical rationale for the presence of each group. An a priori conceptual foundation is strongly advised. Additionally, the groups can vary substantially in size, although small groups may present some problems in follow-up analyses.

It is possible to examine whether the likelihood of being in a specific trajectory for one variable is related to the likelihood of being in a specific trajectory for another variable. However, the relations between the two sets of trajectories are not reflected in one simple correlation; thus, it is possible to determine that some groups in one trajectory are related to some groups in another trajectory, but certain groups are unrelated to group membership in the other trajectory. One weakness, however, is that, as with the bivariate LGC, it is not possible to evaluate temporal precedence in growth mixture modeling; one can only determine if two trajectories are related.

Trait-State-Error Model

Thus far we have emphasized the distinction between stochastic and deterministic developmental processes as a factor in choosing a modeling technique. Kenny and Zautra (1995) discussed another important consideration in the conceptualization of change and presented the trait-state-error model (TSE; see also Cole, Martin, & Steiger, 2005).

Overview of the Model

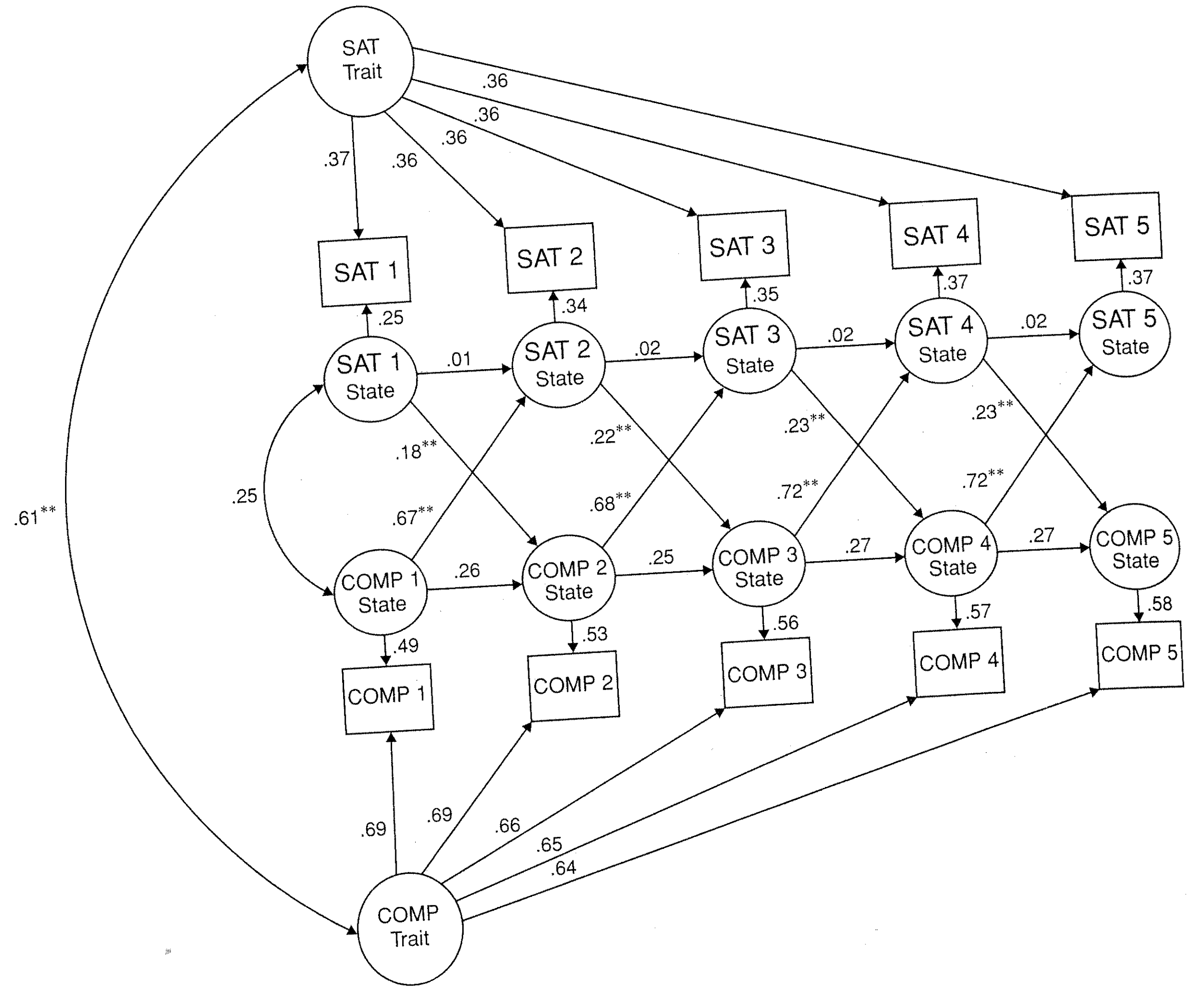
As its name suggests, the TSE model is designed to partition a variable into three components: (1) a stable baseline component that does not change over time (trait component), (2) a time-dependent component that fluctuates as a result of development or the proximal influences from other constructs (state component), and (3) a random error component (see Figure 4.5).

The trait component is conceptualized as the portion of a construct that remains steady and unchanging over time. Although both are described as stable, the trait component is conceptually different from the deterministic change process inherent in the LGC models. Whereas deterministic change continues to show development over time (growth), the trait component of the TSE model is stable and *un*changing over time.

It is around this baseline trait component that change from one time to the next takes place and is modeled as the state component in the TSE model. Change is conceptualized as stochastic in nature and is captured through a series of autoregressive paths. In this way, the state component is allowed to fluctuate over time, and the influence of earlier levels on later levels can be estimated.

Finally, the TSE model estimates an error component. This portion of a variable is conceptualized as random fluctuation that is unrelated to change over time (e.g., measurement error).

By way of example, consider perceived romantic competence. To the extent that an individual perceives herself to be socially skilled in other relationship contexts (e.g., with peers), she may perceive herself as similarly competent in the romantic domain. This serves as a trait-like, baseline level of perceived romantic competence. Over time, she is likely to experience both negative and



Model Fit	
X^2 (36)	95.11
CFI	0.91
RMSEA	0.09
AIC	9797.92

Variance Accounted For			
	R^2		R^2
SAT 1	.20	COMP 1	.72
SAT 2	.24	COMP 2	.72
SAT 3	.25	COMP 3	.74
SAT 4	.26	COMP 4	.74
SAT 5	.26	COMP 5	.75

Figure 4.5. Trait-state-error model of romantic competence and satisfaction. Parameters are standardized (**$p < .01$; *$p < .05$). Error terms (not shown) are correlated within time. SAT = relationship satisfaction; COMP = romantic competence.

positive interactions with romantic partners, causing state-like fluctuations in her perceived romantic competence. Of course, at every time point, some amount of measurement error also will be responsible for fluctuations in perceived romantic competence. Moreover, if the individual perceives herself as growing in romantic competence over time, this change will not be directly captured in the TSE model.

As in the other models, the TSE model may be specified as a bivariate system (see Figure 4.5). To this end, the latent trait factors for each variable are allowed to covary, as are the within-time state and error components. Further, it is possible to model the cross-lagged influence of one state component on the other state component, as in the autoregressive cross-lagged model.

Research Questions

Of primary interest in the TSE model is the ability to partition a variable into state-like and trait-like components. Thus, the key research question is the following:

1) What proportion of the variance in perceived romantic competence and romantic relationship satisfaction is accounted for by trait, state, and error variance, respectively?

When modeled as a bivariate system, additional research questions may be addressed:

2) To what extent is the trait component of perceived romantic competence related to the trait component of romantic relationship satisfaction, thereby suggesting that competence and satisfaction share features that lead to similar scores on the measures of both constructs?
3) Do earlier estimates of the state-like component of perceived romantic competence predict subsequent estimates of the state-like component of romantic relationship satisfaction? Conversely, do earlier estimates of the state-like component of romantic relationship satisfaction predict subsequent estimates of the state-like component of perceived romantic competence?

Data Illustration

As can be seen from Figure 4.5, the bivariate TSE model provided a reasonable fit to the data. The first research question is addressed by partitioning perceived romantic competence and romantic relationship satisfaction into separate components of trait, state, and error variance. For perceived romantic competence, 47.2% of the variance was accounted for by the trait component, and 24.2% was accounted for by the state component. The remaining 28.6% of variance was error variance. For romantic relationship satisfaction, 13.1% of the variance was accounted for by the trait component, and 6.4% was accounted for by the state component. Nearly 80% of the total variance in romantic relationship satisfaction was estimated to be error variance. Thus, a trait component accounted for the largest portion of the variances in perceived romantic competence, whereas error accounted for the majority of the variance in romantic relationship satisfaction.

Examining the bivariate components of the model revealed a significant correlation between the two latent trait factors. This finding suggests that competence and satisfaction in emerging adults share common features that lead to similar scores on measures of both constructs. In addition, both sets of cross-lagged regression paths (earlier competence predicting later satisfaction and vice versa) were significant. Thus, in both cases, the state-like component of one precedes and predicts the later state-like portion of the other. A similar relationship was found for competence predicting satisfaction in the autoregressive cross-lagged model, though not the other way around. The presence of both cross-lagged paths suggests that competence and satisfaction may be involved in a reciprocal feedback loop.

Summary

The TSE model has both advantages and disadvantages. Its primary advantage is its ability to partition variance and thereby identify the relative contribution of trait-like and state-like components within a construct. Change is described in terms of the stochastic processes that occur within the state component – much like in the autoregressive cross-lagged model. One key difference between these models is the ability of the TSE model to describe change and its influence on the state components of other variables separately from the stable and unchanging trait component. Relatedly, the TSE model can account for the influence of error variance on the manifest scores over time. In so doing, it removes this source of fluctuation in scores from the analysis of change in the state component.

Similar to the autoregressive cross-lagged model, the TSE model is limited in several ways. Most important, it does not provide a clear picture of any mean-level growth that occurs over a developmental period. The TSE model also presents several technical challenges (see Cole et al., 2005). It may have difficulty partitioning the state component from the error component when stability within the construct is not high. In other words, when the relationship between a construct at one time point and the next is not strong, as is the case at the early time points for romantic relationship satisfaction (see Figure 4.1), the estimate of error variance may become inflated. This seems to be a likely explanation for the very large error component in romantic relationship satisfaction and suggests that the TSE model is not suitable for modeling this construct – at least not during this developmental period. Other technical challenges associated with the TSE model include the need for at least four time points of longitudinal data and the complexity of model specification required for model identification and stable parameter estimates. Cole and colleagues (2005) described these challenges more fully and offered an alternative modeling strategy when multiple indicators are available.

Despite these limitations, this type of model offers an alternative conceptualization of constructs that is not considered in more traditional approaches (e.g., autoregressive cross-lagged and LGC models). Partitioning a variable into trait and state components, while simultaneously analyzing change processes, provides a different perspective on the processes that occur during this developmental period.

ROMANTIC RELATIONSHIP SATISFACTION AND PERCEIVED ROMANTIC COMPETENCE IN EMERGING ADULTHOOD

As part of this review, we applied different analytical models to the same data on youth who were making the transition from adolescence into emerging adulthood. Taken together, the analyses provide an interesting mosaic of the developmental nature of relationship satisfaction, romantic competence, and their ties with each other. Across all of the models presented, there was a significant positive association between romantic competence and relationship satisfaction. Emerging adults who perceive themselves to be competent in romantic situations are more satisfied in their relationships. The LGC models revealed that emerging adults tend to perceive themselves as more competent and to become more satisfied in their romantic relationships over time. Both the autoregressive cross-lagged model and the TSE model revealed that emerging adults' sense of romantic competence predicts later romantic relationship satisfaction; the reverse was also true for the TSE (but not the autoregressive cross-lagged) model, raising the possibility of a reciprocal feedback loop between these constructs. As emerging adults gain more experience in romantic relationships, they become increasingly confident in their ability to successfully negotiate romantic interactions, which leads to greater satisfaction.

The GMM results add to the complexity of the developmental picture during this period. Specifically, it found multiple trajectories for both perceived romantic competence and romantic relationship satisfaction. Different groups of emerging adults may have relatively high or low points of satisfaction at different times; in fact, for those who begin at a lower level, satisfaction seems to remain low over time. Similarly, emerging adults reported varying levels of perceived romantic competence, and those in the lowest group followed a different pattern of development than those who reported more perceived competence. Overall, the GMM results demonstrate the need to consider heterogeneity in developmental patterns.

MODELS OF CHANGE

Having illustrated and compared the application of each model, an important question remains unanswered: How does one select a particular model to use? For convenience, several factors discussed in this chapter are listed in Table 4.1.

Care must be taken to match research questions with the best statistical model. For example, the autoregressive cross-lagged model lends itself to examining developmental stability within variables, as well as time-specific relations across variables. This model is particularly useful when the research question involves determining temporal priority among related variables or establishing prospective relations. In contrast, LGC models are better suited

Table 4.1. *Important considerations when selecting models of change*

Questions to ask
1.) What specific research questions are important to address?
2.) How is the development of a construct expected to unfold?
a.) Is it a stochastic or deterministic process?
b.) Might there be multiple trajectories of development?
c.) Might there be a stable, unchanging component in the developmental construct?
3.) Is there reason to believe that the nature of development may change over time?
4.) What data are available, and will they support the selected model?
5.) How might the use of several models provide a more complete understanding of the developmental construct?

to answering questions about the pattern of growth, individual differences in growth, and the relation between initial level and growth. Although similar to a traditional LGC model in its ability to characterize growth, GMM provides the unique ability to identify multiple trajectories. Thus, when multiple trajectories are expected or when a researcher is interested in variations in developmental progress, the GMM approach may be best suited. Finally, the TSE model is particularly useful in characterizing the nature of a construct in terms of stable trait and fluctuating state components and modeling stochastic change within the state component.

The second consideration in choosing a model is the theoretical conceptualization of the underlying change mechanism. When the processes are stochastic in nature or when change does not occur smoothly or in a continuous fashion, then autoregressive techniques may be useful. LGC models may be more appropriate when change processes are thought to be more deterministic in nature and can be characterized as trajectories over time. However, adding a single latent trajectory may not adequately capture the complexity of change processes across individuals, suggesting the use of growth mixture models. The TSE model conceptualizes change somewhat differently, considering developmental constructs to be partially stable and unchanging and to be partially state-like or stochastic. This modeling technique is particularly useful in isolating the change component of a variable and assessing for stability and influence on later time points.

Of course, selecting a model based on the nature of change presupposes that the process of change is understood. Our observations of perceived romantic competence and romantic relationship satisfaction provide some guidance on this topic. First, the degree of stability may suggest a change process. The autoregressive cross-lagged model revealed that perceptions of competence were fairly stable across the transition into emerging adulthood; relationship satisfaction, however, was moderately stable only during emerging adulthood. These findings are consistent with our hypothesis that romantic competence develops in a deterministic fashion, whereas satisfaction is more stochastic. Second, the proportion of variance that is accounted for by each model may suggest a particular process of change. More variation in competence was accounted for when modeled as a trajectory, suggesting deterministic change. Interestingly, the same was true of satisfaction, though to a lesser degree. This finding suggests that there may be some modest element of continuity in satisfaction; however, in conjunction with the observation that stability increased during emerging adulthood, it could be that romantic relationship satisfaction may begin as a variable, stochastic process and become increasingly deterministic over time. Third, the GMM model illustrated the need to assess for multiple deterministic trajectories. When subgroups develop along trajectories with opposite trends, a variable may appear stochastic at the group level.

A practical issue to consider in selecting a modeling strategy is the availability of the data. LGC models require at least three data points, though more are preferable. The TSE model requires at least four time points and is ideally run with large samples (e.g., $N = 500$; Cole et al., 2005). It is also worth mentioning that the number and spacing of time points may influence how a variable seems to change. With only a few time points, a variable may appear stochastic, but with additional data collection, a deterministic trajectory may emerge. Similarly, if the time points are spaced relatively far apart, associations over time may be less stable, making the variable appear stochastic in nature; however, collecting data more closely in time may reveal a smoother, more continuous developmental process. Finally, the nature of a variable may change over time. As mentioned previously, romantic relationship satisfaction at first appears stochastic in nature, but may become more deterministic over time. The number and spacing of data collection time points must be adequate to capture such a process.

Finally, the preceding discussion assumes that one must choose a particular model to use based on a consideration of research questions and a theoretical conceptualization of change. The prevailing view holds that these models represent competing theories of change and are mutually exclusive (see Bollen & Curran, 2004, for an exception). We suggest that in some instances the models are less competitive and more complementary than traditionally thought. Each model seems to offer a unique and valuable perspective on the developing system of variables. In fact, interpreting the results of multiple models in conjunction may promote a more complete understanding of the nature of development. At the same time, it is important to remember that the different models address different questions and imply different theories of change. The use of multiple models would only be appropriate when the different questions are pertinent and when multiple forms of change processes may be present.

In addition, there are other models available that were not described in this chapter. For example, we examined linear growth curve models, but quadratic ınd other nonlinear models exist as well (Burchinal & Appelbaum, 1991; Grimm 2008). Additionally, alternative models exist, such as variations on the TSE model (Cole et al., 2005) and the latent difference score model (McArdle & Hamagami, 2001), as well as several hybrid models that combine features of the autoregressive cross-lagged model with a bivariate LGC model (Bollen & Curran, 2004). These models all describe change at the level of a single reporter. Recent advances in the analysis of interdependent data permit scholars to track longitudinal changes over time using reports from both participants in a relationship (Laursen, Popp, Burk, Kerr, & Stattin, 2008; Popp, Laursen, Kerr, Stattin, & Burk, 2008; see also Chapter 5). Thus, the investigator today has a range of promising choices.

This chapter underscores the importance of carefully identifying the questions of interest and the implicit process of change when modeling important developmental transitions. Emerging adulthood is a period of transition and growth, during which the nature of change may take many forms. As we have seen with romantic relationship satisfaction, the nature of change itself may change (e.g., become more deterministic). Paying careful attention to these processes is essential if we are to capture the richness of developmental change in romantic relationships in emerging adulthood.

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