

MULTIVARIATE AUTOREGRESSIVE CROSS-LAGGED MODELING OF THE RECIPROCAL LONGITUDINAL RELATIONSHIP BETWEEN PERCEIVED CONTROL AND ACADEMIC ACHIEVEMENT¹

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Summary.—Although many studies have demonstrated positive associations between perceived control and academic achievement, few studies have actually explored which of the two constructs is the determinant of the other. There are only a few longitudinal studies on the relationship of perceived control and academic achievement. The present study examined the reciprocal longitudinal relation between perceived control and academic achievement. Further, considering the multiethnic background of the USA, this study investigated how the relationship between two constructs varies with ethnicity. Using a randomly selected sample of 1,500 students from Asian, Black, Hispanic, and White groups in the National Education Longitudinal Study data, Autoregressive Cross-lagged Modeling was performed to get a complete picture of the longitudinal relationship. Results showed a positive longitudinal effect of academic achievement on perceived control across the ethnic groups. Explanations for these findings are discussed.

Perceived control, based on Rotter's (1954, 1966) social learning theory, refers to a person's belief that one has control over situational outcomes. "Internally oriented" people perceive that they have more control over their own life events. Conversely, "externally oriented" people sense that factors such as powerful others, fate, or chance determine their life events (Rotter, 1989).

Since Rotter's theorizing about locus of control, more elaborate concepts have been developed. For example, Weiner's attribution theory (1979) was developed to explain students' reaction to success or failure and their attributions. Goal orientation theory was developed to explain the amount and kind of effort the students would expend.

Perceived control, however, has been continuously studied (e.g., Goff & Goddard, 1992; Janssen & Carton, 1999; Carden, Bryant, & Moss, 2004) because the relationship between locus of control and achievement is "logical and intuitively appealing" (Findley & Cooper, 1983, p. 419). Logically, when people feel more able to control their own outcomes, they should exert more effort and vice versa.

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Few studies, however, have actually explored which of the two constructs is the determinant of the other; most of the research has drawn on cross-sectional analysis on observational data, which has limitations in specifying causality. Also, relatively little is known about how the relationship between perceived control and achievement varies with ethnicity. Therefore, the present study investigated the longitudinal relation between perceived control and academic achievement to examine the causal relation across ethnic groups (i.e., Asians, Blacks, Hispanics, and Whites).

Perceived Control and Achievement

Previous studies have assumed perceived control to be an important predictor of academic achievement. For example, Bar-Tal and Bar-Zohar (1977) reviewed 36 studies and concluded that the more internal locus of control "caused" the higher academic achievement. Carden, *et al.* (2004) examined the association of internal locus of control and academic achievement and noted that, "Locus of control is the precedent of academic achievement" (p. 582). With some exceptions, however, most of these studies have not investigated causal directions with rigorous statistical methods. For example, Findley and Cooper (1983) reviewed 275 hypotheses in 98 research reports and noted that all of these studies invariably measured locus of control as disposition. There was no manipulation of the locus of control. Therefore, the findings cannot substantiate the claim that internal locus of control enhances academic achievement.

Other studies focusing on the relationship between academic achievement and perceived control with children have revealed different important issues. In their cross-national study of children's perceived control and math achievement, Ho, Zimmer, Sentruck, Fisher, Peralta, Chiu, and Wang (2000) pointed out that cultural differences should be taken into account in the study of perceived control. They noticed a positive correlation between internal control and mathematics achievement in American students but no significant correlation in Asian students.

Considering the importance of different family socialization beliefs and practices in shaping students' perceived control and the concurrent effect on their academic achievement, ethnic discrepancy should not be ignored in the study of perceived control (Yan & Gaier, 1994; Tuss, Zimmer, & Ho, 1995). However, the few cross-cultural investigations which have been conducted to date have limitations in comparative methodology in that they used relatively small samples. Also, little is known about other minority ethnic groups' (i.e., Hispanic and Black) perceived control.

In the present study, students' academic achievement and perceived control are suggested to have a reciprocal relationship. Working with this premise, the longitudinal relationship between the two constructs is examined.

However, the multiethnic background of the USA is also considered to ascertain the possibility of differential patterns in the reciprocal relationships across ethnic groups.

Research Questions

The research on the question of the directionality between sense of control and academic achievement has been scarce. This study aims to advance knowledge of perceived control and academic achievement by addressing the reciprocal, longitudinal, and ethnic variation issues related to this topic. Specifically, our research questions are (a) Is there a causal, directional relationship between perceived control and academic achievement? How does this relationship change over five years of a student's secondary education? and (b) Does the longitudinal relationship between perceived control and academic achievement differ across ethnic groups?

METHOD

Participants

The data were drawn from the base year (1988) and the first (1990) and second (1992) follow-up surveys of the National Education Longitudinal Study (National Center for Education Statistics, 1994), conducted by the U.S. Department of Education. This study represents national longitudinal educational studies conducted by the National Center for Education Statistics (NCES) at the U.S. Department of Education. Data on a variety of demographic, academic, social, psychological, and familial variables, including a set of items related to perceived control, were collected. The proposed study investigated the longitudinal relation between students' academic achievement and perceived control using the Base Year, First follow-up, and Second Follow-up data. The NELS database is appropriate for the objectives of this study because it provides a large, national sample of adolescent students, and the data are longitudinal so it is possible to evaluate the reciprocal relationship between perceived control and academic achievement.

From the Base Year (1988), NELS followed a sample of 24,599 eighth graders (approximately, Asian American, 6.4%; African American, 9.8%; Hispanic, 12.5%; White, 62.0%, Others, 2%; Unknown, 7.3%) from 1,052 schools. This study used a randomly selected sample of 1,500 students from each ethnic group from the three waves or a total of 6,000 students for the longitudinal analyses.

Measures

For academic achievement, several achievement scores (e.g., grades, standardized scores) are available in NELS data. Among them, IRT theta scores (indicating unbiased achievement estimated from Item Response Theory) were used. The IRT theta scores are particularly useful for longitudinal analysis because the scores were standardized across years. Reading, mathematics,

science, and history IRT theta scores in the three waves (1988, 1990, and 1992) were used as an indicator of the latent variables of academic achievement.

For perceived control, six items were used as an indicator of the latent variable of perceived control. These items are based on the Pearlin Mastery Scale (Pearlin, Elizabeth, Morton, & Joseph, 1981), which measures how strongly people believe that reinforcement is a result of their own behavior (internal control) or a result of fate or chance (external control). The scale, originally developed for a study using longitudinal data to observe the process of stress with a sample of 2,300 participants ages 18 to 65 years, is a 7-item scale on which higher scores reflect the perception of greater mastery over one's environment. Pearlin, *et al.* reported a correlation of .44 between Time 1 (conducted in 1972–73) and Time 2 (conducted in 1976–77) measures. In the present study, a 6-item version adapted for use as part of NELS was used. The respondent may strongly disagree, disagree, agree, or strongly agree with these questions. All items were coded so that higher scores indicate a higher sense of control. That is, responses to the items were coded 1: Strongly disagree, 2: Disagree, 3: Agree, and 4: Strongly agree. Cronbach coefficients alpha for the items were 0.72, 0.72, and 0.73, respectively, for the three waves. In Table 1 are listed the six items measuring perceived control.

TABLE 1
PERCEIVED CONTROL ITEMS

No.	Item
1	I don't have enough control over the direction my life is taking.
2	In my life, good luck is more important than hard work for success.
3	Every time I try to get ahead, something or somebody stops me.
4	My plans hardly ever work out, so planning only makes me unhappy.
5	When I make plans, I am almost certain I can make them work.
6	Chance and luck are very important for what happens in my life.

Procedure

To study the longitudinal relationship between academic achievement and perceived control, autoregressive cross-lagged modeling (ACLM) was used in this study. The key characteristic of the autoregressive model is that the scores at time $[t]$ are adequately explained by the score variation at time $[t - 1]$ (Curran & Bollen, 2001). Thus, this model is particularly appropriate for longitudinal analysis of occasion-to-occasion transmission data where the score at time [2] depends on the score at time [1], and in turn, the score at time [3] depends on the score at time [2], and so forth (Bast & Reitsma, 1997). The parameter values obtained by regressing the measure at each time point onto the same measure at the previous time point are called autoregressive coefficients.

In this study, the autoregressive model was extended to the bivariate case with two distinct variables to allow the cross-lagged paths to represent reciprocal influences across constructs over time. The bivariate autoregressive cross-lagged model can be represented as

$$y_i[t] = \beta_1 y_i[t-1] + \beta_2 z_i[t-1] + e_i[t];$$

$$z_i[t] = \gamma_1 z_i[t-1] + \gamma_2 y_i[t-1] + r_i[t],$$

where $y_i[t]$ represents the measure of the outcome variable y for individual i at time $[t]$, and $z_i[t]$ represents the measure of the outcome variable z for individual i at time $[t]$.

In the equations, $y_i[t-1]$ and $z_i[t-1]$ are the measures at time $[t-1]$, and $e_i[t]$ and $r_i[t]$ are the residuals for individual i at time $[t]$. Coefficients β_1 and γ_1 are the autoregressive parameters. Coefficients β_2 and γ_2 are the cross-lagged coefficients that represent the longitudinal prediction of one construct at time $[t]$ from the other at time $[t-1]$, controlling for the autoregressive prediction of that construct from itself at time.

In this study, autoregressive cross-lagged relations were modeled in the repeated latent variables rather than in the observed scores. Typically, the observed scores are summed composites of multiple indicators (or items), which, however, do not take into account the measurement errors of the multiple indicators. Another major advantage is that the assumption of measurement invariance across time can be tested. The assumption of measurement invariance indicates that the construct measured repeatedly retains the same interpretation across waves. The test of the assumption is essential to ensure that it is the outcome of theoretical interest that is changing rather than the scale used to measure the construct (Sayer & Cumsille, 2001).

In the present study, an autoregressive cross-lagged modeling was performed to study the reciprocal relationship between perceived control and academic achievement. In the model, perceived control and academic achievement measured in the first wave (1988) were specified to covary to represent the relationship between the constructs. Covariances were also specified between the error term of perceived control and that of academic achievement measured in Waves 2 and 3. That is, the covariance between the error of perceived control (PC90) and that of academic achievement (Ach90) measured in 1990 was specified. Similar covariances were specified between the two variables measured in 1992. A failure to model the error covariance structure adequately can lead to biased estimates of the magnitude of true change and even misspecification of the true change patterns (Chan, 1998). The path-diagram of the autoregressive cross-lagged model tested in this study is presented in Fig. 1.

Because the chi-squared fit index is highly sensitive to sample size, to evaluate the fit of the autoregressive cross-lagged model, the nonnormed fit index (NNFI; Bentler & Bonett, 1980) and root mean square error of ap-

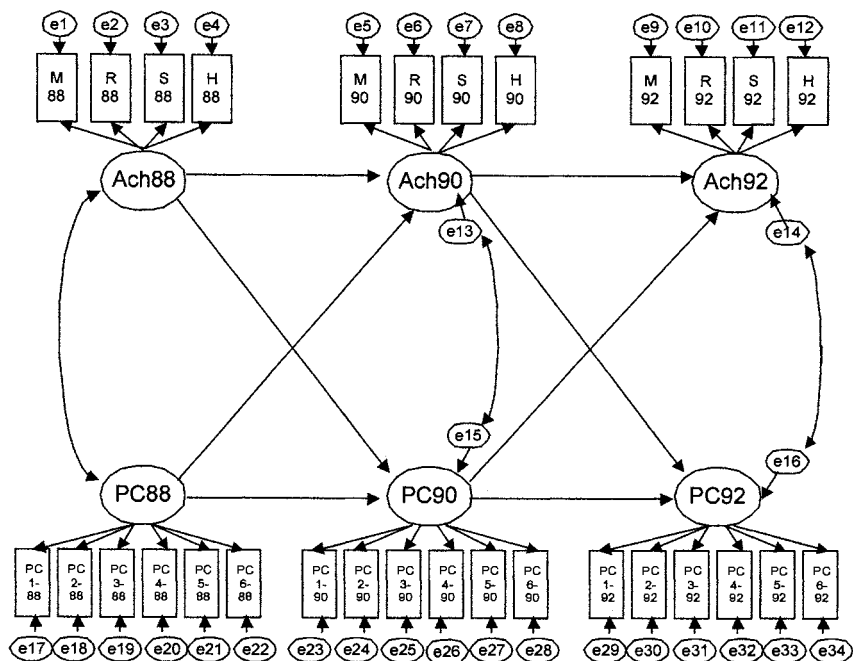


Fig. 1. Autoregressive cross-lagged model. *Note.*—Ach = the latent variables of academic achievement; R, M, and S = reading, math, and science IRT theta scores, respectively. PC = the latent variables of perceived control; PC1–PC6 = the six items of perceived control in Table 1; 88, 90, 92 = variables measured in 1988, 1990, and 1992, respectively.

proximation (RMSEA; Steiger & Lind, 1980) which are relatively independent of sample size were used. Another reason for choosing these indexes is that both indexes take into account model complexity, which is an important property for comparing several alternative models with different magnitudes of complexity. According to the recent simulation study by Hu and Bentler (1999), values of .95 or above for NNFI and values of RMSEA of .06 or smaller indicate good fit.

As in most longitudinal data, some subjects are unavailable during one or more data-collection periods. Because listwise deletion (LD) and pairwise deletion (PD) can result in biased parameter estimates due to nonrandom attrition (Arbuckle, 1996), this study employed full information maximum likelihood (FIML) estimation, which has been very efficient for incomplete data (Schafer & Olsen, 1998). To explain under which situation full information maximum likelihood performs better than listwise deletion or pairwise deletion, it is necessary to discuss missing data mechanisms: missing completely at random (MCAR), missing at random (MAR), and nonignorable, according

to Little and Rubin's (1989) definition. A missing mechanism is MCAR when the cause of missingness is a completely random process. However, it is MAR when missing values are related to other variable(s) but are unrelated to the values which would have been observed. A nonignorable missing mechanism indicates that missing values are related to the values which would have been observed. If data are MCAR, LD, PD, and FIML, all yield unbiased estimates. However, if the missing mechanism is only MAR, but not MCAR, FIML yield relatively unbiased estimates but LD and PD produce severely biased results. Even under nonignorable situations, full information maximum likelihood estimates are less biased than the other methods (Muthen, Kaplan, & Hollis, 1987; Little & Rubin, 1989; Schafer, 1997).

RESULTS

First, our data were checked to assess whether they met the normality assumption. Because maximum likelihood estimation can produce distorted results when the assumption is severely violated (Curran, West, & Finch, 1996), the normality of each variable was investigated in terms of its kurtosis and skewness. According to the guideline of severe nonnormality (i.e., skew > 2 ; kurtosis > 7) proposed by West, Finch, and Curran (1995), the normality assumption of all the variables was well met.

Given the assumption was satisfied, the autoregressive cross-lagged modeling was performed. To ensure that the latent variable had the same interpretation at each time point, two models were compared: Model 1 without any constraints and Model 2 with the equality constraints of the factor loadings across time. Establishing measurement invariance across time is required because measurement invariance constitutes evidence that the same construct is being measured across time and measured with the same precision (Chan, 1998). The comparison between the two models in terms of NNFI and RMSEA demonstrates that Model 2 fits better than Model 1, indicating the equality constraints of factor loadings over time are valid. NNFI and RMSEA were used to compare the two nested models here because the χ^2 difference test, which is widely used to compare the fit of nested models, is very sensitive to sample size, particularly when sample size is large (Anderson & Gerbing, 1988; Marsh & Grayson, 1990; Steenkamp & Baumgartner, 1998). The parameter estimates obtained from the autoregressive cross-lagged model are presented in Table 2.

Of particular interest are cross-lagged coefficients, which represent the reciprocal relationships between perceived control and academic achievement. There was no influence between two constructs during the period from Grades 8 to 10. Although the coefficient for Hispanics was statistically significant, the magnitude was very small, and the significance of the results may be simply due to using large sample sizes for the two groups. However,

TABLE 2
AUTOREGRESSIVE CROSS-LAGGED MODELING: MODEL FIT

Model	χ^2	<i>df</i>	NNFI	RMSEA
1-Asian	3208.728	394	0.971	0.069
2-Asian	3269.903	410	0.972	0.068
1-Black	2074.818	394	0.978	0.053
2-Black	2102.997	410	0.979	0.052
1-Hispanic	2488.557	394	0.976	0.060
2-Hispanic	2540.402	410	0.976	0.059
1-White	3166.310	394	0.973	0.069
2-White	3201.011	410	0.974	0.069

academic achievement in Grade 10 influenced significantly perceived control in Grade 12 across the four ethnic groups.

Concerning the autoregressive coefficients, a very strong relationship ($>.90$) between adjacent time points in academic achievement and a strong relationship ($>.54$) between adjacent time points in perceived control across all ethnic groups were found. This indicates that the relative standing of students' academic achievement remained more stable than perceived control throughout the studied period.

TABLE 3
AUTOREGRESSIVE CROSS-LAGGED MODELING: STANDARDIZED PARAMETER ESTIMATES

Parameter	Ethnic Group			
	Asian	Black	Hispanic	White
Ach90 \leftarrow Ach88	0.979*	0.944*	0.902*	0.956*
Ach92 \leftarrow Ach90	0.992*	0.982*	0.999*	0.997*
PC90 \leftarrow PC88	0.598*	0.651*	0.556*	0.629*
PC92 \leftarrow PC90	0.670*	0.583*	0.586*	0.539*
Ach90 \leftarrow PC88	-0.006	0.046	0.075*	-0.009
Ach92 \leftarrow PC90	0.007	0.019	-0.019	-0.027
PC90 \leftarrow Ach88	0.084	0.101	0.071	0.057
PC92 \leftarrow Ach90	0.210*	0.226*	0.227*	0.237*

*Statistically significant $\alpha = .05$.

DISCUSSION

In summarizing the findings of this longitudinal study, the most central results are that academic achievement has significant influence on subsequent perceived control, whereas the reverse causal ordering of perceived control on academic achievement has not been observed. The causal effect of academic achievement toward perceived control is found only at higher grades (i.e., between 10 and 12). Such a relationship between academic achievement and perceived control, however, is not detected for learners in Grades 8 to 10. The above findings are consistent among all four ethnic groups.

The current finding that academic achievement is the determinant of

perceived control differs from previous studies. One possible explanation of why academic achievement is the determinant of perceived control in the present study could be that academic achievement is a form of social status in the classroom (McAuliffe, 1991), and as such, the achievement would influence students' competence belief, which is closely related with perceived control.

Another important result is that the causal effect of academic achievement toward perceived control is detected only in higher grades (Grades 10 to 12), but not in lower grades (Grades 8 to 10). A "critical age threshold" in the causal relationship between academic achievement and perceived control can be posited. When students are younger, they may not be certain whether their outcomes are contingent upon their ability or luck. As they become older, however, through successive outcomes, students receive more feedback about their achievement, so they may attribute their outcomes to ability or luck with more confidence. Findley and Cooper (1983) support this speculation. Reviewing 208 studies on the relationship between locus of control and academic achievement, Findley and Cooper compared effect size (r) for different age groups and reported that younger groups (Grades 1 to 3) and older groups (college students) showed relatively weaker correlations, while junior high students showed the highest effect size (average $r = .35$). Marsh, Kong, and Hau (2000) also reported that higher school-average achievements tend to lead lower academic self-concepts (contrast effect) in the research on the big-fish-little-pond effect.

Across all four ethnic groups, causal effects of academic achievement on perceived control were found. It also could be argued that the simple internal-external bipolar measure of perceived control in the current study might be inappropriate to capture variations among different ethnic groups. This finding suggests that researchers conducting cross-cultural studies should employ a multidimensional approach, which systematically varies situations, sources of action, outcomes, and consequences to measure perceived control thoroughly.

Although the cross-lagged models examined here fit the data well, this study also has potential analytic limitations. Note that data of the NELS is hierarchical: students nested within schools. Although students of the same school are likely to produce common sources of variation, the effect of the violation of the assumption of independent observation may not be serious when the size of the design effect is less than 2.0, according to the simulation study by Muthen and Satorra (1995). Given the interclass correlation of .2, which is a typical value for achievement scores due to school components (Muthen, 1997), the design effect is larger than 2.0 when the average number of students per school is larger than 6. Because the average number of students per school is less than 3 for each of the four ethnic groups, the effect of the clustering in the data can probably be ignored.

Further research on other age groups is necessary, and it should include other relevant variables to increase knowledge of how ethnic differences in perceived control and academic achievement develop. The matter of the interval between time points should also be considered. Although the influence of academic achievement is significant, the magnitude is relatively too small to claim a meaningful, substantive directionality between the two constructs. However, given the long time interval between time points (2 yr.), the size effect cannot be ignored. Subsequent research could be conducted to evaluate what would be the effect of changing the interval between time points on the results.

Considering that both individual characteristics (e.g., personality and behavioral styles) and contextual environments (e.g., interpersonal relationships with parents, teachers, and peers) play important roles in successful academic achievement, another direction for further study is also investigation of a comprehensive mechanism which might account for the process of multiple influences on adolescents' academic development, as this is at the heart of the educational process.

The implication of this study is that higher academic achievement leads students to have higher perceived control. It is educationally important to provide students with as many opportunities as possible to experience their own academic achievement through attainable tasks, small projects, and examinations. Experiencing higher academic achievement should support a belief in competence and a higher sense of perceived control, which in turn would result in subsequent higher academic achievement.

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