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Risk and resilience profiles and their transition pathways in the ABCD Study

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Abstract

The transition from childhood to adolescence presents elevated risks for the onset of psychopathology in youth. Given the multilayered nature of development, the present study leverages the longitudinal, population-based Adolescent Brain Cognitive Development Study to derive ecologically informed risk/resilience profiles based on multilevel influences (e.g., neighborhood and family socioeconomic resources, parenting, school characteristics) and their transition pathways and examine their associations with psychopathology. Latent profile analysis characterized risk/resilience profiles at each time point (i.e., baseline, Year-1, Year-2); latent transition analysis estimated the most likely transition pathway for each individual. Analysis of covariance was used to examine associations between profile membership at baseline (i.e., ages 9–11) and psychopathology, both concurrently and at Year-2 follow-up. Further, we examined the associations between profile transition pathways and Year-2 psychopathology. Four distinct profiles emerged across time – High-SES High-Protective, High-SES Low-Protective, Low-SES High-Family-Risk, and Low-SES High-Protective. Despite reasonably high stability, significant transition over time among profiles was detected. Profile membership at baseline significantly correlated with concurrent psychopathology and predicted psychopathology 2 years later. Additionally, profile transition pathways significantly predicted Year-2 psychopathology, exemplifying equifinality and multifinality. Characterizing and tracing shifts in ecologically informed risk/resilience influences, our findings have the potential to inform more precise intervention efforts in youth.

Keywords: Developmental psychopathology; risk and resilience; person-centered approach

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Introduction

The transition from late childhood to early adolescence, characterized by seismic changes occurring within multiple environmental contexts (e.g., school environment, peer interactions, family dynamics), as well as intraindividual changes (e.g., psychosocial functioning, neurocognitive development), creates a "perfect storm" for the development of psychopathology and, indeed, marks the peak of onset/worsening of many common psychopathologies (Casey et al., 2010). Per an ecological model (Bronfenbrenner, 1977), myriad proximal and distal factors (e.g., elements within the micro-, meso-, and exo-systems) work together to shape the profiles and trajectories of youth's development within this critical window. Extensive research has examined associations between particular environmental factors at each ecological level and mental health outcomes in youth. For example, neighborhood and community resources (e.g., area unemployment rates and educational attainment at the neighborhood level) are negatively associated with the development of internalizing and externalizing symptoms (e.g., depression, anxiety, disruptive behaviors) above and beyond household socioeconomic resources (Okuzono et al., 2023). In addition, researchers have established a positive link between family conflict and the development of internalizing and externalizing symptoms in children (Cummings et al., 2015). There is ample evidence that school experiences (e.g., sense of security, school resources, teacher–student relationships) (Aldridge & McChesney, 2018; Rakesh et al., 2023; Thijssen, 2023) and peer relationships (e.g., quality of friendships) (Masten et al., 2009; Sahi et al., 2023) play vital roles in shaping youth's development during the critical transition from late childhood to early adolescence.

Nevertheless, piecemeal focus on the contributions of specific environmental elements to the development of psychopathology (i.e., variable-centered) and cross-sectional "snapshots" of a specific developmental time have limited most of this foundational research. Theoretical models of development's multilayered and transactional nature posit that environmental and intraindividual forces coact to shape development cross-sectionally and longitudinally. In this light, longitudinal studies to trace development are necessary to elucidate equifinality (i.e., singular outcome from different originating points) and multifinality (i.e., differential outcomes from a single originating point) (Cicchetti & Rogosch, 1996; Handley et al., 2024). So far, a handful of longitudinal studies have characterized individual profiles based on environmental elements and found that profile membership significantly predicts mental health outcomes (e.g., Christian et al., 2021; Cooper et al.,

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2023; Retzler et al., 2023). These studies have primarily focused on a single area of environment or functioning (e.g., psychopathology outcome, emotion regulation, sleep problems) (Cooper et al., 2023; Huffman & Oshri, 2022; Retzler et al., 2023), with little attention yet given to the ecological context of development. Further, most studies to date have examined developmental psychopathology primarily from a risk perspective by focusing on risk factors (e.g., low socioeconomic status, family conflict, adverse childhood experiences) associated with negative mental health outcomes to identify at-risk groups and guide intervention efforts (LeMoult et al., 2020). Meanwhile, emerging research is beginning to demonstrate the value of identifying protective factors (e.g., social support, school connectedness, educational attainment, positive childhood experiences; see Buchanan et al., 2023 for a review), which may also inform intervention efforts by enhancing developmental environments and bolstering adaptive modes of emotional functioning and behaviors (Carr et al., 2021; Lerner et al., 2009; Vanderbilt-Adriance & Shaw, 2008). Critically, protective factors, often overlooked in existing empirical research on developmental psychopathology (Cicchetti & Rogosch, 2002), may buffer the effects of risk factors. For instance, taking a strength-based perspective and complementing the traditional examination of adverse childhood experiences, Morris et al. (2021) found that cumulative protective and compensatory experiences (e.g., nurturing relationships, access to various resources) moderated the association between adverse childhood experiences and later parenting attitudes (Morris et al., 2021). Similarly, studies have shown that prosocial characteristics and behaviors of youth are linked with positive developmental outcomes and serve as a protective factor in face of life challenges and adversity (Collie, 2020; Malti & Speidel, 2023); parental factors, such as perceived parental warmth and involvement, may also serve as a protective mechanism and demonstrate positive links with general well-being of the youth (Chen et al., 2014; Lan, 2022; Yap et al., 2014).

To address these gaps, the present study examines multiple layers of the developmental context (e.g., neighborhood, family, school, peer, intraindividual) longitudinally during the critical transition from late childhood to early adolescence. We leverage data from the Adolescent Brain Cognitive Development (ABCD) Study® to derive ecologically informed risk/resilience profiles at preadolescence, which we expect to evolve over the transition to adolescence, and validate these transition profiles' predictive power for adolescent psychopathology.

Method

Participants

The ABCD Study includes nationwide, population-based, diverse longitudinal psychosocial and neurobiological data on youth from preadolescence to early adulthood, with the recruitment procedures extensively described elsewhere (Garavan et al., 2018). In the present study, we used Data Release 4.0, including three annual waves: baseline ($N = 9,854$), Year-1 ($N = 9,275$), and Year-2 ($N = 8,399$) (Table 1, S1). We randomly selected one child per family when twins/siblings were present.

Measures

Drawing from the ecological model (Bronfenbrenner, 1977), we incorporated measures capturing different developmental contexts. See *Supplement* for more details on measures (Table S2 for measure content, Table S3 for measure availability).

Table 1. Demographic characteristics at baseline ($N = 9,854$)

	Mean (years)	SD [range]
Age	9.9	0.62 [8.92–11]
Race	***N***	**Percentage**
White	6,151	62%
Black/African American	1,572	16%
Asian	251	3%
Pacific Islander	10	<1%
Native American/Alaskan/Hawaiian	56	1%
Biracial or multiracial	1,196	12%
Other	470	5%
Ethnicity		
Hispanic or Latino	2,104	21%
Not Hispanic or Latino	7,624	77%
Sex assigned at birth		
Female	4,676	47%
Parental education		
Less than high school	514	5%
High school degree or equivalent	969	10%
Some college	1,280	13%
College degree	2,441	25%
Associate or occupational degree	1,291	13%
Master's or professional degree	3,348	34%

Neighborhood

Growing evidence has demonstrated the effects of neighborhood environment on development, such as neighborhood socioeconomic resources and perceived neighborhood safety (Sripada et al., 2022; Taylor et al., 2020). In the ABCD Study, the participants' primary home addresses were utilized to generate the Area Deprivation Index (ADI) (Singh, 2003) and the Child Opportunity Index (COI) (Acevedo-Garcia et al., 2014), capturing neighborhood economic disadvantages and child opportunity (i.e., educational, health and environmental, and social and economic opportunities). Per ABCD recommendations, we used the ADI and COI scores collected at baseline and extended these scores to Year-1 and Year-2. Additionally, Neighborhood Crime/Safety Survey (Mujahid et al., 2007) captured perceived neighborhood safety, reported by both parent (i.e., primary caregiver) and youth at all three time points – baseline, Year-1, and Year-2.

School environment and peer interactions

School plays an increasingly important role as youth transition into early adolescence. School Risk and Protective Factors Survey assessed the general school protective environment (e.g., positive relationships between youth and teachers) and was reported by youth at all three time points. School Attendance and Grades Questionnaire measured youth's number of excused and unexcused school absences and was reported by parent at Year-2. Peer Behavioral Profile captured both prosocial (e.g., friends who are excellent students) and delinquent (e.g., friends who have skipped school or shoplifted occasionally) peer involvement, as reported by youth at Year-2. Lastly, the Peer Network Health Protective Scale

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captured youth's close friends' protective behaviors against substance use (e.g., advising against substance use) and support-providing behaviors (e.g., helping by talking through problems), as reported by youth at Year-2.

Family dynamics

Family dynamics can often serve as a "protective shield," buffering adverse experiences outside of the home (Pynoos et al., 1999); meanwhile, intrafamily conflict may elevate youth's risk for psychopathology (Weymouth et al., 2019; Yang et al., 2023). We used the Parental Behavioral Inventory for parental warmth/acceptance traits and behaviors (e.g., making youth feel better after discussing worries with them) and the Parental Monitoring Survey for parental monitoring behaviors (e.g., parents knowing the youth's whereabouts). Both measures were reported by youth on the primary and secondary (if applicable) caregiver(s) at baseline and Year-1, with the Parental Monitoring Survey also collected at Year-2. Additionally, the family conflict subscale of the Family Environment Scale (Moos & Moos, 2014) assessed intrafamily conflict and was reported by parent and youth at all three time points. Given the associations between parental psychopathology and youth's mental health outcomes (Gureje et al., 2011), we included parental internalizing and externalizing symptoms, measured by the Adult Self-Reported Scores, as reported by parent at baseline and Year-2.

Another critical factor in shaping family dynamics is household socioeconomic status (SES), which affects multiple aspects and mechanisms of family life (e.g., resource availability and financial stress). We used the income-to-needs ratio, perceived/subjective family material hardship, and highest education of the parents as indicators of household SES. These indicators were reported by parent at all three time points.

Prosocial behavior, traumatic experiences, psychopathology

Positive social interactions with others are essential in attaining better developmental outcomes. Specifically, the tendency to support and benefit others (i.e., prosocial behavior) is associated with better psychosocial functioning (Hirani et al., 2022; Malti & Speidel, 2023). Prosocial Behavior Survey, reported by parent and youth at all three time points, captured youth's prosocial behaviors, including being considerate of other people's feelings and offering help to people in need. On the other hand, traumatic experiences pose a significant risk for psychopathology (Herringa, 2017; McLaughlin et al., 2013), and we utilized the Traumatic Events scale embedded in the Kiddie Schedule for Affective Disorders and Schizophrenia interview (Kaufman et al., 1997) to measure youth's cumulative trauma exposure, reported by parent at baseline and Year-2.

Psychopathology was measured using the Internalizing and Externalizing Syndrome scales from the Child Behavior Checklist (Achenbach & Ruffle, 2000) and was reported by parent at all three time points.

Dimensionality reduction

Given the number of measures and variables of interest, we conducted factor analyses to reduce the dimensionality of our data, identify the most representative variables for each developmental context, and facilitate interpretation. Specifically, we used exploratory factor analysis (EFA) for variable selection and confirmatory factor analysis (CFA) for validation. We randomly halved the sample for robustness and validation purposes, with one half as the test sample for EFA and the other half as the validation sample for CFA. First, EFA using direct oblimin rotation was conducted to explore the dimensionality of our data, utilizing the *factanal* function of R (version 4.2.2; maximum likelihood factor analysis). The variance accounted for by the solution, the variance accounted for by each factor, and the interpretability of the factors were all evaluated to determine the initial plausibility of the factor structure. Variables with factor loadings smaller than 0.35 were removed. Second, a corresponding model was tested using CFA to cross-validate the factor structure derived from EFA. We referenced commonly used model fit recommendations (Bentler, 2007), specifically (a) the comparative fit index (Bentler, 1990), with values greater than 0.95 indicating reasonable model fit and values greater than 0.90 indicating a plausible model; (b) the root mean square error of approximation (Steiger, 1990), an absolute index of overall model fit with values less than 0.08 indicative acceptable model fit and values less than 0.05 indicative of good model fit; and (c) the standardized root mean square residual (SRMR) (Hu & Bentler, 1999), an absolute index of overall model fit with values less than 0.08 indicative of acceptable model fit and values less than 0.05 indicative of good model fit. This procedure was repeated for each time point to identify key variables for inclusion in the next steps – deriving latent profiles using these key variables. See Table S4 for model fit indices and Table S5 for factor loadings of the key variables selected. Statistical analyses were performed in R (version 4.2.2), with the *lavaan* package.

Deriving groups from latent profiles and latent profile transition pathways

Key variables selected from *2.3* Dimensionality Reduction were utilized to illustrate risk/resilience profiles at each time point using latent profile analysis (LPA) (Spurk et al., 2020). Latent transition analysis (Hickendorff et al., 2018) then examined profile transition pathways across time (i.e., from baseline to Year-2). Specifically, in LPA, the selection of the best fitting profile was guided by multiple fit indices, including entropy, Bayesian information criteria, sample-adjusted Bayesian information criteria, Akaike information criteria, bootstrapped likelihood ratio test, and adjusted Lo–Mendell–Rubin test, as well as theoretical interpretability (see Table S6 for model fit indices). After the best-fitting model was determined at each time point, latent transition analysis was performed to determine each individual's most likely transition pathway (see Table S6 for model fit indices). Analyses were performed using Mplus (version 8.9).

Predicting psychopathology symptoms from profiles and pathways

Finally, analysis of covariance was used to examine the associations of profile membership and profile transition pathways with internalizing and externalizing psychopathology, both concurrently and at Year-2 follow-up (controlling for baseline psychopathology). Familywise error for post hoc comparisons was controlled using the Tukey Honest Significant Difference test; post hoc analyses controlled for age and biological sex.

Results

Deriving groups from latent profiles and latent profile transition pathways

Utilizing key variables identified in dimensionality reduction (see *Supplement* for details), we conducted LPA testing 2, 3, 4, 5, and 6

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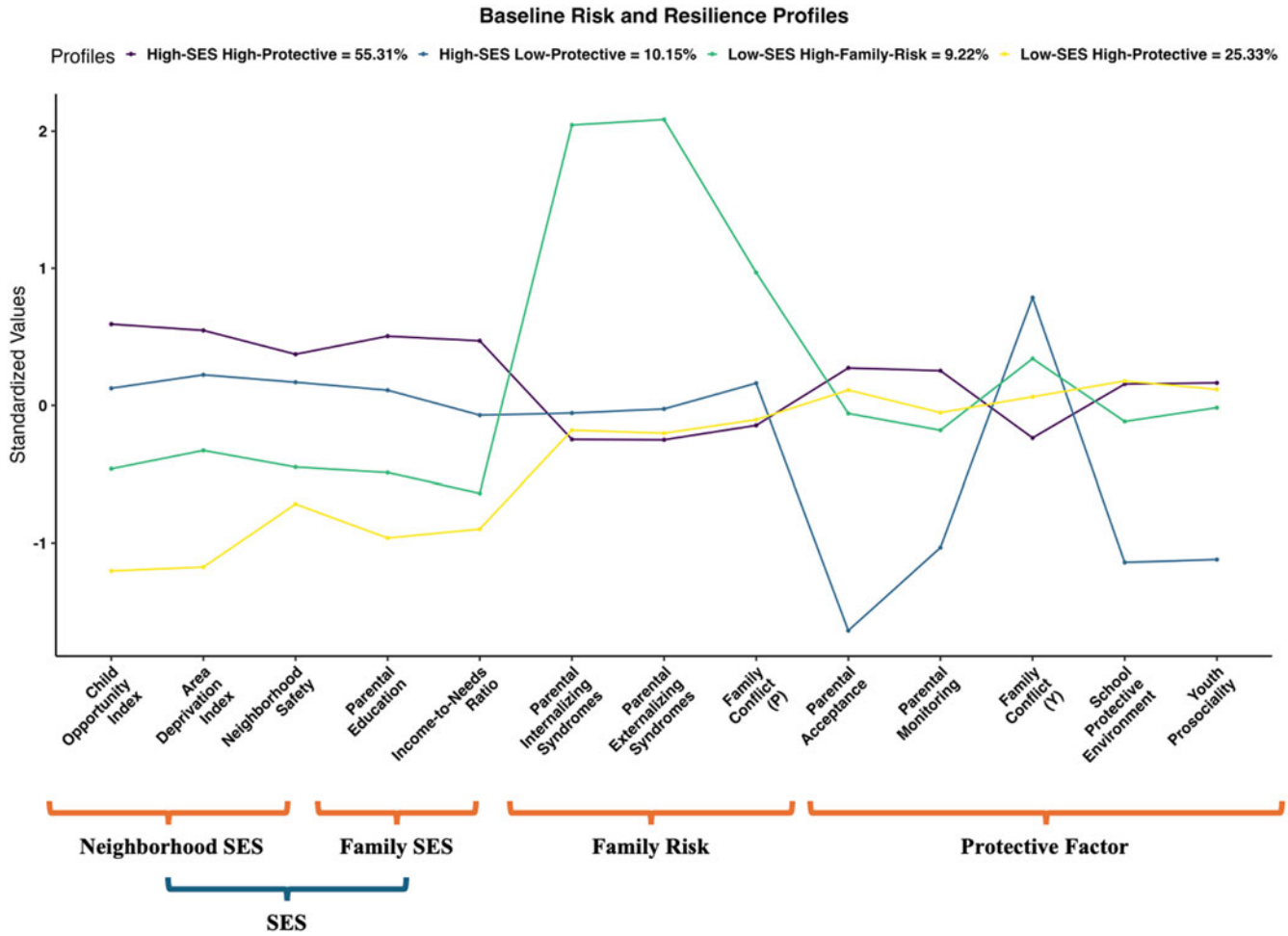

Figure 1. Latent profile characteristics at baseline. Family conflict (P) = parent-report family conflict; family conflict (Y) = youth-report family conflict.

profiles at each time point. Model fit indices and theoretical interpretability indicated that a four-profile solution fits better than other solutions at every time point (Figure 1; see *Supplement* for Year-1, Year-2).

Four distinct profiles emerged. The High-SES High-Protective Group (55.31%) was characterized by relatively high neighborhood and family SES, low family risk (i.e., less family conflict and fewer parental internalizing and externalizing symptoms), and greater protective factor (e.g., more protective school environment, more parental acceptance); the High-SES Low-Protective Group (10.15%) was characterized by relatively high neighborhood and family SES, high family risk, and low protective factor; the Low-SES High-Family-Risk Group (9.22%) was characterized by relatively low neighborhood and family SES, high family risk, and low protective factor; lastly, the Low-SES High-Protective Group (25.33%) was characterized by relatively low neighborhood and family SES, low family risk, and greater protective factor.

Profile membership was fairly stable over time. Overall, 96.26% of the High-SES High-Protective Group, 76.40% of the High-SES Low-Protective Group, 73.83% of the Low-SES High-Family-Risk Group, and 95.88% of the Low-SES High-Protective Group stayed in the same group over time. However, significant change over time was detected: 3.74% of the individuals in the High-SES High-Protective Group transitioned to the High-SES Low-Protective Group at Year-1, 23.60% of the individuals in the High-SES Low-Protective Group transitioned to the High-SES High-Protective Group at Year-1, 13.09% of the individuals in the Low-SES High-Family-Risk Group transitioned to the High-SES Low-Protective Group, and another 13.09% transitioned to the Low-SES High-Protective Group, at Year-2; lastly, 4.12% of the individuals in the Low-SES High-Protective Group transitioned to the Low-SES High-Family-Risk Group at Year-2 (Figure 2).

Predicting psychopathology symptoms from profiles and pathways

Profile membership at baseline was significantly associated with concurrent internalizing (Cohen's $f^2 = 0.15$) and externalizing ($f^2 = 0.16$) symptoms, also predicting Year-2 internalizing ($f^2 = 0.12$) and externalizing ($f^2 = 0.16$) symptoms (Figure 3). Further, transition pathways of profiles over time significantly predicted Year-2 internalizing ($f^2 = 0.22$) and externalizing symptoms ($f^2 = 0.27$) (Figure 4). According to guidelines (Cohen, 1988), Cohen's f^2 values >= 0.02, ☒ 0.15, and ☒0.35 indicate small, medium, and large effect sizes, respectively.

At baseline, the Low-SES High-Family-Risk Group demonstrated the most concurrent internalizing and externalizing symptoms, followed by the High-SES Low-Protective Group, Low-SES High-Protective Group, and High-SES High-Protective

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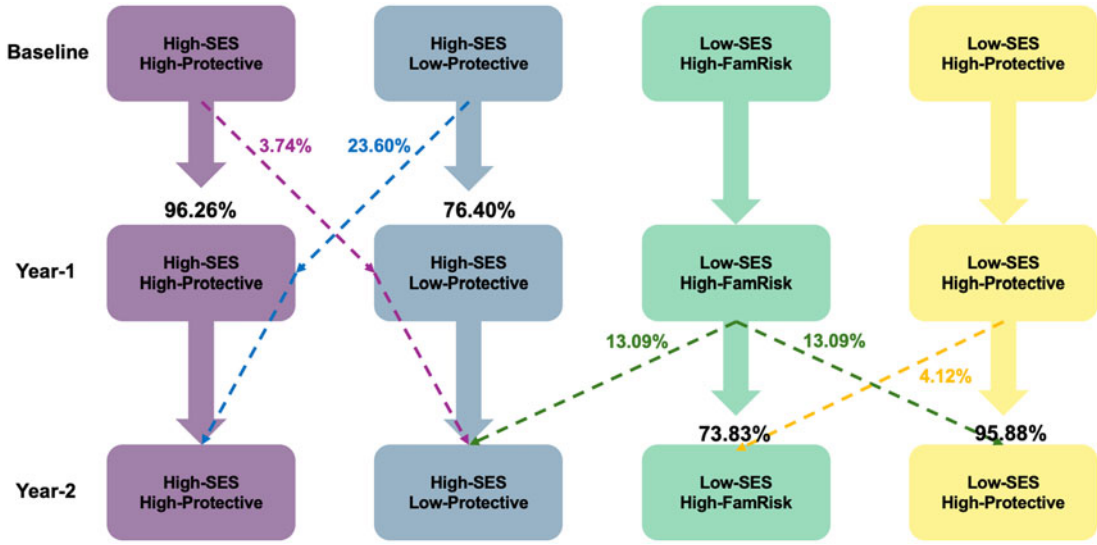

Figure 2. Latent profile transition pathways.

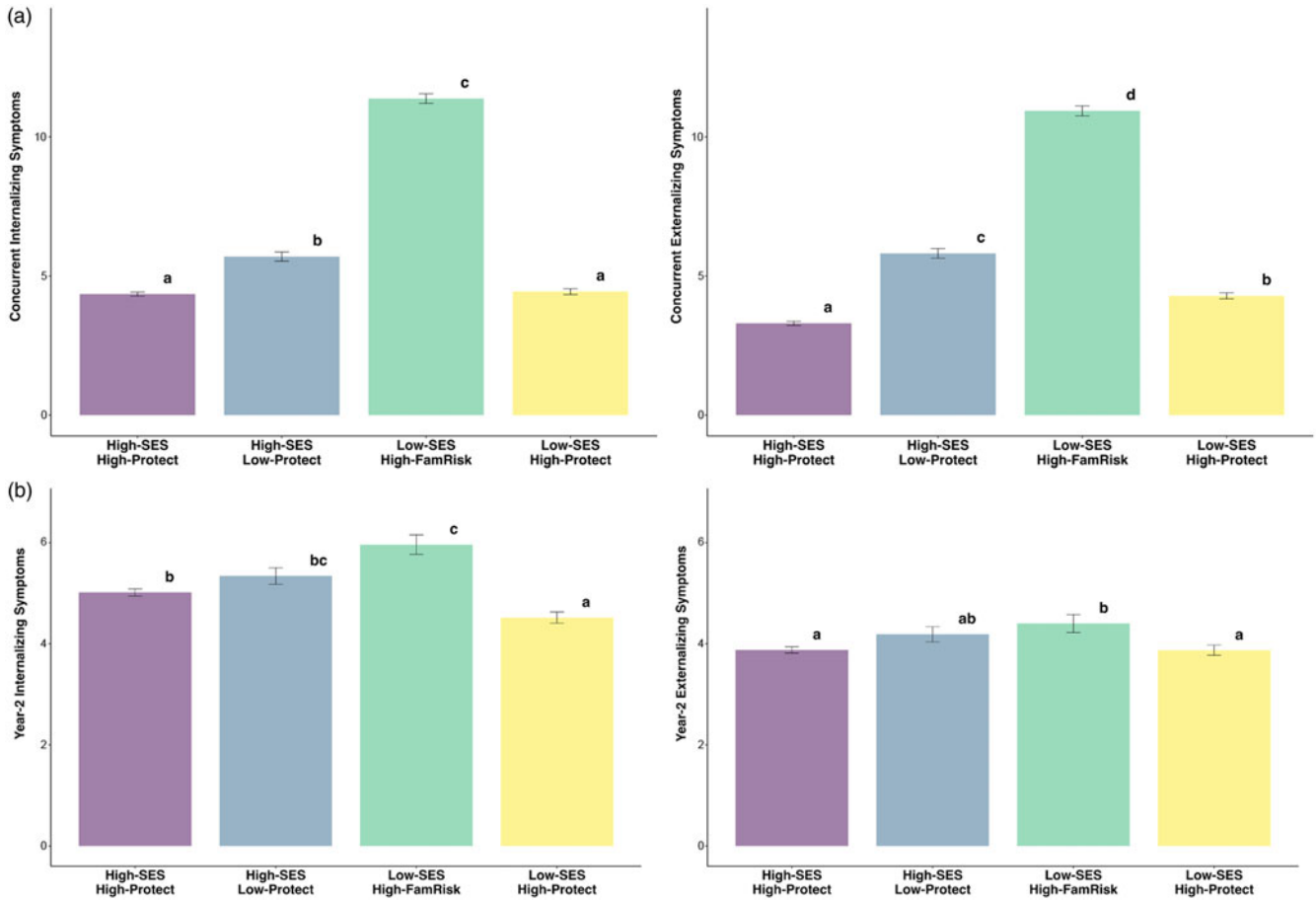

Figure 3. Baseline profiles and psychopathology. (a) Latent profiles at baseline with concurrent internalizing and externalizing symptoms. (b) Latent profiles at baseline predicted Year-2 internalizing and externalizing symptoms (controlling for baseline). Compact letter display (cld) illustrates pairwise comparisons (Tukey HSD); if a group shares >= 1 letter(s) with any other group(s), this group does not statistically differ from the other group(s).

Group (Low-SES High-Protective = High-SES High-Protective for internalizing symptoms; Low-SES High-Protective > High-SES High-Protective for externalizing symptoms) (Figure 3a). Predicting Year-2 internalizing and externalizing symptoms while controlling for baseline psychopathology, the Low-SES High-Family-Risk Group predicted the most internalizing and

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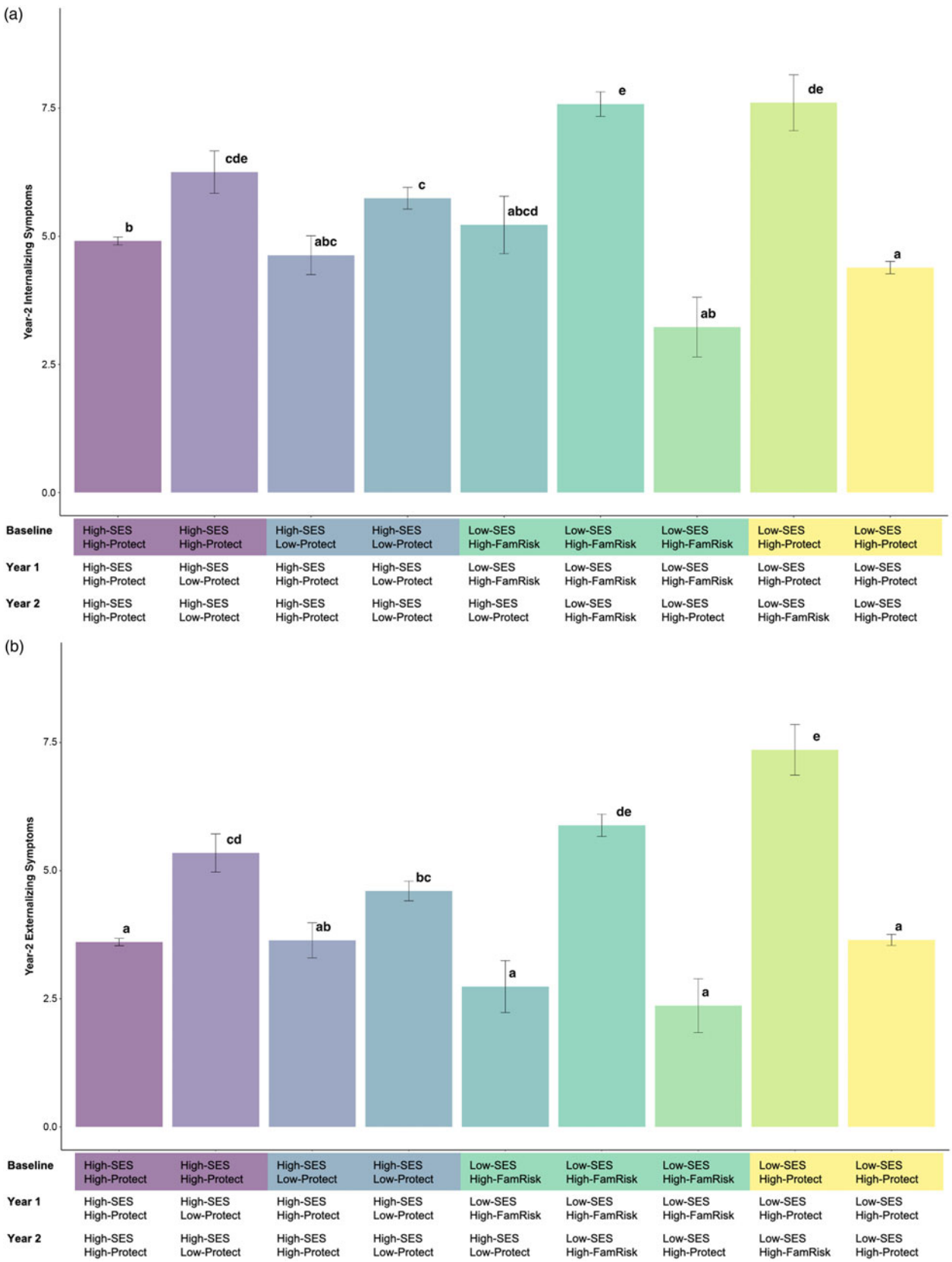

Figure 4. Profile transition pathways and psychopathology.

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externalizing symptoms, significantly more than the High-SES High-Protective and Low-SES High-Protective Groups, while comparable to the High-SES Low-Protective Group (Figure 3b).

Further, profile transition pathways significantly predicted Year-2 psychopathology while controlling for baseline psychopathology. For internalizing symptoms (Figure 4a), individuals starting in the same profile but ending in different profiles presented divergent psychopathology outcomes, indicating developmental multifinality. Individuals who remained in the High-SES High-Protective Group showed significantly fewer internalizing symptoms than those who started in the same group but transitioned to the High-SES Low-Protective Group; individuals who remained in the Low-SES High-Family-Risk Group showed significantly more internalizing symptoms than those who transitioned to a different group later; lastly, individuals who remained in the Low-SES High-Protective Group showed significantly fewer internalizing symptoms than those who later transitioned to the Low-SES High-Family-Risk Group.

For externalizing symptoms (Figure 4b), developmental multifinality and equifinality were observed. Individuals who remained in the High-SES High-Protective Group showed significantly fewer externalizing symptoms than those who started in the same group but later transitioned to the High-SES Low-Protective Group; individuals who remained in the Low-SES High-Family-Risk Group showed significantly more externalizing symptoms than those who transitioned out of this group later; lastly, individuals who remained in the Low-SES High-Protective Group showed significantly fewer externalizing symptoms than those who later transitioned to the Low-SES High-Family-Risk Group. Conversely, individuals who ended in the High-SES Low-Protective Group showed fewer externalizing symptoms when they transitioned from a Low-SES High-Family-Risk Group, compared with those who started in the High-SES High-Protective Group and transitioned to the High-SES Low-Protective Group, while comparable to those who remained in the High-SES Low-Protective Group over time

Discussion

Developmental theoretical work (Bronfenbrenner, 1977; Cicchetti & Rogosch, 2002) and empirical evidence support how different factors in the multilayered ecological context shape youth's development cross-sectionally and shift over time. In alignment with this framework, the present study identified salient developmental forces within multiple ecological contexts (e.g., neighborhood, family, school, peer network) that combined to shape distinct risk/resilience profiles characterized by socioeconomic resources within both neighborhood and family, family risk (e.g., family conflict and parental psychopathology), and protective factors spanning multiple domains (e.g., parenting, school, peer interactions, prosociality). Groupwise comparison among profiles further illustrated the crucial roles of protective factors and SES as critical differentiators for developmental psychopathology in the present study. Indeed, for youth with similarly high SES and low family risk, protective factors emerged as a critical differentiator for developmental psychopathology, such that greater protective resources concurred with fewer internalizing and externalizing symptoms. However, such differences diminished (i.e., became comparable) two years later. Meanwhile, for youth with similarly low family risk and adequate protective resources, lower SES was linked with comparable internalizing symptoms concurrently and even fewer internalizing problems after 2 years. In contrast, it concurred with more externalizing symptoms, which diminished after two years.

The implications are twofold. First, cross-sectionally, our findings align with existing literature supporting the buffering effect of protective factors, shedding light on intervention efforts by identifying both patterns of risk to intervene (e.g., intrafamily conflict) and patterns of resilience to harness (e.g., cultivating more prosocial behaviors in youth, investing more in school facilities and teacher–student relationships). Our findings also support the link between lower socioeconomic resources, both family- and neighborhood-wise, and the emergence of externalizing symptoms, demonstrated in several studies (Evans, 2016; Peverill et al., 2021; Taylor & Barch, 2022), including studies leveraging the ABCD Study (Kim et al., 2022; Maxwell et al., 2023). Further, the observed association between lower SES and externalizing symptoms, but not internalizing symptoms, may reflect divergent etiological pathways for internalizing and externalizing psychopathology (Peverill et al., 2021; Ramphal et al., 2020). For instance, a few studies suggest that the association between low SES and externalizing behaviors may be uniquely mediated by reductions in cortical surface areas indicated in various domains of functioning (e.g., executive functioning) (Kim et al., 2022), reduced intracranial volume (Maxwell et al., 2023), as well as poorer inhibitory control (Taylor & Barch, 2022). These findings, including ours, underscore how external factors such as poverty cast a significant influence on developmental psychopathology, calling for meso-system changes and policies addressing broader societal resource and opportunity inequalities. Second, longitudinally, the diminishing effect of protective factors on internalizing and externalizing psychopathology and the differential influences of SES on internalizing versus externalizing psychopathology illustrate the dynamic interplay between environmental forces and developmental psychopathology over time. The buffering effects of protective factors, while observed initially, did not endure after 2 years after controlling for psychopathology at baseline. Speculatively, other experiences in the ecological context (e.g., SES, family dynamics) may arise and temporarily overshadow the "protective shield"; indeed, studies have shown that resilience may reemerge later in life (i.e., "late bloomers") (Masten & Tellegen, 2012). On the other hand, the opposition direction of change for internalizing versus externalizing symptoms suggests that a singular, deficit-only model of SES tends to oversimplify the picture and miss the nuances, as other processes within the ecological context (e.g., family risk, protective factors), in combination with SES, lead to different risk/resilience profiles and project divergent psychopathology outcomes. Additionally, the finding that lower SES was linked with comparable concurrent and even fewer Year-2 internalizing symptoms, while more concurrent yet comparable Year-2 externalizing symptoms, may account for mixed findings in existing literature on the association between SES and psychopathology (Vollebergh et al., 2006; Wight et al., 2006), emphasizing the importance of considering other developmental forces, as well as when the "snapshot" is taken.

The longitudinal, population-based design of the ABCD Study allows for characterizing risk/resilience profiles and examining their associations with concurrent and future psychopathology; it is also a well-suited avenue for observing developmental continuity versus discontinuity (i.e., stable vs. shifting profiles), as well as equifinality versus multifinality, contributing to more precise intervention efforts. Both continuity and discontinuity were observed, such that youth in the High-SES High-Protective Group and Low-SES High-Protective Group showed the most

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stable profile membership. In contrast, individuals in the other two groups (i.e., Low-SES High-Family-Risk, High-SES Low-Protective) showed greater transition probabilities, indicating differences in the overall stability of the ecological context for different risk/resilience profiles. Further, transition pathways and their associations with developmental psychopathology exemplify the experience-dependent nature of development, echoing developmental equifinality and multifinality.

Overall, youth who started with the same profile membership but followed different pathways demonstrated different internalizing and externalizing psychopathology (i.e., multifinality). Notably, the effects are bidirectional. On the one hand, youth who followed pathways that were characterized by increasing risk or decreasing protective resources showed more psychopathology than peers who stayed in the same group. For example, youth who started with lower risk levels and adequate protective resources (e.g., High-SES High-Protective) demonstrated a significant increase in internalizing and externalizing psychopathology when they transitioned into a greater-risk or lower-protective environment. On the other hand, youth who started with greater risk levels and fewer protective resources (e.g., Low-SES High-Family-Risk Group) demonstrated a significant decrease in psychopathology when they transitioned into a lower-risk or higher-protective environment. In a similar vein, equifinality manifested in the present study, as youth who ended with the same profile membership (e.g., High-SES Low-Protective) showed fewer psychopathology when they transitioned from environments marked by more risk or fewer protective resources (e.g., Low-SES High-Family-Risk), again illustrating experience-dependent development. These patterns demonstrated heightened sensitivity to ecological risk/resilience forces across this critical transition to early adolescence. However, they also, and more importantly, signal opportunities for practical intervention efforts (Lee et al., 2014) to reduce risk and harness resilience. From an assessment perspective, our findings emphasize the need to consider the dynamic evolvement of the developmental context, characterized by changes in multiple ecological domains, as focusing on one single domain or taking a "snapshot" of a specific developmental time may "miss the boat" and misguide intervention efforts.

A few limitations shall be considered. First, the present study draws from the ecological model and focuses on the relatively inner layers (i.e., micro-, meso-, exo-systems). While we recognize the significant influences of broader sociocultural layers (e.g., laws, political climates) upon youth's development, including broader sociocultural forces is beyond the scope of the present study and is not well supported by available assessments from the ABCD Study. Second, per the ABCD Study's recommendations and guidelines, we utilized the baseline ADI and COI scores (i.e., residential history-derived scores in the ABCD Study) and extended them to later time points. This decision may have limited the transition probability of the risk/resilience profiles, as it reduces the heterogeneity in our data.

To conclude, the present study, both theory- and data-driven, presented ecologically derived youth's risk/resilience profiles at different time points; it also characterized the transition pathways among profiles during the critical transition from late childhood to early adolescence and linked the profiles and transition pathways with developmental psychopathology. Our findings reflected developmental equifinality and multifinality and echoed the experience-dependent nature of development, presenting a more integral illustration of the ecological context and shedding light on more precise intervention efforts in youth.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/S0954579424001603.

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Competing interests. The authors declare no conflict of interest.

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