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Unveiling the Heterogeneity of Sensation Seeking and Collectivism Development in Chinese Adolescents

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ABSTRACT

Objective: Understanding the impact of sociocultural tendencies on the personality development of adolescents represents a critical theoretical and practical issue in the field of adolescent development. In the context of China's collectivist culture, the developmental trajectories of and the interaction between sensation seeking and collectivism among adolescents remain largely unknown.

Method: This study examined the heterogeneity of the joint growth patterns of sensation seeking and collectivism and their interactions across distinct latent trajectory classes. We collected 3-year longitudinal data from 20,225 Chinese adolescents (60.45% male).

Results: We identified four unique joint developmental trajectories. Contrary to the traditional view that collectivism inherently suppresses sensation seeking, most adolescents (89.52%) exhibited synchronous growth of both dimensions. The development of adolescent sensation-seeking behavior was significantly influenced by their alignment with societal contribution-driven happiness and an unquestioning prioritization of collective interests.

Conclusions: Our findings underscore the nuanced interplay and commonalities between sensation seeking and collectivism development among Chinese adolescents.

1 | Introduction

Collectivism is an important value among Chinese adolescents that emphasizes the interdependence and connections of individuals within social groups (Oyserman and Lee 2008; Raeff, Greenfield, and Quiroz 2000). Research has reported that sensation seeking is closely related to individualism (Kapetanovic et al. 2023). Adolescents' desire for novel, exciting, and stimulating experiences is significantly higher in individualistic cultures than in collectivist cultures (Harden and Tucker-Drob 2011). However, among individuals with collectivist values, the development of sensation seeking may differ because they prioritize the welfare of the group over personal interests, and they assimilate themselves into societal norms and expectations (Tjosvold, Law, and Sun 2003). Furthermore, adolescence is a crucial stage for the internalization and stabilization of collectivist values (Yurgelun-Todd 2007). Individual differences in the developmental trajectory of collectivism, such as the timing, level, and rate of collectivism development, may further influence or be influenced by the development of sensation seeking (Mathijssen et al. 2021). In China, where collectivism is deeply rooted, exploring the developmental dynamics of sensation-seeking behavior, in conjunction with collectivism, is essential for comprehending the diversity of the interplay between these factors.

Chuqi Chen, Xingke Wang, and Tenghui Shen contributed equally to this work.

This study was not preregistered, and therefore, there was no mention of an analysis plan.

1.1 | Sensation Seeking and Collectivism

There is a consensus that, in individualistic cultures, sensation seeking develops primarily during adolescence. Sensation seeking is a personality trait that reflects the desire for novel, exciting, and stimulating experiences (Harden and Tucker-Drob 2011). It typically becomes more prominent with the onset of adolescence, peaks in mid-adolescence, and declines in early adulthood (Freund, Schulenberg, and Maslowsky 2021). However, not all individuals follow the same developmental trajectory (Schwaba and Bleidorn 2018). Research indicates that race influences the developmental trajectory of sensation seeking. For example, the sensation-seeking trajectory of Black adolescents differs from that of adolescents who belong to the "Other" racial group (i.e., adolescents who self-identify as neither Black nor White; Collado et al. 2014). Therefore, the developmental trajectory of sensation seeking likely varies among adolescents (Tieskens et al. 2022).

Collectivism is the opposite of individualism, the latter of which prioritizes personal needs (Oyserman and Lee 2008). Collectivism is a value system that emphasizes group cohesion and shared interests over individual pursuits and plays a crucial role in shaping interpersonal relationships and societal interactions (Boer and Boehnke 2016). In contrast to the emphasis on assertiveness and independence in individualistic cultures, children in more collectivist cultures are raised to value relatedness and interdependence (Grotevant 1998). Collectivistic parents expect their children to show high levels of agreeableness in the family and other groups (Gorla et al. 2024). Moreover, to achieve group harmony, children must learn to respect others and obey authority (Gorla et al. 2024). Although such values are considered to be instilled from an early age and evolve throughout adolescence (Lim and Lim 2004; Prioste et al. 2015), concrete mapping of the developmental trajectory of collectivism is notably scant. A study conducted in the Netherlands suggested that the perception of collectivistic values is stable from the age of 12 years; thus, these values may be deeply rooted in early adolescence (Oppenheimer 2004). However, this may not be fully applicable to Chinese adolescents, whose trajectories of collectivism development remain largely unexplored. Furthermore, relationships between various social systems, such as familial, educational, and societal systems, may introduce nuances to the development of collectivism in adolescents (Leijse, Koning, and Van Den Eijnden 2023).

1.2 | Association Between Sensation Seeking and Collectivism

Previous research has suggested that sensation seeking and collectivism are correlated. First, according to the cognitive-affective personality system theory from a long-term developmental perspective, adolescents' cognitive-emotional system is not fixed; rather, it is influenced by genetics and sociocultural environments (Mischel and Shoda 1995). Owing to adolescence being an important stage for socialization, adolescents' collectivist beliefs can impact personality traits, such as sensation seeking (Yurgelun-Todd 2007). Second, research on sensation seeking has reported developmental differences across social-cultural contexts (Martins et al. 2015; Yoneda, Ames, and Leadbeater 2019). Cross-cultural studies have identified unique psychological characteristics that are closely associated with specific cultures (Voulgaridou and Kokkinos 2023). For instance, in contrast to individualistic cultures, Chinese people tend to positively evaluate modesty and negatively evaluate immodest truths (Fu et al. 2016; Fu and Lee 2024); thus, the development of sensation seeking in Chinese adolescents may also exhibit unique characteristics. Therefore, an in-depth exploration of the relationship between sensation seeking and collectivism in China is not only relevant but also crucial.

The development of sensation seeking may also be inhibited in collectivist cultures. Sensation seeking, characterized by the quest to seek novelty and excitement, represents an inherent drive during adolescence, which is a phase deeply tethered to identity exploration (Freund, Schulenberg, and Maslowsky 2021). However, this drive may not be congruent with collectivistic values, which emphasize harmony, group coherence, and conformity (Wijaya 2014). Furthermore, China's cultural backdrop introduces an additional layer of complexity. Rooted in millennia of tradition, Chinese collectivism champions the group over the individual, potentially dampening the expressive pursuits of sensation seeking (Triandis 2001). The nurturing environment of China tends to prioritize societal harmony and interdependence, which discourages behaviors that challenge these norms (Steffensmeier, Zhong, and Lu 2017). Therefore, the sensation-seeking tendencies of adolescents may be subtly modulated or rechanneled in the face of dominant cultural narratives. Recognizing and dissecting such interplay between sensation seeking and collectivism is vital.

1.3 | Interaction Between the Development Trajectories of Sensation Seeking and Collectivism

The relationship between sensation seeking and collectivism is best reflected in their dynamic developmental process. Because adolescents' sensation seeking and collectivism develop continuously (Yoneda, Ames, and Leadbeater 2019), focusing on the relationship between the two factors at only one particular moment may yield inaccurate results that lack practical significance. Studies have shown that collectivism is impacted by individualism caused by globalization and rapid economic development; moreover, this phenomenon is more prevalent among young people (Ma, Hu, and Gocłowska 2016). Several studies exploring the cultural and psychological transformations brought about by social change in China have concluded that individualism is on the rise while collectivism is declining (Ma, Hu, and Gocłowska 2016; Zhang 2010). In addition, adolescents have become more independent and no longer passively follow the standards of the older generation but are eager to see the world with their own eyes (Roche et al. 2014). Therefore, it is necessary to study the relationship between sensation seeking and collectivism from a developmental perspective.

It is noteworthy that the interplay between sensation seeking and collectivism reflected by their co-development trajectory is heterogeneous among adolescents. Indeed, studies have identified various developmental trajectories for sensation seeking in adolescents (Mathijssen et al. 2021). Specifically, there are differences in not only overall trends of rising or declining trajectories but also in initial levels and rates of development, even when trajectories follow a consistent trend (Tieskens et al. 2022). Similarly, there are individual differences in the

development of collectivism. As mentioned above, demographic variation may contribute to this diversity (Collado et al. 2014). However, sensation seeking and collectivism are more important factors that influence their development than demographic variation (Triandis 2001). That is, adolescents exhibit different initial levels and rates of collectivism development, which may lead to differences in the developmental trajectories of sensation seeking. Thus, exploring the diversity of joint development trajectories will help gain a more comprehensive understanding of the relationship between sensation seeking and collectivism.

Given the unique link and development of collectivism and sensation seeking during adolescence, we aimed to explore the heterogeneity of their joint developmental patterns. Specifically, we examined the potential impact of collectivism on sensation seeking and the subtle relationship between culture and personality via their various trajectories. The Chinese context, with its rich tapestry of values and norms, offers a unique lens to understand how intrinsic personal motivations navigate changes in overarching cultural values.

1.4 | Current Study

Studies to date have reported on the developmental trends of collectivism and sensation seeking during adolescence and their heterogeneity. However, research in the Chinese cultural context remains scarce. Furthermore, the intertwined relationship between sensation seeking and collectivism has not been ascertained. Therefore, the current study aimed to integrate the development of both factors into a single framework while exploring the heterogeneity of their joint developmental patterns. The trends of collectivism and sensation seeking may exhibit conflicting or synergistic characteristics. We hypothesized that there would be various classes of joint development of collectivism and sensation seeking (Hypothesis 1). Given the developmental dynamics of sensation seeking and collectivism, we used network analysis as a supplement to visualize connections and explore how they change over time under different classes. Additionally, we hypothesized that the association between collectivism and sensation seeking would vary between different classes and over time (Hypothesis 2). This longitudinal exploration within the Chinese cultural context deepens our understanding of the development of adolescent personality and values.

2 | Methods

2.1 | Participants and Procedures

Participants were first- and second-grade students from 20 secondary vocational schools in the Guangdong, Sichuan, Hebei, and Guizhou provinces. We used stratified random sampling. Three-wave longitudinal statistics were gathered at 1-year intervals. At Time 1 (T1; March–April 2017), 20,225 students (mean [M] age = 16.76 years, standard deviation [SD] = 0.68) participated in the study, of whom 19,982 (98.79% of T1 participants) and 8886 (43.93% of T1 participants) individuals participated at Time 2 (T2) and Time 3 (T3), respectively. At baseline, 60.45% of the sample was male, 96.29% had Han nationality, and 23.67% came from a single family. Additionally, 41.63% had a left-behind experience, and 26.53% were the only child in the family. The average annual household income was 4.19 (categorized as 1–9; SD = 2.26), and fathers and mothers had an average of 8.93 and 8.23 years of education, respectively. Details of the samples in the three waves are presented in Table S1. Participants' data were included if they completed the first assessment. Because the second-grade students surveyed at T1 had graduated from school by T3, there was a considerable dropout of subjects at T3. To verify the homogeneity of participants between T1 and T3, we conducted a series of t-tests and chi-square tests to compare demographic information. Results showed that age ($t = 10.42$, $p < 0.001$), father's education ($t = 6.00$, $p < 0.001$), mother's education ($t = 5.64$, $p < 0.001$), annual household income ($t = 5.46$, $p < 0.001$), sex ($\chi^2 = 10.42$, $p = 0.001$), and left-behind experience ($\chi^2 = 9.12$, $p = 0.003$) differed significantly between T1 and T3. However, the effect sizes were extremely small (i.e., $d < 0.13$; $\varphi < 0.02$), which indicated that the differences were trivial.

Each participant was assigned a unique identifier to enable data matching among the three assessment points. All demographic information was assessed at baseline, and adolescents' sensation-seeking and collectivism tendency scores were evaluated at each time point. Written informed consent was obtained from each participant after a full explanation of the study procedure was provided. Parents/guardians of participants aged below 18 years were informed, and their consent was obtained. Participants completed online questionnaires in the computer classrooms of their respective schools. To ensure a controlled environment, students were supervised by trained psychology teachers, computer teachers, and graduate students who had received specific instructions from the investigators or teachers involved in the study. The study was reviewed and approved by the Institutional Review Board of Human Research Ethics Committee for Non-clinical Faculties at Hangzhou Normal University and Beijing Normal University.

2.2 | Measures

2.2.1 | Demographic Information

The comprehensive demographic profile encompassed variables such as sex, age, nationality, family structure, history of left-behind experiences, one-child policy status, school tier, and SES. SES was calculated using principal components analysis, based on the maximum years of education of each parent and annual household income (Appendix B). Family structure denoted whether the participant came from a single-parent household, and one-child policy status indicated whether the participant was an only child. School tier referred to the level of the participant's school, which was classified into three categories: national demonstration school, provincial demonstration school, and regular school. Annual household income was categorized as follows: 1 ≤ 3000 RMB, 2 = 3001–6000 RMB, 3 = 6001–10,000 RMB, 4 = 10,001–30,000 RMB, 5 = 30,001–50,000 RMB, 6 = 50,001–100,000 RMB, 7 = 100,001–150,000 RMB, 8 = 150,001–200,000 RMB, and 9 > 200,000 RMB.

2.2.2 | Sensation Seeking

The sensation seeking subscale from the Substance Use Risk Profile Scale (Woicik et al. 2009) was used to assess sensation seeking. The scale consists of six items (e.g., "I enjoy new and exciting experiences, even if they are unconventional"). Participants responded to items using a 4-point Likert-type scale (i.e., completely agree, agree, disagree, and completely disagree). The scores for each item were summed to generate a total sensation-seeking score ranging from 6 to 24. Higher scores indicate a greater inclination for sensation seeking. The internal consistency coefficient of the original English version of the scale was 0.7. We used the Chinese version of the scale that we have used previously. Internal consistency coefficients of the scale were 0.79 at T1, 0.88 at T2, and 0.90 at T3, which indicated high reliability.

2.2.3 | Collectivism

Collectivism was measured by the National Children's Study of China (Dong and Lin 2011) using the Children and Adolescents' Value Scale, which is a self-report questionnaire comprising 27 items and six dimensions: learning attitude, money attitude, power attitude, national identification, collectivism, and environmental protection. We focused on the collectivism dimension, which consists of four items (e.g., "Collective interests always take precedence over everything else"). Participants responded to these items using a 4-point Likert-type scale (i.e., completely agree, somewhat agree, somewhat disagree, and completely disagree). A higher score indicated stronger beliefs regarding collectivism and public welfare. The internal consistency coefficient of the collectivism dimension was 0.80 at T1, 0.90 at T2, and 0.89 at T3, which indicated the high reliability of the scale.

2.3 | Data Analysis

We first calculated the descriptive statistics of the variables. To ensure confidentiality and longitudinal data accuracy, we also performed normality and longitudinal measurement invariance tests on the data. We then built a parallel process growth mixture model (GMM) to determine joint developmental trajectories of collectivism and sensation seeking using Mplus version 8.3 (Muthén and Muthén 2019). The modeling process was initiated using a single-class model, and the class number was iteratively increased at each step (Liu and Perera 2022). To determine the optimal number of classes, we compared the k-class and (k–1)-class models and applied various criteria, such as the Bayesian information criterion (BIC), Akaike information criterion (AIC), adjusted BIC (aBIC), Vuong-Lo–Mendell–Rubin likelihood ratio test (VLMR), and entropy. To select the optimal number of classes, we considered the clarity and distinctiveness of the identified classes and aimed to strike a balance between model fit and interpretability. We considered 5% of the overall sample as the minimum acceptable number for each class (Ram and Grimm 2009).

To gain a more comprehensive understanding of the interaction between collectivism and sensation seeking, we created networks using the R package, qgraph (Epskamp et al. 2012). The qgraph package allows estimations of weighted undirected networks, where nodes and edges represent specific items within two constructs and the relationships between these items, respectively. For each of the four classes determined by the parallel process GMM, three networks were constructed for each time point. Expected influence (EI) was used to measure the centrality of nodes (Zhang et al. 2019), where nodes with a higher EI have a greater effect on others (Borsboom and Cramer 2013). To assess the accuracy of edge weights, we performed robustness tests using the R package, bootnet (Epskamp, Borsboom, and Fried 2018). In addition, we assessed the stability of results using correlation stability (CS) coefficients: CSs of 0.25 and 0.5 indicate adequate and good network stability, respectively (Epskamp, Borsboom, and Fried 2018). Finally, the structural difference between networks was assessed using the R package, NetworkComparisonTest (van Borkulo, Epskamp, and van Borkulo 2016). The global strength (i.e., the sum of the actual weights of all edges in a network) was used to quantify network connectivity.

2.4 | Transparency and Openness

The data used in the study was obtained from the China Psychological Development Tracking Project, which was overseen by the Development Research Center of the State Council of China. Because unauthorized dissemination or use of this data can result in legal repercussions under Chinese law, we are unable to publicly share the raw dataset. Interested parties who wish to access the data are required to submit a formal application, and access to the data may be granted upon approval. The code used for our analysis can be accessed at [https://anonymous.4open.science/r/Sensation-seeking-and-Collectivism-3CB0/].

3 | Results

3.1 | Descriptive Statistics

Table 1 shows the means and SDs for sensation seeking and collectivism. Sensation seeking showed an increasing trend across the three time points: T1: $M = 15.04$, SD = 2.71; T2: $M = 15.83$, SD = 4.05; and T3: $M = 16.56$, SD = 4.35. Collectivism remained relatively stable over time: T1: $M = 12.06$, SD = 2.34; T2: $M = 12.02$, SD = 2.68; and a slight rise at T3: $M = 12.66$, SD = 2.52. All variables were normally distributed (Table S2; Figures S1 and S2), and both sensation seeking and collectivism had strong measurement invariance (Table S3).

3.2 | Parallel Process Growth Mixture Models for Sensation Seeking and Collectivism

3.2.1 | Unconditional Model

For the joint growth trajectories of sensation seeking and collectivism, we examined models with classes varying from 1 to 5 (Table 2). The two-class model was unsatisfactory because its entropy score was below the commonly accepted threshold of

TABLE 1 | Mean and standard deviations for sensation seeking and collectivism ($N = 20,225$).

Variable	*M*	SD
T1 sensation seeking	15.04	2.71
T2 sensation seeking	15.83	4.05
T3 sensation seeking	16.56	4.35
T1 collectivism tendency	12.06	2.34
T2 collectivism tendency	12.02	2.68
T3 collectivism tendency	12.66	2.52

Abbreviations: *M* = mean; SD = standard deviation; T1 = Time 1, March–April 2017; T2 = Time 2, 1 year after T1; T3 = Time 3, 2 years after T1.

0.80. The three-class model had a higher entropy score but an imbalanced class distribution, with one class representing only 0.91% of the sample. Both the four- and five-class models offered superior fit statistics. However, the five-class model introduced an additional class that constituted only 0.57% of the sample, which did not meaningfully enhance the model's interpretability. Considering the statistical criteria, class distribution, and interpretability, we selected the four-class model as the most appropriate representation of our data on the joint growth trajectories of sensation seeking and collectivism.

Figure 1 illustrates the model-implied curves derived from the parallel process GMM of sensation seeking and collectivism and the smoothed lines from the raw trajectories for each latent class. Although class 1 (10.48%) started with the lowest initial level of sensation seeking (ISS intercept = 13.57, $p < 0.001$), it showed a substantial increase over time (SSS slope = 1.78, $p < 0.001$). In addition, this class displayed a high initial level of collectivism (IC intercept = 15.20, $p < 0.001$), which declined significantly over time (SC slope = −1.46, $p < 0.001$). Class 2 (10.75%) showed the highest initial level of sensation seeking (ISS intercept = 18.17, $p < 0.001$) that decreased gradually over time (SSS slope = −0.65, $p < 0.001$) and also the highest level of initial collectivism (IC intercept = 15.60, $p < 0.001$) that exhibited a steep decline (SC slope = −1.61, $p < 0.001$). Class 3 (14.52%) began with a moderate level of sensation seeking (ISS intercept = 14.68, $p < 0.001$), which increased slightly over time (SSS slope = 0.78, $p < 0.001$). This class started with the lowest level of collectivism (IC intercept = 8.49, $p < 0.001$), which rapidly increased to a high level (SC slope = 2.19, $p < 0.001$). Finally, class 4 (64.25%), which was the majority, started with a slightly higher level of sensation seeking (ISS intercept = 14.85, $p < 0.001$) than class 3, which showed a moderate increase over time (SSS slope = 0.81, $p < 0.001$). Collectivism for class 4 began at a moderate level (IC intercept = 11.80, $p < 0.001$) and remained fairly stable (SC slope = 0.28, $p < 0.001$).

3.2.2 | Model With Covariates

Based on previous studies, we initially included SES, sex, and age as covariates for sensation seeking and collectivism trajectories in our model. However, the model fit and latent class agreement consistency deteriorated significantly. Thus, we incrementally removed covariates from the model and found that the model fit and classification consistency did not significantly deteriorate when only SES was included as a covariate. The introduction of SES into the proposed GMM for joint development enhanced the model fit above that of the unconditional GMM (Table 2). Cohen's Kappa test confirmed substantial concordance of the latent classes between the unconditional GMM and the GMM including a covariate, as reflected in the Kappa value of 0.98 ($z = 215$, $p < 0.001$). Approximately, 1.65% (334 out of 20,225) of the sample changed class assignments between the two models.

Table 3 illustrates the odds ratios (ORs) of SES on the latent classes in the joint growth trajectories of sensation seeking and collectivism (reference class: class 4). SES showed a significant effect only on the likelihood of assignment to class 2. A higher SES significantly increased the likelihood of an individual being assigned to class 2 (OR = 1.45, $p < 0.001$) but not class 1 (OR = 1.01, $p = 0.845$) or 3 (OR = 1.00, $p = 0.852$).

3.3 | Network Analysis Across Four Latent Classes

3.3.1 | Network Generation and Stability

The sensation-seeking and collectivism networks exhibited considerable stability, as reflected in the CS coefficients of EI, which ranged from 0.67 to 0.75. Notably, networks without connections between sensation-seeking and collectivism nodes displayed CS coefficients of bEI at 0, whereas networks with connections yielded CS coefficients of bEI between 0.36 and 0.75. For each network, most centrality values were estimated to be different from one another in difference tests (Figures S3–S6). All networks demonstrated high-precision confidence intervals (CIs) for edge weights (Figures S7–S10). Most edges in the 12 networks had no overlapping CIs with other edges in the same network.

Figure 2 delineates the evolution of networks across three separate time points for each of the four identified latent classes. Across all classes, the network changed from sparse to dense over time. In class 1, the T1 network encompassed a few interconnected sensation-seeking nodes, with no apparent connections within the collectivism nodes. At T2, nodes associated with sensation seeking and collectivism started to interconnect within their respective constructs, albeit not across the two constructs. However, at T3, there was a marked escalation in interconnectedness, with most nodes merging into a densely linked network. In class 2, most sensation-seeking nodes were interconnected at T1, whereas all collectivism nodes, except C01 (“an individual's happiness depends on their contribution to society”), remained isolated. Intriguingly, C01 did establish a connection with SS05 (“I am interested in experience for its own sake, even if it is illegal”). Extensive interconnectedness between all nodes was observed at T2 and T3. The initial network of class 3 at T1 exhibited interconnected sensation-seeking nodes within its construct, whereas, among the collectivism nodes, only C01 (“an individual's happiness depends on their contribution to society”) and C03 (“one should never engage in activities that are unacceptable to society”) were negatively connected. However, at T2, the interconnectivity within and across the sensation-seeking and collectivism constructs had changed. At T3, nodes across both constructs had fully integrated. For class 4, the

TABLE 2 | Model fit statistics of parallel process growth mixture models for sensation seeking and collectivism.

Model	AIC	BIC	aBIC	VLMR		Class count (percentage)					
				p	Entropy	Class 1	Class 2	Class 3	Class 4	Class 5	
Unconditional model											
1-class	482,665.12	482,823.41	482,759.85	—	—	20,225 (100%)	—	—	—	—	
2-class	481,943.31	482,141.18	482,061.73	<0.001	0.77	18,611 (92.02%)	19,972 (7.98%)	—	—	—	
3-class	481,454.62	481,692.06	481,596.73	<0.001	0.85	18,547 (91.70%)	183 (0.91%)	1495 (7.39%)	—	—	
4-class	476,761.23	477,038.24	476,927.01	<0.001	0.86	2119 (10.48%)	2175 (10.75%)	2936 (14.52%)	12,995 (64.25%)	—	
5-class	476,293.96	476,610.55	476,483.43	<0.001	0.88	2933 (14.50%)	2134 (10.55%)	2038 (10.08%)	13,004 (64.30%)	116 (0.57%)	
Model with covariates											
4-class	476,594.28	476,895.04	476,774.28	<0.001	0.86	2314 (11.44%)	2009 (9.93%)	2936 (14.52%)	12,966 (64.11%)	—	

Note: The 4-class model is the final class solution.
Abbreviations: AIC = Akaike Information Criterion; aBIC = adjusted BIC; BIC = Bayesian Information Criterion; VLMR = Vuong-Lo–Mendell–Rubin likelihood ratio test.

T1 network showed interconnected sensation-seeking nodes within its construct, with no discernible links among the collectivism nodes. At T2, nodes within each construct (i.e., sensation seeking and collectivism) had begun to interconnect, with C01 ("an individual's happiness depends on their contribution to society") forming links with SS02 ("I enjoy new and exciting experiences, even if they are unconventional"), SS03 ("I like doing things that frighten me a little"), and SS05 ("I am interested in experience for its own sake, even if it is illegal"). At T3, although most nodes were interconnected, the overall network demonstrated lower density than the T3 networks of classes 1, 2, and 3.

3.3.2 | Network Comparison

We tested the network structure invariance of different classes at the same time point. The network structure differed significantly between all classes at T1 (M [0.11, 0.25], all $ps < 0.001$) and T2 (M [0.10, 0.22], $ps \leq 0.004$). However, at T3, only two pairs of network structures differed significantly: the networks between classes 2 and 4 ($M = 0.13$, $p = 0.031$) and the networks between classes 3 and 4 ($M = 0.13$, $p = 0.004$). We also explored the structural invariance between the T1 and T2 networks and the T2 and T3 networks for each class. All pairwise comparisons of network structures showed significant differences (M [0.09, 0.86], $ps \leq 0.001$) except for the T2 and T3 networks in classes 2 ($M = 0.11$, $p = 0.447$) and 3 ($M = 0.11$, $p = 0.190$).

The global strengths of the sensation-seeking and collectivism networks across the four classes at three time points are shown in Figure 3. Broadly speaking, all classes demonstrated an increasing global strength trajectory over time. Between-class comparisons of global strength showed that, at T1, global strength differed significantly between all classes (S [0.86, 2.75], all $ps < 0.001$) except between the networks of classes 2 and 3 ($S = 0.21$, $p = 0.701$) and classes 2 and 4 ($S = 0.65$, $p = 0.222$). At T2, the networks between classes 1 and 4 emerged as the only pair that did not differ significantly ($S = 0.20$, $p = 0.751$); all other class combinations showed significant differences (S [1.62, 6.06], $p \leq 0.015$). However, at T3, none of the networks showed a significant difference (S [0.08, 1.69, $p > 0.05$]) except for class 2 vs. class 4 ($S = 2.38$, $p = 0.004$) and class 3 versus class 4 ($S = 2.46$, $p < 0.001$). Within each class, the global strength of most networks significantly exceeded that of their previous time point (S [1.63, 13.46], $ps \leq 0.001$). However, there were no significant differences in global strength between the networks of T2 and T3 within both classes 2 ($S = 0.34$, $p = 0.758$) and 3 ($S = 2.08$, $p = 0.054$).

4 | Discussion

The values and traits of adolescents are evolving continuously. In this study, we primarily focused on the associations of sensation seeking and collectivism by observing joint developmental trajectories. Additionally, we explored how the unique associations of these factors underlie developmental patterns via network analyses. To the best of our knowledge, this is the first study to evaluate the development of and the association between these personality traits in Chinese adolescents. The

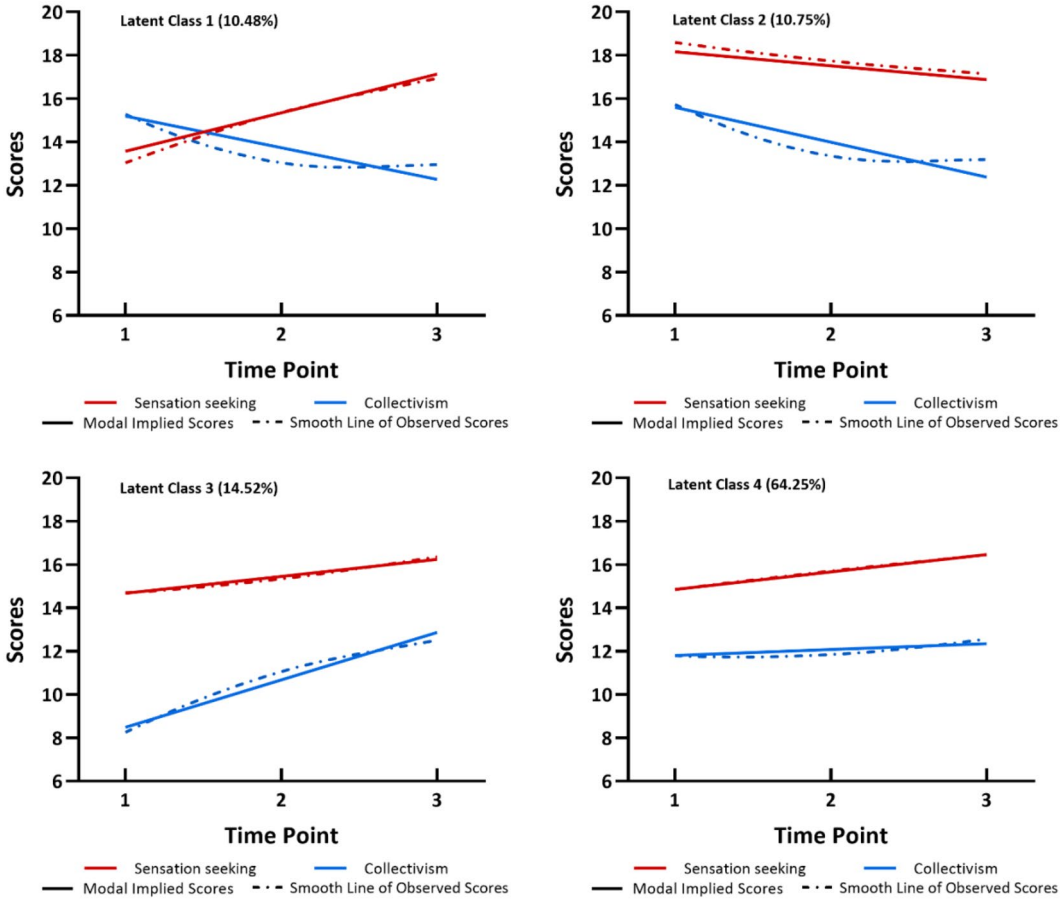

FIGURE 1 | Model-implied trajectory and smooth line of the bivariate outcome. [Color figure can be viewed at wileyonlinelibrary.com]

TABLE 3 | Odds ratio of covariates for joint growth trajectories of sensation seeking and collectivism.

	Class 1		Class 2		Class 3	
Covariates	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
SES	1.01	[0.94, 1.07]	1.45***	[1.35, 1.55]	1.00	[0.96, 1.05]

Abbreviations: CI = confidence interval; OR = odds ratio; SES = socioeconomic status. Reference class: class 4.
***$p < 0.001$.

joint growth trajectories observed in this study demonstrated the heterogeneous development of sensation seeking and collectivism. Moreover, our findings highlight the intricate interplay between individual personality and sociocultural contexts. Specifically, we identified four distinct joint developmental trajectories of sensation seeking and collectivism. The network analysis model graph showed that sensation seeking developed earlier than collectivism. Under the collectivist culture, the collectivist orientation of adolescents developed gradually. Individuals began to recognize the nuanced relationship between collective interests and personal pleasure, which subsequently affected the development of sensation seeking. Our research corroborates the cognitive-affective personality systems theory, which emphasizes that individual cognitive changes impact personality traits. Our observation that SES contributes to the heterogeneity in the development of sensation seeking and collectivism also has theoretical and practical significance.

4.1 | The Joint Developmental Trajectories of Sensation Seeking and Collectivism

The current study identified distinct joint developmental trajectories of sensation seeking and collectivism in adolescents, providing insights into the nuanced relationship between these two constructs. This finding supports Hypothesis 1. The four joint developmental patterns of sensation seeking and collectivism observed in adolescents are a stable equilibrium pattern, an adversarial growth pattern, a synchronous growth pattern, and a dual-decline pattern.

In the first instance, separate observations of adolescent developmental trajectories for sensation seeking and collectivism revealed subgroups that follow different developmental patterns. This is consistent with studies conducted in other countries (Yoneda, Ames, and Leadbeater 2019). The development of sensation seeking in Chinese adolescents follows several different trajectories.

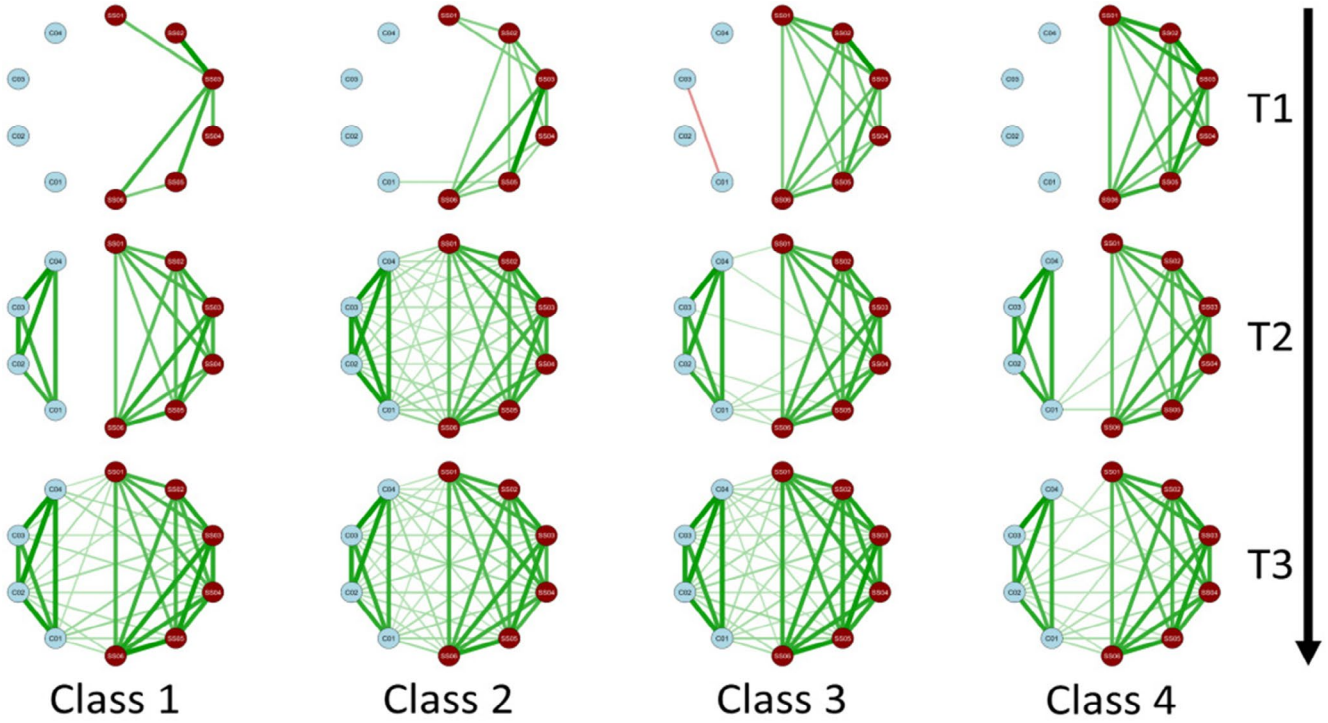

FIGURE 2 | Sensation-seeking and collectivism networks at three time points across four classes. [Color figure can be viewed at wileyonlinelibrary.com]

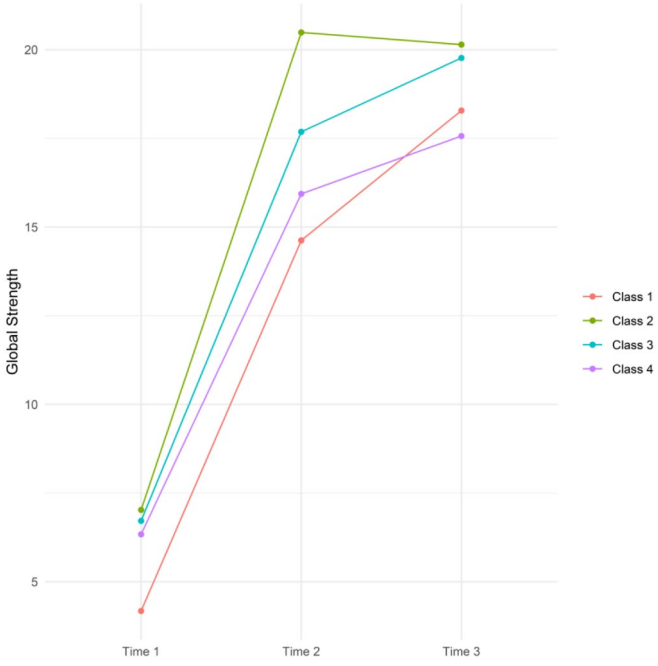

FIGURE 3 | Changes in global strength over time of the sensation-seeking and collectivism networks for the four classes. [Color figure can be viewed at wileyonlinelibrary.com]

Notably, when we examined the development of collectivism using the average scores at the three time points, collectivism appeared relatively stable, which aligns with previous research (Oppenheimer 2004). However, when we applied an individual-centered approach to explore the development of collectivism, we observed three developmental trends in adolescents: rising, declining, and relatively stable. Although the vast majority of adolescents showed an upward trend in sensation seeking and collectivism, the initial levels and rates of growth varied considerably. These findings underscore the importance of using an individual-centered approach (Depaoli 2013; Liu and Perera 2022).

More importantly, the varying initial levels and developmental trajectories of collectivism in adolescents may impact the progression of sensation seeking and vice versa. The majority of adolescents (64.25%) showed a stable pattern for both sensation seeking and collectivism, which we termed a stable equilibrium pattern. The stability of these trajectories indicates that most adolescents effectively maintain a balance between their desire for novel experiences and societal norms (i.e., well-regulated development; Hitlin and Vaisey 2013). Research indicates that individuals in collectivist cultures typically adopt a conservative attitude toward risk, aiming to avoid behaviors that could be perceived as deviating from social norms. This risk-averse mindset often makes them more cautious in seeking novel experiences, which in turn influences their sensation-seeking behaviors (Defoe, Rap, and Romer 2022). Furthermore, perceptions of positive emotions differ between cultures. Compared with their Western counterparts, Asians tend to view the utility of positive emotions more negatively, perceiving them as potentially more harmful, and exhibit a reduced preference for such emotions (Ma, Tamir, and Miyamoto 2017). This suggests that Chinese adolescents may evaluate the emotional experiences associated with sensation seeking more negatively, leading them to consciously moderate their pursuit of these experiences. Therefore, these adolescents may effectively employ subtle mechanisms to balance their personal desire for thrilling experiences with the need to

uphold societal obligations and relationships (McIntyre-Mills, Romm, and Corcoran-Nantes 2017).

During development, adolescents may fluctuate between higher sensation seeking or higher collectivism. Some of the adolescents in our study exhibited the fastest growth in sensation seeking and a corresponding decline in collectivism. This pattern indicates the potential struggle to reconcile growing sensation-seeking behaviors with waning collectivist values (Zaidi, Couture-Carron, and Maticka-Tyndale 2016). The decrease in collectivism may not simply denote a shift away from traditional values; rather, it may symbolize an evolving sense of autonomy (Chen, Pan, and Xu 2016). This burgeoning autonomy may, in turn, conflict with collective norms as these adolescents begin to explore boundaries and develop their own identities (Juang, Syed, and Cookston 2012; Kleinkorres, Stang-Rabrig, and McElvany 2023).

By contrast, another subgroup showed a rapid increase in collectivism, with a slower rise in sensation seeking. This suggested that these individuals gradually gained an understanding of societal expectations and the potential consequences of their actions (Chen et al. 2012). This perspective highlights the crucial role of peer groups in adolescent socialization (Henneberger, Mushonga, and Preston 2021). It is often assumed that individuals in their teenage years are more inclined to take risks. However, research indicates that when the possibility of peer rejection is present, adolescents are likely to avoid engaging in risky behaviors (Tomova, Andrews, and Blakemore 2021). In collectivist cultures, individuals tend to select activities that enhance their sense of group belonging when seeking stimulation, rather than simply pursuing excitement for its own sake. Therefore, to maintain harmony with societal expectations, these adolescents make an internal compromise at the expense of their personal desires (Kwan, Bond, and Singelis 1997). This hints at the limitations of a collective-focused sociocultural environment in addressing the evolving needs of young individuals (Lomas et al. 2022).

The current study also indicates that SES influences the relationship between collectivism and sensation seeking. We identified a distinct pattern of simultaneous development of sensation seeking and collectivism. Adolescents from higher socioeconomic backgrounds initially exhibited high levels of both sensation seeking and collectivism, which subsequently declined over time. Previous studies suggest that individuals in higher social positions are more likely to express their internal attributes and characteristics directly (Kraus, Piff, and Keltner 2009). In contrast to their lower SES peers, these adolescents may have received greater encouragement regarding their personal goals and interests, leading them to explore their identities and engage in risk-taking behaviors, resulting in higher initial levels of sensation seeking. Additionally, higher SES is associated with better educational resources, which may enhance adolescents' understanding and acceptance of collectivist values. The observed dual-decline pattern indicates that these adolescents developed a more nuanced comprehension of societal expectations and personal risks, resulting in a decrease in both sensation-seeking behaviors and adherence to collective values (Galambos, Barker, and Krahn 2006).

Through a comprehensive analysis of the various patterns of joint development discussed above, we observed that the tension and balance between sensation seeking and collectivism are commonly present in different groups, although the relative strength of each may differ. Due to inherent individual differences, some adolescents may initially display greater maturity and adaptability in sensation seeking or collectivism traits than their peers. This diversity underscores the distinct influences of varying environmental contexts on the development of adolescents. Furthermore, adolescents demonstrate a trend toward increased consistency in both sensation seeking and collectivism as they evolve from varying levels. Evaluations from social support systems, such as peers and family, significantly influence adolescents' values and behaviors. In their pursuit of social acceptance, adolescents gradually adjust their behaviors to align with the collective norms of their group (Gorodnichenko and Roland 2012).

4.2 | The Association of Sensation Seeking and Collectivism and Its Change Over Time

Sensation seeking and collectivism gradually establish a connection over time, with variations in the timing and strength of this connection between different groups, supporting Hypothesis 2. Notably, adolescents initially struggle to grasp the significance of collectivism for themselves; instead, they gradually internalize collectivist values. It is through this process that the association between sensation seeking and collectivism becomes apparent. Furthermore, sensation seeking and collectivism can coexist and manifest in diverse forms depending on contextual factors. A nuanced understanding of this interplay is essential to comprehensively support the healthy development of adolescents.

The current study offers insight into the dynamics of sensation seeking and collectivism via network analysis. In the early stages, sensation seeking exhibited high interconnectedness, pointing to a shared underlying drive, which is consistent with Zuckerman's theory (Zuckerman and Aluja 2015). However, nodes within collectivism showed a lack of interconnection at T1. This finding aligns with theoretical research that suggests that collectivism represents a complex structure, with its encompassing concepts showing relative independence (Triandis 2018). That is, unlike sensation seeking, the various concepts of collectivism may not have formed a common underlying psychological mechanism in adolescents, and adolescents' understanding of collectivism may be fragmented in the early developmental stages. Adolescents are in a developmental stage characterized by the formation of self-awareness and personal identity (Chen, Pan, and Xu 2016). During this period, adolescents tend to prioritize individual needs and self-actualization, which may result in a delayed comprehension and internalization of collectivist values. However, when adolescents enter a new environment, they need to reconstruct their relationship with their surroundings and seek recognition and a sense of belonging from the group (Albarello, Crocetti, and Rubini 2017). The social interactions within the school environment significantly influence adolescents' sense of group identity, thereby fostering the development of collectivist values. As they interact more with peers and teachers, adolescents gradually develop a more comprehensive and nuanced understanding of collectivism (Verhoeven, Poorthuis, and Volman 2019). Additionally, the

diverse trajectories of collectivism during this process suggest that adolescents may reflect on these values, striving to establish a unique balance between personal interests and the greater good (Trommsdorff 2011).

Network analysis revealed differences in the timing of the connection between sensation seeking and collectivism between various groups. The timing of individuals' initial formation of connections varies, potentially influenced by the developmental environments of adolescents. Significantly, adolescents from higher SES backgrounds identify the link between sensation seeking and societal contribution at an earlier stage than their counterparts from lower social classes. This suggests that adolescents from more advantaged backgrounds may have had greater access to sensation-seeking opportunities and collective norms, which contributed to their initial understanding of this relationship (Beilmann et al. 2014; Kraus, Piff, and Keltner 2009). However, as adolescents progress through their development, the disparities in the strength of the relationship between sensation seeking and collectivism tend to diminish. This convergence may indicate a common developmental trajectory among individuals during the adolescent period.

The current study indicated there is an intensifying interplay between specific aspects of sensation seeking and collectivism over time. The network structure invariance reflects the dynamic nature of these relationships as they transition from fluidity to stability in Chinese adolescents. At an earlier age, the pursuit of sensation-seeking behaviors may overshadow considerations related to collectivism owing to immature inhibitory functions (Steinberg 2010). However, with time, values intrinsic to collectivism, which is deeply rooted in Chinese culture (Gorodnichenko and Roland 2012), are gradually internalized. This process unfolds gradually, enabling young individuals to integrate these values into their broader psychological framework, which includes sensation-seeking tendencies. This aligns with existing research indicating that cultural values can affect the extent to which individuals prioritize internal factors (such as attitudes toward stimulation) over external factors (such as social norms) in their behavioral decisions (Shteynberg, Gelfand, and Kim 2009). Furthermore, these findings suggest that during socialization, the cultural environment (collectivism) and adolescents' psychological traits (sensation seeking) interact continuously, influencing psychological processes. This interaction reflects the principles of the cognitive-affective personality system theory (Mischel and Shoda 1995).

4.3 | Limitations

Although our study provides valuable insight into the joint developmental trajectories of sensation seeking and collectivism among Chinese adolescents, there are several limitations. First, our sample was restricted to the four provinces of Hebei, Guangdong, Guizhou, and Sichuan, which may not fully represent the diverse geographical and cultural backgrounds within China. As such, future studies could include a broader range of geographical and cultural contexts to improve the generalizability of the findings. Moreover, cross-cultural research would be a valuable extension of our study. The Chinese context could be compared with other cultural settings to enrich our understanding of the development of sensation seeking and collectivism and how they relate to each other.

Second, our measurement of collectivism comprised only four items. Therefore, we may not have captured every facet of this complex construct. For instance, finer categorizations, such as vertical and horizontal dimensions of collectivism, could not be distinguished using our measurement scale. Future studies could use more comprehensive scales or develop new instruments for a more thorough assessment of the various aspects of collectivism.

Lastly, our data were collected annually over 3 years. This time frame may not have captured short-term fluctuations or the long-term development of sensation seeking and collectivism. Future studies could collect data at shorter intervals or extend the longitudinal follow-up period. Such research would provide a more nuanced understanding of the evolution and influence of these factors throughout adolescence.

5 | Conclusions

Our study showed that there are four distinct joint growth trajectories of sensation seeking and collectivism in Chinese adolescents: adversarial growth pattern, dual-decline pattern, synchronous growth pattern, and stable equilibrium pattern. Sensation seeking and collectivism are interconnected via a congruence in happiness driven by individual and societal contributions and a prioritization of collective interests.

Adolescents with different joint developmental trajectories of sensation seeking and collectivism may converge over time in terms of the relational dynamics of sensation seeking and collectivism. Such similarities may stem from the cumulative influence of China's distinctive collectivist education, culture, and social environment, which is a hypothesis that warrants further exploration and validation. Most Chinese adolescents are typically exposed to a highly collectivist educational environment, which profoundly shapes their development.

For educators and mental health professionals, our findings underscore the importance of acknowledging developmental diversity when developing interventions. Recognizing an adolescent's specific developmental trajectory would enable professionals to offer more personalized and precise interventions. Future research could explore the universality of these developmental trajectories across different cultural and educational contexts. Moreover, the impact of the intricate relationship between sensation seeking and collectivism on adolescents' mental health and behavior warrants further exploration. Taken together, our study highlights the importance of comprehending the diversity and complexity of adolescents to accurately assess and support their growth and development in a constantly evolving social and cultural landscape.

Author Contributions

All authors contributed to the manuscript's conceptual development. Chuqi Chen, Xingke Wang, and Tenghui Shen lead the data analysis

and drafting of the manuscript. All authors revised and approved the final version of the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.