

Childhood Environmental Unpredictability and Prosocial Behavior in Adults: The Effect of Life-History Strategy and Dark Personalities

Menghao Ren¹, Shengqi Zou^{1,2}, Shuyu Ding³, Daoqun Ding^{1,4}

¹Department of Psychology, School of Education Science, Hunan Normal University, Changsha, People's Republic of China; ²Cognition and Human Behavior Key Laboratory of Hunan Province, Hunan Normal University, Changsha, People's Republic of China; ³Department of Education, Shandong Women's University, Jinan, People's Republic of China; ⁴Center for Mind and Brain Sciences, Hunan Normal University, Changsha, People's Republic of China

Correspondence: Daoqun Ding, Department of Psychology, School of Education Science, Hunan Normal University, 36 Lushan Road, Changsha, Hunan, 410081, People's Republic of China, Tel +86-731-88872869, Email psychding@hunnu.edu.cn

Purpose: Childhood environments have an impact on an individuals' behavior and cognition. We explored the relationship and possible mechanisms between childhood environmental unpredictability (CEU) and prosocial behavior (PSB) in adults.

Participants and Methods: We recruited Chinese college students (N = 1035) and adopted a questionnaire survey and structural equation modeling.

Results: The results showed that CEU negatively predicted PSB in adults. Life-history strategy and dark personality chains mediated this relationship. Higher CEU facilitated faster development of life-history strategies in individuals, and dark personalities, via fast life-history strategies, further influenced PSB in adults. The mediating pathways of Machiavellianism, narcissism, and sadism were significant, while psychopathy was not. Women were more prosocial than men, and there was no sex difference in the influence mechanism of CEU on PSB.

Conclusion: This study has practical significance as it emphasizes the importance of shaping a stable childhood environment and that individuals' prosociality can be improved by intervening in the mediation.

Keywords: childhood environmental unpredictability, prosocial behavior, life-history strategy, dark personality

Introduction

Childhood environment often shapes individual personality and development and can predict individual behavior in the future.^{1,2} Childhood environmental unpredictability (CEU) refers to the temporal or spatial unpredictability of risks, resources, and threats of violence in the childhood environment.^{3,4} In nature, it manifests itself in the unpredictability of food availability and natural enemies in the early years of a species. In human society, it refers to the unpredictability of childhood resources, residential and upbringing environment.^{1,5} The measure revolves around how often this unpredictability occurs in childhood. CEU can lead to more aggressive⁶ and overeating behaviors in adults,⁷ risk-taking,⁸ and cognitive biases.⁹ CEU can also lead to pathological¹⁰ and dark¹¹ personality in adults. CEU is negatively related to openness, conscientiousness, extraversion, and agreeableness in adults, while neuroticism is positively predicted.¹² Thus, CEU negatively impacts an individual's behavior and personality.

Social functioning is a key factor in individual behavior and cognition. Prosocial behavior (PSB) generally refers to all behaviors that meet social expectations and are beneficial to others, groups, or society, and is an important factor in individual social cognition and behavior.¹³ However, most previous studies have focused on the impact of CEU on individuals' negative behavior, while few have explored whether CEU negatively affects individuals' PSBs. Wu et al¹⁴ found that CEU could significantly predict adolescents' PSB. Childhood poverty also predicts less PSB and volunteerism among adolescents.¹⁵ In adult studies, only a meta-analysis showed that CEU can negatively predict individuals' PSB.¹⁶

Few empirical researchers have examined this relationship in adults. However, PSB plays a very important and positive role in promoting individuals' wellbeing and mental health.^{17,18} Therefore, we examined the relationship between CEU and PSB in adults and the possible mechanisms behind these individual differences.

Life-History Strategy

According to life-history theory, CEU causes problematic behavior and pathological personality development because it shapes individuals' faster life-history strategies.^{4,9,19} Faster life-history strategies cause individuals to focus more on the present rather than the future, and be more self-centered than others.⁴ Accordingly, they are more inclined to allocate resources to themselves to ensure their reproduction in their current environment, rather than directing resources to others, resulting in lower prosociality.^{20–23} Moreover, faster life-history strategies can also lead to more aggressive⁶ and risk-taking behavior,²⁴ and impulsiveness,^{8,24} further indicating from the side that faster life-history strategies can predict lower prosociality. Therefore, we propose that life-history strategy may play a mediating role between CEU and PSB.

Dark Personalities

As aforementioned, individuals' lower prosociality because of life-history strategies is multifaceted; hence, this macro perspective seems limited in explaining the relationship between CEU and PSB. Dark personalities have received considerable attention recently, and many studies have taken dark personalities as synonymous with fast life-history strategies.²⁵ Dark personality traits are complex and varied.²⁶ In this study, we adopted the Dark Tetrad, that includes Machiavellianism, narcissism, psychopathy, and sadism.²⁷ Similarly, studies have found a positive predictive relationship between CEU and dark personalities.²⁸ Therefore, we believe that dark personalities may further explain how fast life-history strategies influence PSBs. That is, CEU affects individuals' PSB via dark personality traits, as fast life-history strategies and dark personalities play a chain mediation role.

The relationship between dark personality traits and PSB may be complex. Dark personalities have been considered negative and antisocial since their inception.²⁹ Dark personalities tend to predict less PSB,^{30,31} greater unethical behavior,³² and less honesty and humility.^{33,34} Dark personalities as fast life strategies also predict higher levels of aggression.³⁵ Therefore, we believe that dark personalities can negatively predict PSB.

Regarding specific components, psychopathy is often indicated by impulsiveness, violence, and dishonesty,²⁹ and sadists often derive pleasure from seeing others hurt and abused.³⁶ Psychopathy and sadism are more effective predictors of aggression.³⁵ These components may negatively predict PSB.^{30,37} Although Machiavellianism is also "dark"³⁸ people with this characteristic pay considerable attention to their own interests and may use any means to obtain them.³⁹ As PSBs tend to be motivated by altruism and egoism,⁴⁰ people with Machiavellianism tend to engage in deceptive behavior disguised as prosocial, if helping others is beneficial to their own interests.³² Extant studies also show that there is both a positive and negative correlation between Machiavellianism and PSB.^{31,41} Therefore, some uncertainty surrounds the relationship between Machiavellianism and PSB, which we further explored. Konrath et al⁴⁴ found that the relationship between narcissism and PSB depends on the type of PSB. Narcissists pay more attention to the rewards that can be secured for themselves in a situation⁴² and tend to engage in PSB in public because this improves their image and satisfies their vanity.^{43,44} In other situations, they are selfish or negative.^{44,45} We explored the relationship between narcissism and PSB from the perspective of traits.

Interestingly, there are similar sex differences in both life-history strategies and dark personalities. Men's life-history strategies are generally faster than those of women,^{21,46} and men have higher levels of dark personality traits than do women.^{27,35} That is, because men have faster life-history strategies and higher levels of dark personality, will men have lower prosocial levels than women? If the above-mentioned chain mediation effects hold, will the sex differences in life-history strategies and dark personalities cause sex differences in the chain mediation effects? These problems are discussed here.

Accordingly, this study explored the relationship between CEU and PSB in adults, hypothesizing that life-history strategies and dark personalities have chain mediation effects. We further believe that there may be sex differences that require further validation. We used a questionnaire and built structural equation models to test these hypotheses.

Materials and Methods

Participants

Chinese college students ($N = 1213$) completed an online questionnaire. In the questionnaire, we set up three attention-check items. A total of 178 participants failed one or more items and were thus excluded from the sample, leaving 1035 participants (595 women, $M_{age} = 22.45 \pm 2.687$ years). All participants read and signed the informed consent form and received remuneration (about 6 RMB) after completing the questionnaire. This study was approved by the ethics committee of our affiliated institution and complied with the Declaration of Helsinki.

Materials and Procedure

Childhood Environment

The revised CEU questionnaire was used ($\alpha = 0.860$).⁷ Six items ($\alpha = 0.846$) were used to measure parental behavior and emotional unpredictability (eg “Whether my parents discipline me when I am naughty depends on his/her mood”)⁴⁷ and three items ($\alpha = 0.636$) measured the unpredictability of residential environments (eg “Things were often chaotic in my house”).⁴⁸ Response options ranged from 1 (*completely disagree*) to 7 (*completely agree*). A higher score indicated higher CEU.

Ellis et al⁴ noted that individuals’ CEU and childhood environmental harshness (CEH) may affect their life-history strategies. As the object of this study is CEU, CEH was controlled. CEH was measured through four items ($\alpha = 0.895$; eg “My family usually had enough money for things when I was growing up”).⁴⁹ Response options ranged from 1 (*completely disagree*) to 7 (*completely agree*). To enhance understanding, we made reverse-coded the scores. Higher scores indicated higher CEH.

Life-History Strategy

The 20-item ($\alpha = 0.851$) Mini-K was used to measure individuals’ life-history strategies (eg “I avoid taking risks”).⁵⁰ Response options ranged from 1 (*completely disagree*) to 7 (*completely agree*). To enhance understanding, we made reverse-coded the scores. Higher scores indicated faster life-history strategies.

Dark Personality

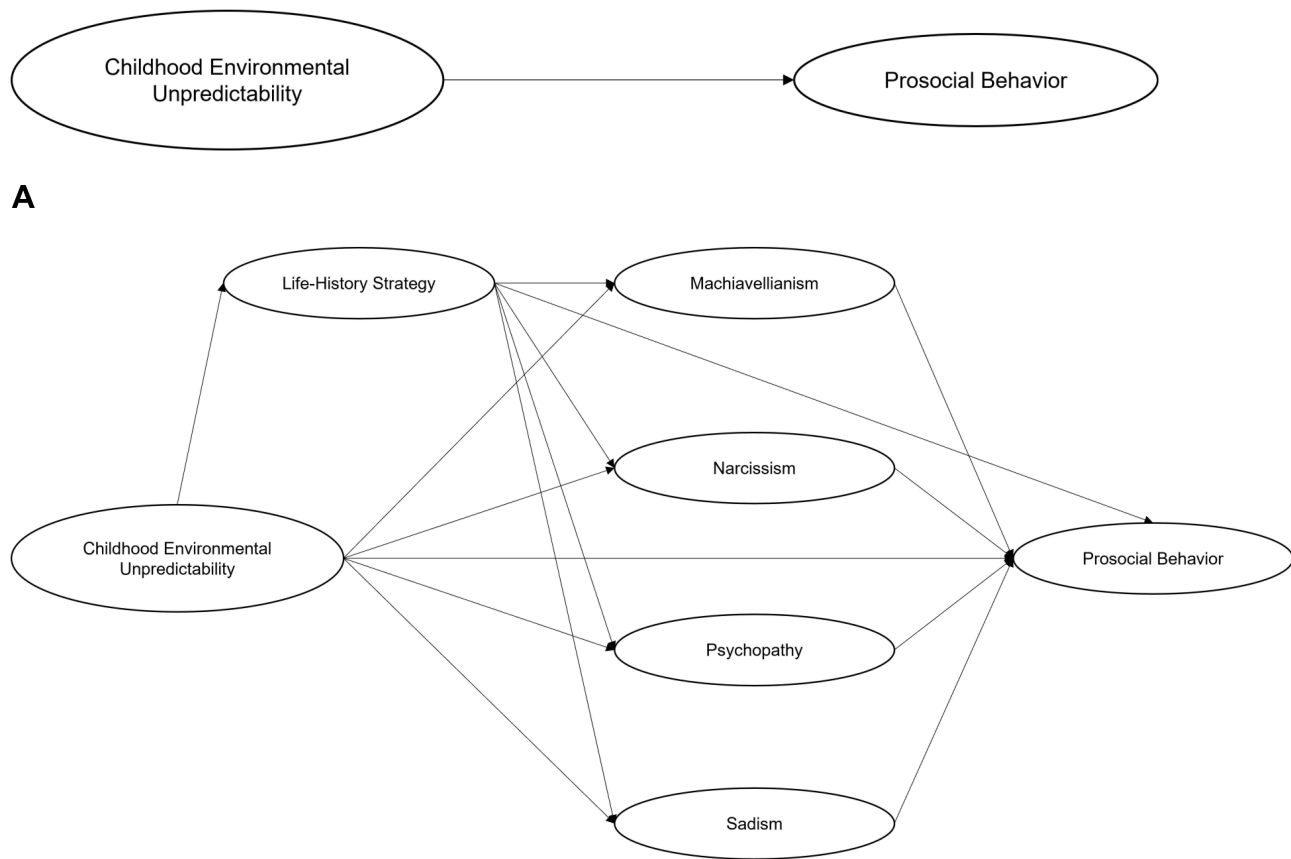
The Short Dark Tetrad (SD4) was used to measure individuals’ dark personality traits.²⁷ Twenty-eight items were measured, of which seven measured Machiavellianism ($\alpha = 0.902$, eg “It’s not wise to let people know your secrets”), seven measured narcissism ($\alpha = 0.903$, eg “I have some exceptional qualities”), seven measured psychopathy ($\alpha = 0.901$, eg “People often say I’m out of control”), and seven measured sadism ($\alpha = 0.856$, eg “I enjoy watching violent sports”). Response options ranged from 1 (*completely disagree*) to 7 (*completely agree*). Higher scores indicated a higher degree of dark personality traits.

PSB

The revised version of the Prosocial Tendencies Measure (PTM) was used to measure participants’ PSB.^{51,52} Twenty-six items covering six dimensions of PSB were measured: public (4 items, $\alpha=0.853$; eg “I can help others best when people are watching me”), anonymous (5 items, $\alpha=0.921$, eg “I prefer to donate money anonymously”), altruistic (4 items, $\alpha=0.874$, eg “I often help others, even if I don’t get any benefit from it.”), compliant (5 items, $\alpha=0.892$, eg “I never hesitate to help others when they ask for it”), emotional (5 items, $\alpha=0.907$, eg “Emotional situations make me want to help needy others”), and dire (3 items, $\alpha=0.800$, eg “I tend to help people who are in a real crisis or need”). Response options ranged from 1 (*completely disagree*) to 5 (*completely agree*). Higher scores indicated a higher degree of PSB.

Data Analysis

Descriptive statistics and internal consistency tests were performed using SPSS 25. CEU, Mini-K, SD4, and PTM were packaged using the item-balance method,⁵³ and control variables (age, sex, and CEH) were included. The structural equation models were established using Mplus 8.3 (see Figure 1A and B). Model 1 was used to test the main effect and Model 2 was used to test the chain indirect effects. The fit of the measurement models reached the standard (Model 1: $\chi^2 = 97.534$, $df = 26$, RMSEA = 0.052, CFI = 0.978, TLI = 0.970, SRMR = 0.039; Model 2: $\chi^2 = 1042.699$, $df = 349$,



B

Figure 1 Theoretical model diagrams of Models 1 and 2. **(A)** Model 1. The main effect model; **(B)** Model 2. The mediation model.

RMSEA = 0.044, CFI = 0.958, TLI = 0.951, SRMR = 0.044). Factor loadings $|\lambda|$ of the measurement models ranged 0.401–0.936. Bootstrap estimation (5000 samples) was used to verify the mediation model.

Results

Preliminary Analysis

Table 1 presents the results of the descriptive statistics. CEU was significantly negatively correlated with PSB ($r = -0.321$, $p < 0.001$) and associated with faster life-history strategies ($r = 0.309$, $p < 0.001$). Faster life-history strategies were significantly associated with dark personalities (Machiavellianism: $r = 0.306$, $p < 0.001$; narcissism: $r = 0.255$, $p < 0.001$; psychopathy: $r = 0.305$, $p < 0.001$; sadism: $r = 0.345$, $p < 0.001$) and PSB ($r = -0.317$, $p < 0.001$). Dark personalities were significantly negatively correlated with PSB (Machiavellianism: $r = -0.333$, $p < 0.001$; narcissism: $r = -0.354$, $p < 0.001$; psychopathy: $r = -0.342$, $p < 0.001$; sadism: $r = -0.442$, $p < 0.001$). CEU was significantly positively correlated with narcissism ($r = 0.317$, $p < 0.001$), psychopathy ($r = 0.284$, $p < 0.001$), and sadism ($r = 0.239$, $p < 0.001$) but significantly negatively correlated with Machiavellianism ($r = -0.252$, $p < 0.001$), which indicates the need for further analysis.

The Main Effect Analysis

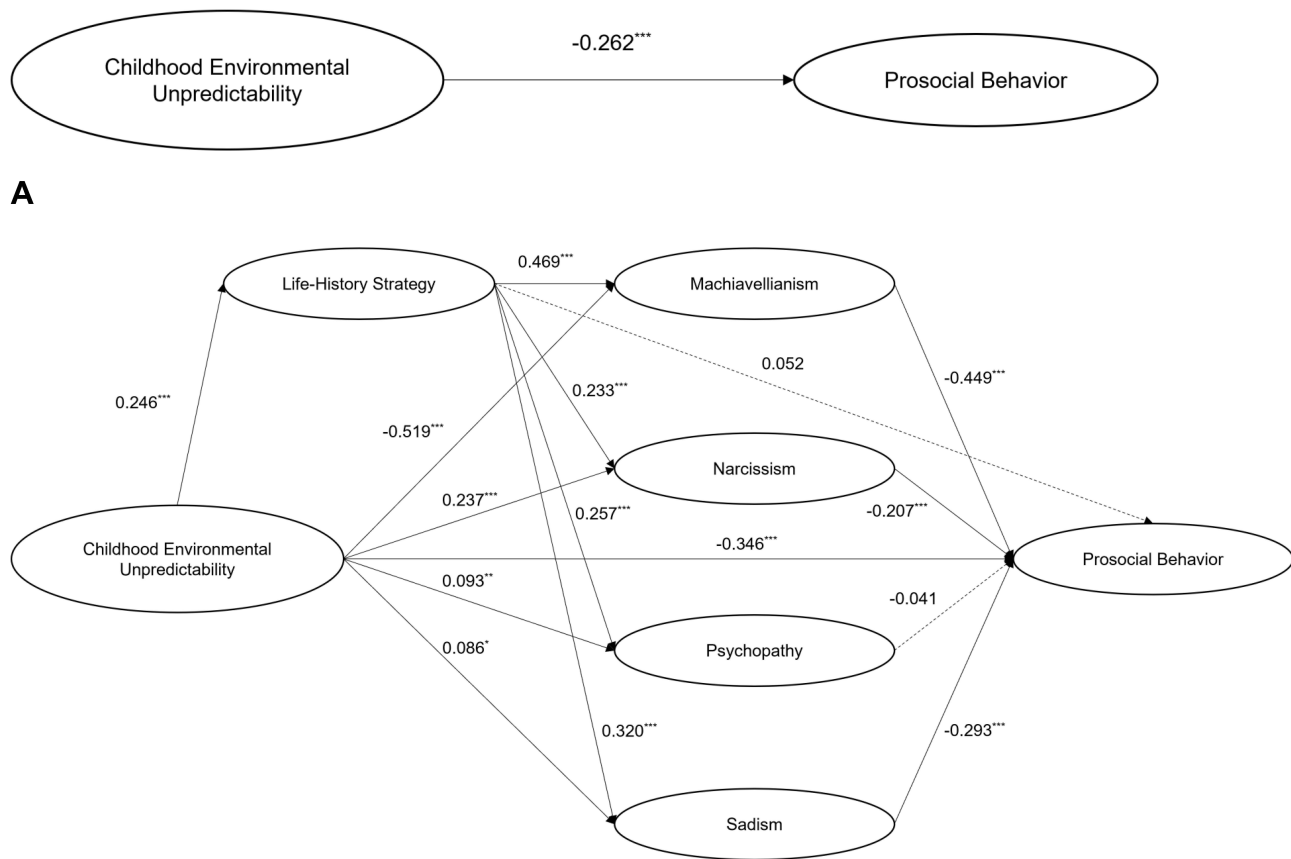
Model 1 conformed to the standard (see Figure 2A; $\chi^2 = 183.459$, $df = 82$, RMSEA = 0.035, CFI = 0.983, TLI = 0.978, SRMR = 0.035). CEU significantly negatively predicted PSB ($\beta = -0.262$, $p < 0.001$) in adults after controlling for sex, age and CEH. The mechanism of this relationship requires verification.

Table 1 The Results of Descriptive Statistics

	<i>M</i> (<i>SD</i>)	1	2	3	4	5	6	7	8	9	10
1. CEU	3.612 (0.945)	—									
2. CEH	4.491 (1.282)	0.289***	—								
3. Life-history strategy	3.342 (0.662)	0.309***	0.312***	—							
4. Machiavellianism	4.669 (1.157)	-0.252***	0.176***	0.306***	—						
5. Narcissism	3.965 (1.075)	0.317***	0.209***	0.255***	0.010	—					
6. Psychopathy	3.111 (1.018)	0.284***	0.198***	0.305***	0.232***	0.259***	—				
7. Sadism	3.489 (1.172)	0.239***	0.274***	0.345***	0.210***	0.220***	0.422***	—			
8. PSB	5.104 (0.738)	-0.321***	-0.270***	-0.317***	-0.333***	-0.354***	-0.342***	-0.442***	—		
9. Sex (Men = 1; Women = 2)	—	-0.185***	-0.128***	-0.135***	-0.090**	-0.154***	-0.606***	-0.208***	0.166***	—	
10. Age (years old)	22.45 (2.687)	-0.121***	-0.098**	0.123***	0.028	-0.157***	-0.093**	-0.008	0.130***	0.086**	—

Notes: ** $p < 0.01$, *** $p < 0.001$.

Abbreviations: M, mean; SD, standard deviation; CEU, childhood environmental unpredictability; CEH, childhood environmental harshness; PSB, prosocial behavior.



B

Figure 2 The structural equation model diagrams of Models 1 and 2. **(A)** Model 1. The main effect model; **(B)** Model 2. The mediation model. **Notes:** * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Model 1 and Model 2 controlled for sex, age, and CEH. **Abbreviation:** CEH, childhood environmental harshness.

The Mediation Analysis

Model 2 had a good fit (see [Figure 2B](#); $\chi^2 = 1305.166$, $df = 497$, $RMSEA = 0.048$, $CFI = 0.947$, $TLI = 0.938$, $SRMR = 0.051$). CEU significantly negatively predicted PSB ($\beta = -0.346$, $p < 0.001$) and significantly predicted faster life-history strategies ($\beta = 0.246$, $p < 0.001$) in adults. Faster life-history strategies predicted higher levels of dark personalities (Machiavellianism: $\beta = 0.469$, $p < 0.001$; narcissism: $\beta = 0.233$, $p < 0.001$; psychopathy: $\beta = 0.257$, $p < 0.001$; sadism: $\beta = 0.320$, $p < 0.001$) but not PSB ($\beta = 0.052$, $p = 0.309$). Machiavellianism, narcissism, and sadism significantly negatively predicted PSB (Machiavellianism: $\beta = -0.449$, $p < 0.001$; narcissism: $\beta = -0.207$, $p < 0.001$; sadism: $\beta = -0.293$, $p < 0.001$) but psychopathy was not significant ($\beta = -0.041$, $p = 0.377$). CEU significantly positively predicted narcissism ($\beta = 0.237$, $p < 0.001$), psychopathy ($\beta = 0.093$, $p = 0.005$), and sadism ($\beta = 0.086$, $p = 0.020$), but Machiavellianism was negatively predicted ($\beta = -0.519$, $p < 0.001$).

The results of the mediation analysis showed that the indirect effects mediated by life-history strategies and dark personalities and the pathways of Machiavellianism, narcissism, and sadism were all significant and negative (see [Table 2](#)). However, the pathway mediated by psychopathy was not significant.

To further test whether the above main effect and chain mediation effects were stable across different types of PSBs, we incorporated all types of PSBs into the model and established Models 3 and 4 respectively (controlled for sex, age, and CEH; see [Figure 3A](#) and [B](#)). Models 3 ($\chi^2 = 851.905$, $df = 517$, $RMSEA = 0.025$, $CFI = 0.984$, $TLI = 0.982$, $SRMR = 0.021$) and 4 ($\chi^2 = 2305.517$, $df = 1127$, $RMSEA = 0.032$, $CFI = 0.964$, $TLI = 0.959$, $SRMR = 0.038$) fit well. In Model 3 (see [Figure 3A](#)), CEU could significantly and negatively predict all types of PSBs (public: $\beta = -0.251$, $p < 0.001$; anonymous: $\beta = -0.240$, $p < 0.001$; altruistic: $\beta = -0.116$, $p = 0.002$; compliant: $\beta = -0.157$, $p < 0.001$; emotional: $\beta = -0.152$, $p < 0.001$; dire: $\beta = -0.162$, $p < 0.001$). In Model 4 (see [Figure 3B](#)), the results of the chain mediation analysis are illustrated in [Table 2](#).

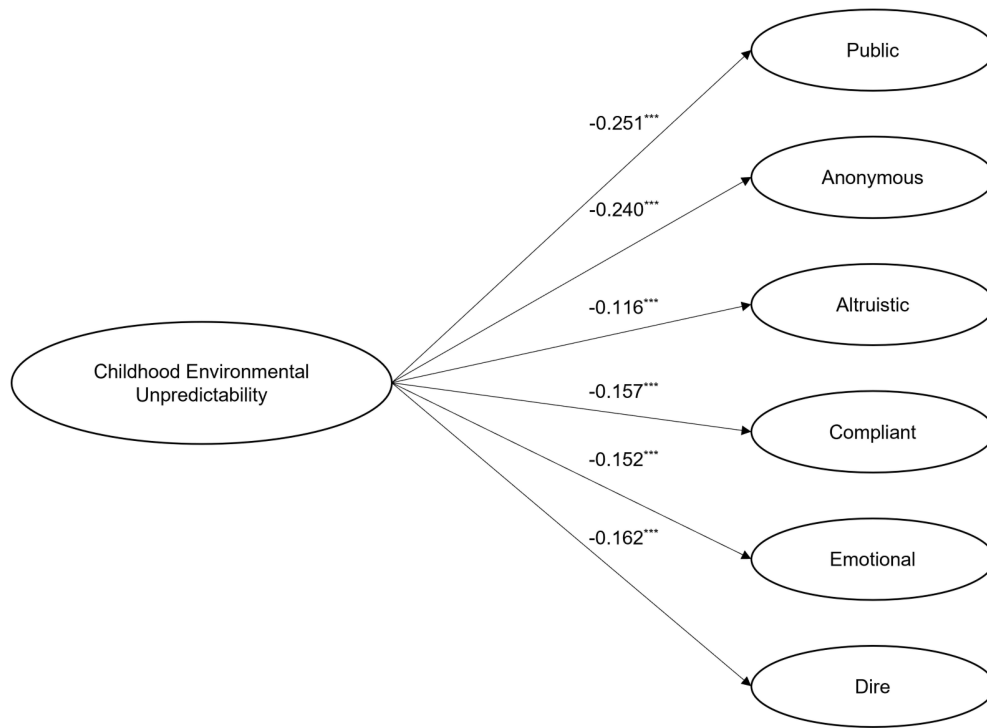
Table 2 The Results of Chain Mediation Analysis (5000 Bootstrap Samples)

Pathways	Estimate	SE	95% CI	
			Lower	Upper
CEU → Life-history strategy → Machiavellianism → PSB	-0.052	0.011	-0.076	-0.033
CEU → Life-history strategy → Narcissism → PSB	-0.012	0.003	-0.019	-0.007
CEU → Life-history strategy → Psychopathy → PSB	-0.003	0.003	-0.010	0.003
CEU → Life-history strategy → Sadism → PSB	-0.023	0.006	-0.037	-0.015
CEU → Life-history strategy → Machiavellianism → Public	-0.047	0.011	-0.074	-0.029
CEU → Life-history strategy → Narcissism → Public	-0.020	0.005	-0.032	-0.011
CEU → Life-history strategy → Psychopathy → Public	-0.009	0.004	-0.019	-0.003
CEU → Life-history strategy → Sadism → PSB	-0.016	0.005	-0.028	-0.008
CEU → Life-history strategy → Machiavellianism → Anonymous	-0.044	0.010	-0.067	-0.027
CEU → Life-history strategy → Narcissism → Anonymous	-0.007	0.003	-0.014	-0.003
CEU → Life-history strategy → Psychopathy → Anonymous	-0.001	0.003	-0.008	0.005
CEU → Life-history strategy → Sadism → Anonymous	-0.016	0.005	-0.028	-0.009
CEU → Life-history strategy → Machiavellianism → Altruistic	-0.035	0.009	-0.057	-0.022
CEU → Life-history strategy → Narcissism → Altruistic	-0.008	0.003	-0.016	-0.004
CEU → Life-history strategy → Psychopathy → Altruistic	-0.003	0.003	-0.011	0.003
CEU → Life-history strategy → Sadism → Altruistic	-0.015	0.005	-0.025	-0.007
CEU → Life-history strategy → Machiavellianism → Compliant	-0.018	0.006	-0.032	-0.009
CEU → Life-history strategy → Narcissism → Compliant	-0.006	0.002	-0.012	-0.003
CEU → Life-history strategy → Psychopathy → Compliant	0.000	0.003	-0.006	0.007
CEU → Life-history strategy → Sadism → Compliant	-0.019	0.005	-0.031	-0.011
CEU → Life-history strategy → Machiavellianism → Emotional	-0.040	0.009	-0.062	-0.025
CEU → Life-history strategy → Narcissism → Emotional	-0.008	0.003	-0.014	-0.004
CEU → Life-history strategy → Psychopathy → Emotional	-0.001	0.003	-0.008	0.005
CEU → Life-history strategy → Sadism → Emotional	-0.014	0.004	-0.025	-0.007
CEU → Life-history strategy → Machiavellianism → Dire	-0.026	0.008	-0.045	-0.014
CEU → Life-history strategy → Narcissism → Dire	-0.003	0.002	-0.009	0.001
CEU → Life-history strategy → Psychopathy → Dire	0.002	0.003	-0.004	0.009
CEU → Life-history strategy → Sadism → Dire	-0.011	0.004	-0.021	-0.005

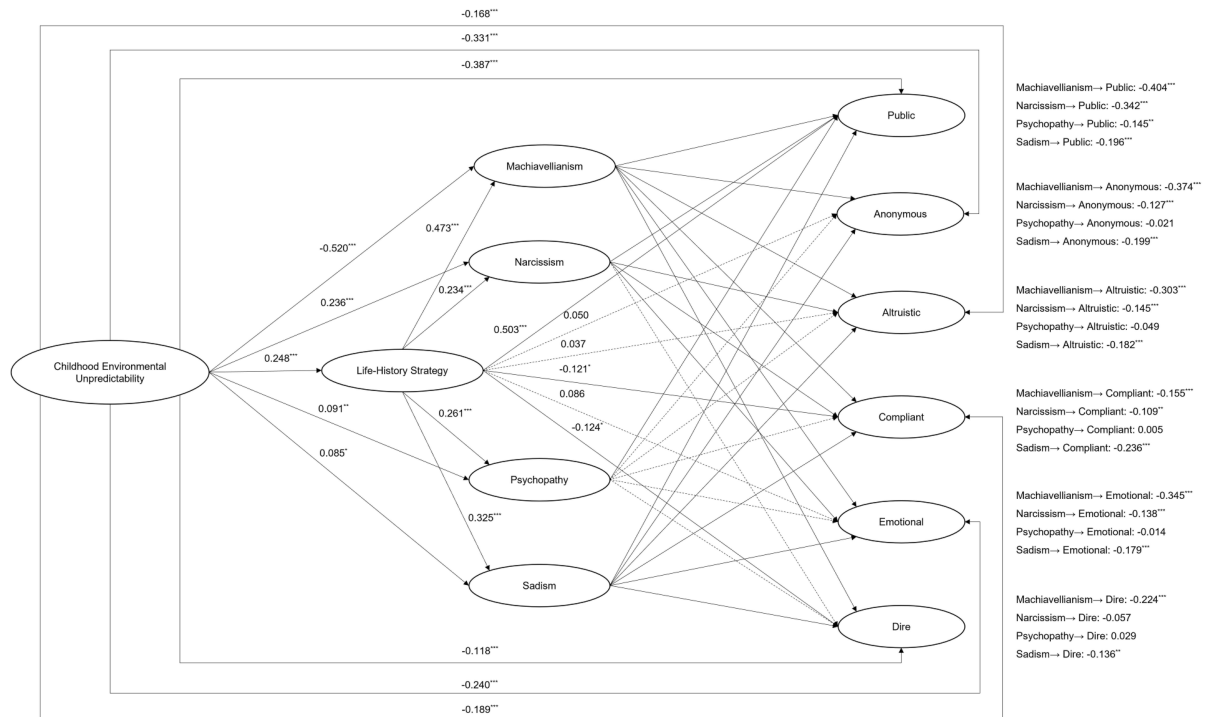
Abbreviations: CEU, childhood environmental unpredictability; PSB, prosocial behavior.

Sex Differences

An independent sample *t*-test showed that women were more prosocial than men. Men had faster life-history strategies and higher levels of dark personalities (*t*-test results see [Supplementary Material Table S1](#)). Model 1 (Men: $\chi^2 = 151.615$, $df = 72$, RMSEA = 0.050, CFI = 0.970, TLI = 0.962, SRMR = 0.047; Women: $\chi^2 = 137.526$, $df = 72$, RMSEA = 0.039,



A



B

Figure 3 The structural equation model diagrams of Models 3 and 4. **(A)** Model 3. The main effect model includes all types of PSBs; **(B)** Model 4. The mediation model includes all types of PSBs.

Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Model 3 and Model 4 controlled for sex, age, and CEH.

Abbreviations: PSB, prosocial behavior; CEH, childhood environmental harshness.

CFI = 0.979, TLI = 0.974, SRMR = 0.040), Model 2 (Men: $\chi^2 = 911.833$, $df = 376$, RMSEA = 0.057, CFI = 0.925, TLI = 0.913, SRMR = 0.059; Women: $\chi^2 = 974.403$, $df = 376$, RMSEA = 0.052, CFI = 0.931, TLI = 0.920, SRMR = 0.063), Model 3 (Men: $\chi^2 = 778.986$, $df = 492$, RMSEA = 0.036, CFI = 0.969, TLI = 0.965, SRMR = 0.032; Women: $\chi^2 = 840.095$, $df = 492$, RMSEA = 0.034, CFI = 0.971, TLI = 0.966, SRMR = 0.030) and Model 4 (Men: $\chi^2 = 1926.991$, $df = 1091$, RMSEA = 0.042, CFI = 0.940, TLI = 0.933, SRMR = 0.044; Women: $\chi^2 = 2102.453$, $df = 1091$, RMSEA = 0.039, CFI = 0.942, TLI = 0.935, SRMR = 0.050) fit the data well for both men and women. Multigroup analysis showed strict invariance of measurement models of Models 1, 2, 3 and 4 (see [Supplementary Material Tables S2–S5](#)). Models fit for the freely estimated path coefficients (Model 1: $\chi^2 = 309.014$, $df = 164$, RMSEA = 0.041, CFI = 0.975, TLI = 0.972, SRMR = 0.048; Model 2: $\chi^2 = 1981.181$, $df = 794$, RMSEA = 0.054, CFI = 0.925, TLI = 0.918, SRMR = 0.063; Model 3: $\chi^2 = 1678.929$, $df = 1040$, RMSEA = 0.034, CFI = 0.970, TLI = 0.967, SRMR = 0.034; Model 4: $\chi^2 = 4163.169$, $df = 2259$, RMSEA = 0.040, CFI = 0.940, TLI = 0.935, SRMR = 0.048) and constrained path coefficients (Model 1: $\chi^2 = 314.231$, $df = 169$, RMSEA = 0.041, CFI = 0.975, TLI = 0.973, SRMR = 0.050; Model 2: $\chi^2 = 2014.302$, $df = 823$, RMSEA = 0.053, CFI = 0.924, TLI = 0.920, SRMR = 0.066; Model 3: $\chi^2 = 1697.131$, $df = 1054$, RMSEA = 0.034, CFI = 0.970, TLI = 0.968, SRMR = 0.036; Model 4: $\chi^2 = 4276.908$, $df = 2324$, RMSEA = 0.040, CFI = 0.938, TLI = 0.935, SRMR = 0.053) had no significant differences (Model 1: $\Delta\chi^2 = 5.217$, $\Delta df = 5$, $\Delta CFI = 0$, $\Delta TLI = 0.001$; Model 2: $\Delta\chi^2 = 33.121$, $\Delta df = 29$, $\Delta CFI = -0.001$, $\Delta TLI = 0.002$; Model 3: $\Delta\chi^2 = 18.202$, $\Delta df = 14$, $\Delta CFI = 0$, $\Delta TLI = 0.001$; Model 4: $\Delta\chi^2 = 113.739$, $\Delta df = 65$, $\Delta CFI = -0.002$, $\Delta TLI = 0$). No sex differences were observed in the main or chain mediation effects.

Discussion

As indicated, CEU tends to have serious negative impacts on individuals. We examined whether individual differences in PSB in adults are related to CEU. Data were collected from Chinese college student participants through a questionnaire survey, and a structural equation model was adopted. Results indicated that CEU negatively predicted PSB. Life-history strategies and dark personalities mediated this relationship. The mediating pathways of Machiavellianism, narcissism, and sadism were significant; however, psychopathy was not.

The results confirmed our hypothesis—CEU shapes fast life-history strategies in adults, and dark personalities affect PSBs via fast life-history strategies. The chain mediation mediated by Machiavellianism negatively predicted PSB, suggesting that this kind of personality was more negative. The indirect effect of narcissism was minimal. Under the concept of the Dark Tetrad, narcissism emphasizes the dimension of narcissistic admiration,⁵⁴ which can encourage individuals to generate positive motivations,⁵⁵ contributing to this smaller indirect effect. In our initial hypothesis, psychopathy and sadism were the most negative; however, only the sadism-mediated indirect effects were significant. Perhaps under the influence of collectivism, the self-regulation of Chinese people is stronger; they consider group interests above personal interests. Although psychopathy is destructive and can facilitate antisocial personality disorder, owing to the implicit code of conduct in China, it is less likely to directly cause destructive behavior.^{56–58} Therefore, such destructive personality traits cannot directly predict PSB.

Another paradoxical result is the relationship between CEU and Machiavellianism. Our results are negative, in contrast to a previous study.²⁸ Although the chain indirect effect was negative and consistent with the hypothesis, it produced a suppressing effect.^{59,60} Wen and Ye⁶¹ believed that when the suppressing effect occurs, greater attention should be paid to the mediated indirect effect rather than the direct effect, and mediation should be explained in a broader sense. Therefore, the chain indirect effect mediated by Machiavellianism was established in this study. We were more concerned with the hypothesis of chain mediation, whereby CEU leads to faster life-history strategies that shape higher levels of dark personality traits, which influences individuals' PSB. This suppressing effect also indicates that Machiavellianism has both positive and negative aspects.⁶² Thus, it is significant to clarify the relationship between CEU and Machiavellianism. There may be some moderating variables between CEU and Machiavellianism, which affect the relationship between them. Future research could use a more comprehensive Machiavellianism measurement method.

In Model 2, life history strategies (the fast-slow continuum) were unable to significantly predict PSB. A central assumption of the life-history theory is trade-offs.⁶³ This study initially emphasized the trade-off between current and future reproduction, suggesting that individuals' faster life-history strategies would direct resources toward themselves,

thus ensuring that individuals have sufficient resources for current reproduction.⁶⁴ Such resource orientation is not conducive to individuals' PSB. Accordingly, this study hypothesized that the faster life-history strategies would predict less PSB. However, the life history theory is multi-dimensional,^{64,65} for example, it's still existed the trade-off between parenting and mating. From this perspective, faster life-history strategies will make individuals work harder for mating, and the behavior of developing affinity directs resources towards others, which is prosocial.⁶⁶ The differences between these trade-offs may prevent the fast-slow continuum from significantly predicting PSB in the mediation model. This finding is intriguing and fits well with the recent debate on life-history theory in psychology that psychometrics quantifies life-history theory as a single-dimensional fast-slow continuum, ignoring its multi-dimensional nature.^{64,65,67,68} In future studies, we believe that new measurement tools to specify multiple dimensions of the life-history theory should be developed, not only single-dimensional fast-slow continuum. Alternatively, more specific variables of the life-history theory could be investigated, like the dark personalities proposed in this study, that make the life-history theory more specific, as opposed to using the macro fast-slow continuum to explain individuals' behaviors.

In Model 3, CEU's predictions for all types of PSBs were consistent with the findings in Model 1, indicating that the main effect was stable in all types of PSBs. In Model 4, for anonymous, altruistic, compliant, and emotional PSBs, the chain mediation analysis results were consistent with Model 2. The pathways of the four dark personalities were all significant regarding public PSB, possibly because such public behavior is more associated with reputation and thus has a larger effect size on this type of PSB. Correspondingly, the effect sizes of these dark personalities on the altruistic PSB were smaller than that of other types, indicating that these dark personalities are less associated with behaviors that do not benefit them, and tend to be more self-centered than altruistic.^{25,26,30,31} In addition, narcissism cannot significantly predict PSB, that also verifies that narcissism has diverse effects on different PSBs.⁴² This may be because in a dire situation, narcissists may not weigh up whether or not this behavior will bring them credit, and therefore this cannot be significantly predicted in the model.^{43,44}

The results regarding sex differences were consistent with previous studies: men's life-history strategies tend to be faster than those of women, and dark personality traits are higher. Contrary to our hypothesis, there were no sex differences in the measurement models, the main effect, and the chain mediation effect. Although there were quantitative differences in the results (including life-history strategies, dark personality, and PSB), this did not change effect size and the mediating mechanism, so there was no qualitative difference.

This study fills empirical gaps in the relationship between CEU and PSB in adults, and the findings have practical significance. The results emphasize the importance of shaping a stable childhood environment, which can improve the prosociality of individuals' behavior in adults and have implications for childhood education. Further, studies have found that life-history strategies and personality can also be corrected through acquired experience.¹² Therefore, interventions can be used to improve the prosociality of adults with higher CEU to conform to societal expectations, particularly in collectivistic countries. Although prosociality can be improved through childhood education and acquired intervention, the role of faster life-history strategies and dark personality traits was not denied. Regardless of the speed of life-history strategies and the level of dark personality traits, this may not negatively impact individuals, but is conducive to adaptive survival.^{4,21}

This study has some limitations. First, PSBs are affected by social desirability.⁶⁹ Individuals' PSBs may differ across situations, and some biases would be caused only by measuring them. Future research should adopt field experiments to verify our results. Second, we established a structural equation model using cross-sectional data and found its mechanism. However, this cannot prove causality, and future studies can further verify these findings using longitudinal data or experimental methods. Third, although the Dark Tetrad measures multiple personality variables, it is impossible to accurately measure all aspects of the variables. Future studies can adopt more accurate tools to verify controversial personality variables. Fourth, cultural differences affect PSB.^{70,71} This study is the result of a survey conducted in Eastern collectivist countries; therefore, cross-cultural comparisons could yield interesting findings. Fifth, individuals with higher levels of dark personality traits may exhibit recall bias; the subjective recall of their childhood may differ from those of individuals with a normal personality, affecting the results. Future studies could verify and supplement this study by adopting some objective indicators. Sixth, self-control and impulsivity tend to be associated with less PSB,^{72,73} while CEU^{47,74,75} and the faster life-history strategy^{24,25,74,76} were also associated with lower levels of self-control. So could self-control further explain the relationship between CEU and PSB? Future research can explore this perspective. Finally, the participants were college students, and thus, whether the findings extend to other ages requires verification.

Conclusion

This study found that CEU negatively predicts PSB in adults. Life-history strategy and dark personality chains mediated this relationship, and there was no sex difference in the influence mechanism of CEU on PSB. The results show that childhood environment predicts prosociality in adults, which indirectly indicates the importance of childhood education. Additionally, prosociality in adults may be improved with interventions that focus on life-history strategies and dark personality traits.

Abbreviations

CEU, childhood environmental unpredictability; PSB, prosocial behavior; CEH, childhood environmental harshness; SD4, Short Dark Tetrad; PTM, Prosocial Tendencies Measure.

Data Sharing Statement

The measurement materials, results, data, and Mplus codes for this paper have been deposited in the Open Science Framework (OSF) repository (<https://osf.io/r8svb/>). For peer review: https://osf.io/r8svb/?view_only=9d5a06b35a5840278aa5af2165aeb500.

Ethics Approval and Informed Consent

This study was approved by the Ethics Committee of Hunan Normal University and complied with the Declaration of Helsinki. All participants read and signed the informed consent form and received remuneration (about 6 RMB) after completing the questionnaire.

Acknowledgments

Thanks to all those who contributed to this study.

Funding

This study was supported by National Social Science Foundation of China (19BSH127).

Disclosure

The authors report no conflicts of interest in this study.

References

1. Belsky J, Schlomer GL, Ellis BJ. Beyond cumulative risk: distinguishing harshness and unpredictability as determinants of parenting and early life history strategy. *Dev Psychol.* 2012;48(3):662–673. doi:10.1037/a0024454
2. Belsky J, Steinberg L, Draper P. Childhood experience, interpersonal development, and reproductive strategy: an evolutionary theory of socialization. *Child Dev.* 1991;62(4):647–670. doi:10.1111/j.1467-8624.1991.tb01558.x
3. Brumbach BH, Figueredo AJ, Ellis BJ. Effects of harsh and unpredictable environments in adolescence on development of life history strategies: a longitudinal test of an evolutionary model. *Hum Nat.* 2009;20(1):25–51. doi:10.1007/s12110-009-9059-3
4. Ellis BJ, Figueredo AJ, Brumbach BH, Schlomer GL. Fundamental dimensions of environmental risk: the impact of harsh versus unpredictable environments on the evolution and development of life history strategies. *Hum Nat.* 2009;20(2):204–268. doi:10.1007/s12110-009-9063-7
5. Proffitt Leyva RP, Hill SE. Unpredictability, body awareness, and eating in the absence of hunger: a cognitive schemas approach. *Health Psychol.* 2018;37(7):691–699. doi:10.1037/hea0000634
6. Lu HJ, Chang L. Aggression and risk-taking as adaptive implementations of fast life history strategy. *Dev Sci.* 2019;22(5):e12827. doi:10.1111/desc.12827
7. Luo Y, Niu G, Chen H. Early life environmental unpredictability and overeating: based on life history theory. *Acta Psychol Sin.* 2020;52(10):1224–1236. doi:10.3724/SP.J.1041.2020.01224
8. Griskevicius V, Tybur JM, Delton AW, Robertson TE. The influence of mortality and socioeconomic status on risk and delayed rewards: a life history theory approach. *J Pers Soc Psychol.* 2011;100(6):1015–1026. doi:10.1037/a0022403
9. Wang X, Zhu N, Chang L. Childhood unpredictability, life history, and intuitive versus deliberate cognitive styles. *Pers Individ Dif.* 2022;184:111225. doi:10.1016/j.paid.2021.111225
10. Jonason PK, Zeigler-Hill V, Baldacchino J. Before and after: personality pathology, childhood conditions, and life history outcomes. *Pers Individ Dif.* 2017;116:38–43. doi:10.1016/j.paid.2017.04.027
11. Jonason PK, Icho A, Ireland K. Resources, harshness, and unpredictability: the socioeconomic conditions associated with the Dark Triad traits. *Evol Psychol.* 2016;14(1):147470491562369. doi:10.1177/1474704915623699

12. Chen BB, Shi Z, Sun S. Life history strategy as a mediator between childhood environmental unpredictability and adulthood personality. *Pers Individ Dif*. 2017;111:215–219. doi:10.1016/j.paid.2017.02.032
13. Batson CD, Powell AA. Altruism and prosocial behavior. In: Millon T, Lerner MJ, editors. *Handbook of Psychology: Personality and Social Psychology*. John Wiley & Sons, Inc; 2003:463–484.
14. Wu J, Yuan M, Kou Y. Disadvantaged early-life experience negatively predicts prosocial behavior: the roles of Honesty-Humility and dispositional trust among Chinese adolescents. *Pers Individ Dif*. 2020;152:109608. doi:10.1016/j.paid.2019.109608
15. Lichter DT, Shanahan MJ, Gardner EL. Helping others?: the effects of childhood poverty and family instability on prosocial behavior. *Youth Soc*. 2002;34(1):89–119. doi:10.1177/0044118X02034001004
16. Wu J, Guo Z, Gao X, Kou Y. The relations between early-life stress and risk, time, and prosocial preferences in adulthood: a meta-analytic review. *Evol Hum Behav*. 2020;41(6):557–572. doi:10.1016/j.evolhumbehav.2020.09.001
17. Ugur ZB. Donate more, be happier! Evidence from the Netherlands. *Appl Res Qual Life*. 2018;13(1):157–177. doi:10.1007/s11482-017-9512-0
18. Mayr U, Harbaugh WT, Tankersley D. Neuroeconomics of charitable giving and philanthropy. In: Glimcher PW, Camerer CF, Fehr E, Poldrack RA, editors. *Neuroeconomics: Decision Making and the Brain*. Academic Press; 2009:303–320. doi:10.1016/B978-0-12-374176-9.00020-8
19. Ellis BJ. Timing of pubertal maturation in girls: an integrated life history approach. *Psychol Bull*. 2004;130(6):920–958. doi:10.1037/0033-2909.130.6.920
20. Zuo S, Huang N, Cai P, Wang F. The lure of antagonistic social strategy in unstable socioecological environment: residential mobility facilitates individuals' antisocial behavior. *Evol Hum Behav*. 2018;39(3):364–371. doi:10.1016/j.evolhumbehav.2018.03.002
21. Chang L, Lu HJ, Lansford JE, et al. Environmental harshness and unpredictability, life history, and social and academic behavior of adolescents in nine countries. *Dev Psychol*. 2019;55(4):890–903. doi:10.1037/dev0000655
22. White AE, Kenrick DT, Li YJ, Mortensen CR, Neuberg SL, Cohen AB. When nasty breeds nice: threats of violence amplify agreeableness at national, individual, and situational levels. *J Pers Soc Psychol*. 2012;103(4):622–634. doi:10.1037/a0029140
23. Wu J, Balliet D, Tybur JM, Arai S, Van Lange PAM, Yamagishi T. Life history strategy and human cooperation in economic games. *Evol Hum Behav*. 2017;38(4):496–505. doi:10.1016/j.evolhumbehav.2017.03.002
24. Mittal C, Griskevicius V. Sense of control under uncertainty depends on people's childhood environment: a life history theory approach. *J Pers Soc Psychol*. 2014;107(4):621–637. doi:10.1037/a0037398
25. McDonald MM, Donnellan MB, Navarrete CD. A life history approach to understanding the Dark Triad. *Pers Individ Dif*. 2012;52(5):601–605. doi:10.1016/j.paid.2011.12.003
26. Moshagen M, Hilbig BE, Zettler I. The dark core of personality. *Psychol Rev*. 2018;125(5):656–688. doi:10.1037/rev0000111
27. Paulhus DL, Buckels EE, Trapnell PD, Jones DN. Screening for dark personalities. *Eur J Psychol Assess*. 2021;37(3):208–222. doi:10.1027/1015-5759/a000602
28. Geng Y, Sai X, Jonason PK, et al. Childhood adversity is associated with adulthood white blood cell count through narcissism. *Pers Individ Dif*. 2021;174:110662. doi:10.1016/j.paid.2021.110662
29. Paulhus DL, Williams KM. The dark triad of personality: narcissism, Machiavellianism, and psychopathy. *J Res Pers*. 2002;36(6):556–563. doi:10.1016/S0092-6566(02)00505-6
30. Emer DR, Poepsel DL. Under the radar: everyday sadism predicts both passive-aggressive harms and beneficial actions after accounting for prosocial tendencies. *Pers Individ Dif*. 2021;168:110321. doi:10.1016/j.paid.2020.110321
31. Wertag A, Bratko D. In search of the prosocial personality. *J Individ Differ*. 2019;40(1):55–62. doi:10.1027/1614-0001/a000276
32. Harrison A, Summers J, Mennecke B. The effects of the dark triad on unethical behavior. *J Bus Ethics*. 2018;153(1):53–77. doi:10.1007/s10551-016-3368-3
33. Book A, Visser BA, Blais J, et al. Unpacking more “evil”: what is at the core of the dark tetrad? *Pers Individ Dif*. 2016;90:269–272. doi:10.1016/j.paid.2015.11.009
34. Erickson JM, Sagarin BJ. The prosocial sadist? A comparison of BDSM sadism and everyday sadism. *Pers Individ Dif*. 2021;176:110723. doi:10.1016/j.paid.2021.110723
35. Paulhus DL, Gupta R, Jones DN. Dark or disturbed?: predicting aggression from the Dark Tetrad and schizotypy. *Aggress Behav*. 2021;47(6):635–645. doi:10.1002/ab.21990
36. Buckels EE, Jones DN, Paulhus DL. Behavioral confirmation of everyday sadism. *Psychol Sci*. 2013;24(11):2201–2209. doi:10.1177/0956797613490749
37. Palmer JA, Tackett S. An examination of the Dark Triad constructs with regard to prosocial behavior. *Acta Psychopathol*. 2018;04(1):1–3. doi:10.4172/2469-6676.100161
38. Rauthmann JF, Kolar GP. How “dark” are the Dark Triad traits? Examining the perceived darkness of narcissism, Machiavellianism, and psychopathy. *Pers Individ Dif*. 2012;53(7):884–889. doi:10.1016/j.paid.2012.06.020
39. Jones DN, Paulhus DL. Duplicity among the dark triad: three faces of deceit. *J Pers Soc Psychol*. 2017;113(2):329–342. doi:10.1037/pspp0000139
40. Batson CD. *Altruism in Humans*. United States: Oxford University Press; 2011.
41. Berger C, Batanova M, Cance JD. Aggressive and prosocial? Examining latent profiles of behavior, social status, Machiavellianism, and empathy. *J Youth Adolesc*. 2015;44(12):2230–2244. doi:10.1007/s10964-015-0298-9
42. Campbell WK, Foster JD. The narcissistic self: background, an extended agency model, and ongoing controversies. *Self*. 2007;115:138.
43. Eberly-Lewis MB, Coetzee TM. Dimensionality in adolescent prosocial tendencies: individual differences in serving others versus serving the self. *Pers Individ Dif*. 2015;82:1–6. doi:10.1016/j.paid.2015.02.032
44. Konrath S, Ho MH, Zarin S. The strategic helper: narcissism and prosocial motives and behaviors. *Curr Psychol*. 2016;35(2):182–194. doi:10.1007/s12144-016-9417-3
45. Brunell AB, Tumblyn L, Buelow MT. Narcissism and the motivation to engage in volunteerism. *Curr Psychol*. 2014;33(3):365–376. doi:10.1007/s12144-014-9216-7
46. Hill EM, Ross LT, Low BS. The role of future unpredictability in human risk-taking. *Hum Nat*. 1997;8(4):287–325. doi:10.1007/BF02913037
47. Ross LT, Hill EM. The family unpredictability scale: reliability and validity. *J Marriage Fam*. 2000;62(2):549–562. doi:10.1111/j.1741-3737.2000.00549.x

48. Mittal C, Griskevicius V, Simpson JA, Sung S, Young ES. Cognitive adaptations to stressful environments: when childhood adversity enhances adult executive function. *J Pers Soc Psychol.* 2015;109(4):604–621. doi:10.1037/pspi0000028
49. Griskevicius V, Ackerman JM, Cantú SM, et al. When the economy falters, do people spend or save? Responses to resource scarcity depend on childhood environments. *Psychol Sci.* 2013;24(2):197–205. doi:10.1177/0956797612451471
50. Figueredo AJ, Vásquez G, Brumbach BH, et al. Consilience and life history theory: from genes to brain to reproductive strategy. *Dev Rev.* 2006;26(2):243–275. doi:10.1016/j.dr.2006.02.002
51. Carlo G, Randall BA. The development of a measure of prosocial behaviors for late adolescents. *J Youth Adolesc.* 2002;31(1):31–44. doi:10.1023/A:
52. Kou Y, Hong HF, Tan C, Li L. Revisioning prosocial tendencies measure for adolescent. *Psychol Dev Educ.* 2007;23(1):112–117.
53. Matsunaga M. Item parceling in structural equation modeling: a primer. *Commun Methods Meas.* 2008;2(4):260–293. doi:10.1080/19312450802458935
54. Back MD, Küfner AC, Dufner M, Gerlach TM, Rauthmann JF, Denissen JJ. Narcissistic admiration and rivalry: disentangling the bright and dark sides of narcissism. *J Pers Soc Psychol.* 2013;105(6):1013–1037. doi:10.1037/a0034431
55. Grijalva E, Zhang L. Narcissism and self-insight: a review and meta-analysis of narcissists' self-enhancement tendencies. *Pers Soc Psychol Bull.* 2016;42(1):3–24. doi:10.1177/0146167215611636
56. Triandis HC. Individualism-collectivism and personality. *J Pers.* 2001;69(6):907–924. doi:10.1111/1467-6494.696169
57. Li JB, Vazsonyi A, Dou K. Is individualism-collectivism associated with self-control? Evidence from Chinese and US samples. *PLoS One.* 2018;13(12):e0208541. doi:10.1371/journal.pone.0208541
58. Wang G, Liu ZB. What collective? Collectivism and relationalism from a Chinese perspective. *Chin J Commun.* 2010;3(1):42–63. doi:10.1080/17544750903528799
59. MacKinnon DP, Krull JL, Lockwood CM. Equivalence of the mediation, confounding and suppression effect. *Prev Sci.* 2000;1(4):173–181. doi:10.1023/a:
60. Mathieu JE, Taylor SR. Clarifying conditions and decision points for mediational type inferences in organizational behavior. *J Organ Behav.* 2006;27(8):1031–1056. doi:10.1002/job.406
61. Wen Z, Ye B. Analyses of mediating effects: the development of methods and models. *Adv Psychol Sci.* 2014;22(5):731–745. doi:10.3724/SP.J.1042.2014.00731
62. Li D, Zhang W, Wang Y. Parental behavioral control, psychological control and Chinese adolescents' peer victimization: the mediating role of self-control. *J Child Fam Stud.* 2015;24(3):628–637. doi:10.1007/s10826-013-9873-4
63. Stearns SC. *The Evolution of Life Histories.* Oxford: Oxford University Press; 1992.
64. Sear R. Do human 'life history strategies' exist? *Evol Hum Behav.* 2020;41(6):513–526. doi:10.1016/j.evolhumbehav.2020.09.004
65. Bolund E. The challenge of measuring trade-offs in human life history research. *Evol Hum Behav.* 2020;41(6):502–512. doi:10.1016/j.evolhumbehav.2020.09.003
66. Ellis BJ, Del Giudice M. Developmental adaptation to stress: an evolutionary perspective. *Annu Rev Psychol.* 2019;70(1):111–139. doi:10.1146/annurev-psych-122216-011732
67. Frankenhuis WE, Nettle D. Current debates in human life history research. *Evol Hum Behav.* 2020;41(6):469–473. doi:10.1016/j.evolhumbehav.2020.09.005
68. Del Giudice M. Rethinking the fast-slow continuum of individual differences. *Evol Hum Behav.* 2020;41(6):536–549. doi:10.1016/j.evolhumbehav.2020.05.004
69. Paunonen SV, LeBel EP. Socially desirable responding and its elusive effects on the validity of personality assessments. *J Pers Soc Psychol.* 2012;103(1):158–175. doi:10.1037/a0028165
70. Bierhoff HW. *Prosocial Behaviour.* Psychology Press; 2002.
71. Schroeder DA, Graziano WG, Feygina I, Henry PJ. Culture and prosocial behavior. In: *The Oxford Handbook of Prosocial Behavior.* Graziano: Oxford University Press; 2015.
72. Achtziger A, Alós-Ferrer C, Wagner AK. Money, depletion, and prosociality in the dictator game. *J Neurosci Psychol Econ.* 2015;8(1):1. doi:10.1037/npe0000031
73. Ugur ZB. Does self-control foster generosity? Evidence from ego depleted children. *J Behav Exp Econ.* 2021;90:101652. doi:10.1016/j.socec.2020.101652
74. Fennis BM. Self-control, self-regulation, and consumer wellbeing: a life history perspective. *Curr Opin Psychol.* 2022;46:101344. doi:10.1016/j.copsyc.2022.101344
75. Szepeswol O, Simpson JA, Griskevicius V, et al. The effects of childhood unpredictability and harshness on emotional control and relationship quality: a life history perspective. *Dev Psychopathol.* 2022;34(2):607–620. doi:10.1017/S0954579421001371
76. Dunkel CS, Mathes E, Beaver KM. Life history theory and the general theory of crime: life expectancy effects on low self-control and criminal intent. *J Soc Evol Cult Psychol.* 2013;7(1):12–23. doi:10.1037/h0099177

Psychology Research and Behavior Management

Dovepress

Publish your work in this journal

Psychology Research and Behavior Management is an international, peer-reviewed, open access journal focusing on the science of psychology and its application in behavior management to develop improved outcomes in the clinical, educational, sports and business arenas. Specific topics covered in the journal include: Neuroscience, memory and decision making; Behavior modification and management; Clinical applications; Business and sports performance management; Social and developmental studies; Animal studies. The manuscript management system is completely online and includes a very quick and fair peer-review system, which is all easy to use. Visit <http://www.dovepress.com/testimonials.php> to read real quotes from published authors.

Submit your manuscript here: <https://www.dovepress.com/psychology-research-and-behavior-management-journal>