







ORIGINAL ARTICLE

Trajectories of positive attributes from childhood to early adulthood and their association with environmental factors

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Objective: To investigate the trajectory of positive attributes from childhood to early adulthood and how these trajectories might be modified by environmental factors.

Methods: We enrolled 2,511 participants aged 6 to 14 years from a large prospective school-based community cohort of Brazilian children and adolescents, 45% of whom were girls. They were assessed and followed for up to 3 years (with 80% retention) or 6 years (with 71% retention). Positive attributes were assessed by using the Youth Strength Inventory (YSI). A composite measure using several indicators was used to assess childhood exposure to threats and deprivations.

Results: The trajectories of YSI scores were nonlinear for male and female participants, being high in childhood, decreasing in adolescence, and being high again in early adulthood. Exposure to threat and deprivation presented a negative linear association with YSI over time. Furthermore, exposure to threat and deprivation early in life, but not later, presented an additional effect on decreasing positive attributes during the life course.

Conclusion: Our findings provide new evidence on the trajectories of positive attributes in children and adolescents and show how early life adversity affects not only mental disorders but also positive aspects of mental health.

Keywords: Socioemotional skills; positive mental health; personality; adversity; threat; deprivation

Introduction

Children that are empathetic, helpful, and persistent, among other skills, have better future outcomes such as higher employment rates, higher salaries, better work experiences, better interpersonal relationships, and lower risk of engaging in criminal behaviors.¹⁻⁶ This set of positive emotional and behavioral skills, alongside others such as affection, responsibility, and generosity, are called positive attributes,⁷ a construct comprising the main aspects of socioemotional skills, also known as soft or noncognitive skills.^{3,8} Understanding the trajectories of positive attributes from childhood to early adulthood and the etiological factors associated with them is essential not only to prevent children from developing mental health problems but also to prevent chronic diseases and all-cause mortality.^{5,9-11} The determination of typical trajectories allows precise intervention planning for specific age

groups; whereas studying etiological factors that are related to positive attributes allows a better definition of targets for interventions.

Most of the evidence from etiological studies on mental health focus on mental health problems.⁷ Early-life stress is one of the most consistent factors associated with psychopathology¹²⁻¹⁵ and also with mental health traits related to positive attributes.¹⁴ During childhood, traumatic experiences of abuse, neglect, and dysfunctional environments have been shown to influence a range of outcomes, including future psychopathology, personality traits, neural development, reward processing, and emotional reactivity and regulation.^{13,15-18} Sibling studies suggest that the role of environmental factors varies with development, being near-zero in early childhood to moderate in adulthood.¹⁹ However, the current literature is limited in several important ways. First, little is known about concomitant determinants of positive attributes; second, most studies

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use a cross-sectional design, thereby precluding an examination of the developmental trajectory of positive attributes from childhood to early adulthood.

In order to address these gaps, this study aimed to investigate i) the trajectory of positive attributes from childhood to early adulthood and ii) the influences of threat and deprivation on levels of positive attributes. We hypothesize that positive attributes will show stability over the years and will be associated with childhood adversity.

Methods

Participants

Data were obtained from the Coorte Brasileira de Alto Risco para Condições Mentais (Brazilian High-Risk Cohort for Mental Conditions [BHRCS]).²⁰ During the screening phase, all parents at state government-funded schools in the cities of São Paulo (n=35) and Porto Alegre (n=22) on enrollment days were invited to participate. Participation in all phases of the study was voluntary, and written consent and assent were obtained from caregivers and children/adolescents, respectively. Verbal consent and assent were obtained from the parents and children/adolescents who were unable to read or write. Of those approached, 8,012 caregivers (87.3% mothers) consented to be interviewed by lay interviewers using a modified version of the Family History Screen²¹ with the purpose of estimating family risk for psychiatric diagnosis. From a total of 9,997 screened individuals, two subgroups were recruited: a random subsample (n=957) and a high-risk subsample (n=1,554). A total of 2,511 individuals were selected for full evaluation.

We analyzed data collected at baseline (2010 to 2011), at 3-year follow-up (2013 to 2014), and at 6-year follow-up (2018 to 2019). At baseline, 2,511 children and adolescents (aged 6 to 14 years, 45% of whom were female) participated. The 3-year follow-up included 2,010 participants (with 80% retention; aged 9 to 17 years, 44% of whom were female), and the 6-year follow-up included 1,787 participants (with 71% retention; aged 13 to 22 years, 54% of whom were male).

Measures

Positive attributes

Positive attributes were measured by using the Youth Strengths Inventory (YSI), a subscale (section N) of the Development and Well-being Assessment (DAWBA)^{6,22} that assesses positive child characteristics (e.g., lively, easy-going, grateful, responsible). The YSI is a 12-item scale in which caregivers respond to the extent to which the descriptions apply to the child as “no,” “a little,” or “a lot.” YSI factor scores were extracted from a confirmatory factor analysis (CFA) model and modeled as a one-factor model using items from the three-time points. The one-factor solution was performed and indicated adequate fit indices (root mean square error of approximation [RMSEA] = 0.086 [90%CI 0.083-0.089]; comparative fit index [CFI] = 0.974; Tucker-Lewis index [TLI] = 0.969).

Adverse experiences: threat and deprivation

Threat and deprivation were measured through indicators based on theoretical models of adversity selected from the baseline assessment of the BHRCS.²³ Variables selected to measure experiences of threat were extracted from the DAWBA Posttraumatic Stress Disorder (PTSD)²² assessment and from questionnaires developed specifically for the BHRCS.²⁴ These independent variables include lifetime exposure to bullying, physical or sexual abuse, assault or threat, witnessing domestic violence, and witnessing assault. Measures of deprivation included indicators of neglect, parental absence, maternal education level, family income (measured in quintiles), and socioeconomic classification according to the Brazilian Economic Classification Criteria (A/B [the wealthiest], C, or D/E [the poorest]).²⁵ We used to generate a formative model to reduce the dimensionality of these indicators into continuous measures of threat and deprivation, as described elsewhere.¹⁵

Statistical analysis

Generalized additive mixed models (GAMMs) were used to test all hypotheses in this study. GAMMs are useful for dealing with nonlinear relationships in data (e.g., trajectories of psychological constructs that may fluctuate over the course of a lifetime) and provide a more accurate representation of the underlying relationships in the data. To run all the GAMMs in R software,²⁶ we used the *gamm4* function in the *gamm4* package.²⁷ GAMMs were fitted by using residual maximum likelihood (REML) for the Gaussian additive model, and smoothing was performed by using penalized regression spline smoothers.²⁷ Smoothing was a function of age by gender to adjust for the trajectory of positive attributes. Age, threat, deprivation, and interactions between age and both threat and deprivation were included as a tensor product smooth (t2) to adjust for the effect of adverse experiences on the trajectory of positive attributes. All models were adjusted for a random slope and intercept of age for each participant. We used inverse probability weights in all GAMMs to account for missing data at follow-up. This weight was based on previous findings from this sample where attrition was related to maternal education at baseline and at the study site.²⁸

GAMMs are interpreted in terms of effective degrees of freedom (edf), a measure of nonlinearity in associations. A linear relationship implies that as the predictor value changes, the corresponding outcome value changes in a consistent and proportional way. An edf of 1 is equivalent to a linear relationship, an edf > 1 and ≤ 2 is equivalent to a weakly nonlinear relationship, an edf of 2 is equivalent to a quadratic U-shaped curve (i.e., outcome changes are proportional to the square of the predictor variable), and an edf > 2 is considered a highly nonlinear relationship. To test our first hypothesis, GAMMs that included age-predicted YSI and were stratified by gender were used to examine the trajectory of positive attributes from childhood to early adulthood. In order to test the second hypothesis, GAMMs were used to examine the

interaction between age and adversity on the prediction of positive attributes (YSI) by using threat and deprivation as predictors with two models.

Ethical considerations

This study was approved by the research ethics committee of Universidade de São Paulo under approval number IORG0004884 (Comissão Nacional de Ética em Pesquisa [CONEP] approval number 15.457, institutional review board project registration number 1132/08). The study was conducted in accordance with the ethical standards outlined in the 1964 Declaration of Helsinki and its subsequent amendments, or equivalent ethical standards.

Results

Positive attributes from childhood to early adulthood

Table 1 describes the variables used in the regression models by each wave of data collection, where variation in age and positive attributes can be observed.

Figure 1 shows the trajectory of positive attributes and psychopathology over time, with differences between male and female participants aged 6 to 22 years. Male and female participants did not predict positive attribute levels (Table 2). However, both male (edf = 3.43, $F = 5.75$, $p < 0.001$) and female (edf = 3.78, $F = 16.92$, $p < 0.001$) participants showed a non-linear association with positive attribute scores. In addition, both male and female participants showed higher levels of positive attributes in childhood, which decline in early adolescence and recover in early adulthood.

Association between positive attributes and experiences of threat and deprivation

We found a nonlinear association between childhood exposure to threat (edf = 2.12, $F = 7.33$, $p < 0.001$) and overall scores of positive attributes as well as a linear threat by age interaction (edf = 1.63, $F = 8.78$, $p = 0.019$). Therefore, we can interpret the fixed effect described in

Table 2, which demonstrated a significant interaction between age and threat. This interaction means that childhood exposure to threat is significantly associated with a decreasing trajectory of positive attributes only when it occurs early in development, and similarly for young adults, threat has no effect on positive attributes (Figure 2A).

A similar outcome was found for childhood exposure to deprivation. We found significant linear associations between childhood exposure to deprivation and positive attribute scores (edf = 1, $F = 58.3$, $p < 0.001$) as well as a linear deprivation by age trend interaction (edf = 2.22, $F = 2.24$, $p = 0.058$). As linear relationship is established, Table 2 demonstrates the negative linear association between deprivation and positive attributes. In addition, deprivation was negatively associated with positive attributes, especially when it occurred in childhood (Figure 2B).

Discussion

This study aimed to examine the etiological factors associated with the trajectory of positive attributes from childhood to early adulthood, controlling for environmental experiences of threat and deprivation. Between the ages of 6 and 22, positive attributes are generally stable but fluctuate from childhood to early adulthood, with no sex differences in the linearity of the association, confirming our initial hypothesis. In addition, exposure to threat and deprivation had a significant impact on the trajectory of positive attributes. Exposure to threat and deprivation is significantly associated with lower positive attributes, and the association of threat with deprivation is more pronounced in early development and appears to be attenuated as the child transitions into early adulthood.

Our results show a generally stable trajectory of positive attributes from adolescence to early adulthood, with no major sex differences in childhood. Reviews of personality trajectories based on the five-factor model of personality domains,^{24,29} which is related to socioemotional skills and positive attributes, indicate that the transition from childhood to adolescence is a turning point in trait trajectories. There is some evidence of

Table 1 Descriptive characteristics of variables used in regression models by wave of data collection

	Baseline (n=2,511)	3-year follow-up (n=2,010)	6-year follow-up (n=1,787)	p-value [†]
Age (years), mean (SD)	10.2 (1.9)	13.5 (1.9)	18.2 (2.0)	< 0.001
Sex				0.496
Female	1,136 (45)	886 (44)	820 (46)	
Male	1,374 (55)	1,124 (56)	967 (54)	
Study site				0.175
Porto Alegre	1,255 (50)	1,025 (51)	945 (53)	
São Paulo	1,256 (50)	985 (49)	842 (47)	
Threat (z score)	0.06 (0.72)			
Deprivation (z score)	0.03 (0.80)			
YSI (z score)	0.01 (0.86)	-0.10 (0.87)	-0.04 (0.87)	< 0.001

Data presented as n (%), unless otherwise specified.

YSI = Youth Strength Inventory – positive attributes measures.

[†] Kruskal-Wallis test or Pearson's chi-square test.

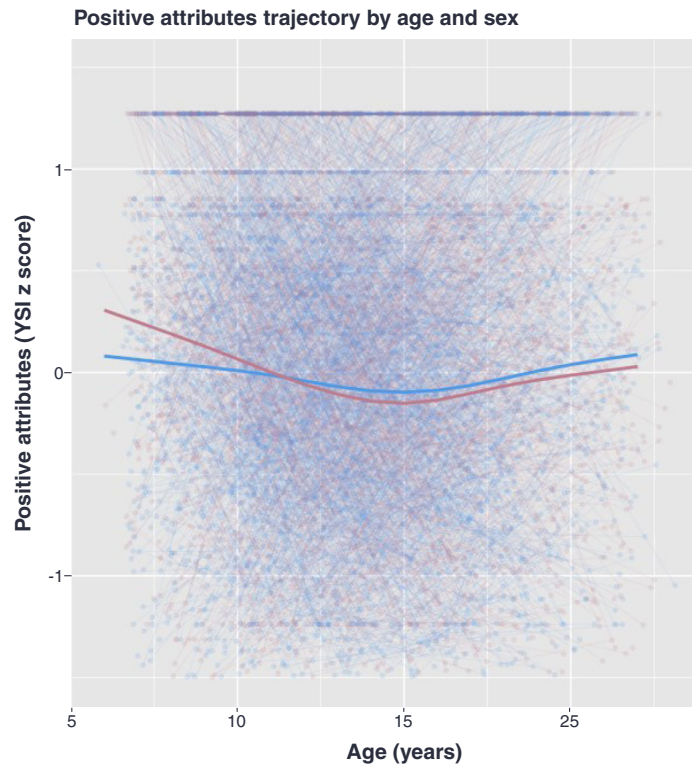


Figure 1 Generalized additive mixed model (GAMM) showing the trajectory of positive attributes from childhood to early adulthood for boys (blue) and girls (red). YSI = Youth Strength Inventory.

Table 2 Fixed effects from linear mixed model components extracted from a generalized additive model

Models	β	95%CI	t value
Positive attributes by age and sex (Figure 1)			
Intercept	-0.03	-0.05 to 0.00	-1.837
Male	0.01	-0.15 to 0.17	0.106
Female	-0.07	-0.26 to 0.12	-0.714
Positive attributes by age and threat (Figure 2A)			
Intercept	0.03	-0.01 to 0.07	1.396
Age	0.02	-0.03 to 0.06	0.762
Threat	-0.25	-0.33 to -0.17	-6.226
Age*Threat	-0.09	-0.13 to -0.05	-4.104
Positive attributes by age and deprivation (Figure 2B)			
Intercept	0.02	-0.02 to 0.06	0.913
Age	-0.02	-0.08 to 0.03	-0.820
Deprivation	-0.16	-0.19 to -0.12	-7.635
Age*Deprivation	-0.08	-0.14 to -0.02	-2.492

Positive attributes, threat, and deprivation were derived from factor models as described in the main text and are presented as z scores.

changes in the five domains around age 15 and increasing stability during adolescence and early adulthood. With respect to sex differences, our results corroborate previous findings of little or no difference between boys and girls.^{24,30,31} However, the literature is conflicting in this regard, as there are studies showing sex differences in personality^{32,33}; according to our study, this might not be replicated for positive personality attributes.

Although positive attributes demonstrated a stable trajectory, they can also change due to the environment. Adversities have a significant impact because exposure to

threat and deprivation early in life is associated with low positive attributes in childhood. Although there is no consistent evidence for this association, early life stress is widely associated with psychosocial outcomes. Studies show that traumatic childhood experiences (e.g., abuse, neglect, and dysfunctional environments) are associated with a range of personality traits, psychopathology, and poor health outcomes.^{12,14,15,18} A growing body of research confirms the impact of early life stress on neural development, patterns of social and emotional information processing, emotional reactivity, emotion regulation, and reward processing.^{12,13,15,17,34} These findings underscore

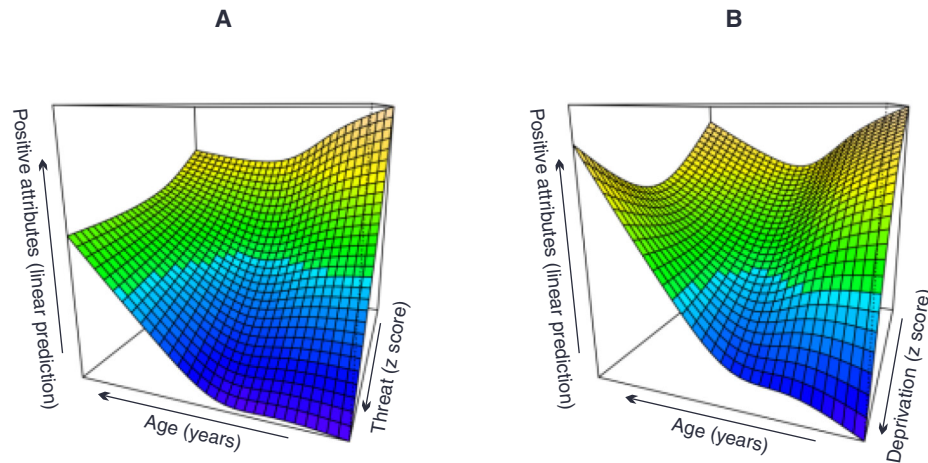


Figure 2 Interaction of age, threat, and deprivation associated with future levels of positive attributes (linear prediction).

the importance of early interventions to prevent experiences of adversity, particularly early in life. In addition to other known consequences of threat and deprivation, the effects of low positive attributes in childhood imply future impairment in a range of domains, such as educational, social, and well-being.³⁻⁶

Some limitations of this study should be mentioned. Although this was a longitudinal study, we only had data from people aged 6 to 22 years, and a longer follow-up period would increase the long-term impact of the results. In addition, observational studies are not suitable for making causal inferences because they may not include all risk factors to explain the chain of causality. In addition, the questionnaires used in this study considered only one source of information: the parents. Future studies in this area could include other sources of information in addition to parents, such as teachers and peers, and approaches to assessing the variables. However, the present study shows trajectories of positive attributes into early adulthood and provides new evidence for their association with environmental experiences. These trajectories appear to be stable and without significant differences between men and women. However, this stability may be altered in the long term, as adverse childhood experiences affect levels of positive attributes over the years. Our findings encourage interventions in childhood to prevent adverse experiences and promote positive attributes, given their significant impact on outcomes such as mental health and education.

This study provides important insights into the trajectories of positive attributes from childhood to early adulthood by focusing particularly on the influence of environmental experiences of threat and deprivation. The results confirm the generally stable nature of positive attributes across this developmental period. Exposure to threat and deprivation early in life has a significant impact on the levels and trajectories of positive attributes, highlighting the importance of early interventions to prevent adversities. The study also clarifies the complex interaction between environmental factors and the life course, in

particular by demonstrating that threat and deprivation early in life can have lasting negative effects on positive attributes. These findings underscore the need for targeted interventions early in life to promote positive attributes and mitigate potential long-term effects on educational, social, and overall well-being outcomes. Overall, this research advances our understanding of the etiological factors that shape the trajectories of positive attributes and provides valuable insights for promoting positive development and resilience in individuals as they transition from childhood to early adulthood.

Availability of data and materials

The authors confirm that the data supporting the findings of this study are available within the article.

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Disclosure

The authors report no conflicts of interest.

Author contributions

ARS: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft.

RFD: Data curation, Formal analysis, Methodology, Writing – original draft, Writing – review & editing.

LKA: Data curation, Formal analysis, Investigation, Methodology, Writing – original draft.

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MSH: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project

administration, Resources, Software, Supervision, Validation, Writing – original draft, Writing – review & editing. GAS: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Writing – original draft, Writing – review & editing. All authors have read and approved of the final version to be published.

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