

The role of executive functions, social cognition and intelligence in predicting social adaptation of vulnerable populations

Michael Schulte

Cognitive Neuroscience Center (CNC), Universidad de San Andrés, Buenos Aires

Natalia Trujillo

Mental Health Group, National Department of Public Health, University of Antioquia -UDEA, calle 62#52-59, Medellín, Colombia 050010

Odir Antonio Rodriguez-Villagra

Institute for Psychological Research, University of Costa Rica, Sabanilla, San José, Costa Rica.

Natalia Salas

Universidad Finis Terrae, Santiago de Chile

Agustin Ibañez

Latin American Brain Health Institute (BrainLat), Universidad Adolfo Ibáñez

David Huepe (✉ david.huepe@uai.cl)

Center for Social and Cognitive Neuroscience (CSCN), School of Psychology, Universidad Adolfo Ibáñez, Santiago de Chile

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Abstract

This study sought to evaluate the roles of and interactions between cognitive processes that have been shown to exhibit impact from socioeconomic status (SES) and living conditions in predicting social adaptation (SA) in a population of adults living in socially vulnerable conditions. Participants included 226 people between the ages of 18 and 60 who have been living in vulnerable contexts throughout life in Santiago, Chile. Data was collected through a battery of psychological assessments. A structural equation model (SEM) was implemented to examine the interrelationships among cognitive and social variables. Results indicate a significant relationship between executive function (EF) and SA through both social cognition (SC) and intelligence. Theory of Mind (ToM), a component of SC, was shown to exhibit a significant relationship with affective empathy; interestingly, this was negatively related to SA. Moreover, fluid intelligence (FI) was found to exhibit a positive, indirect relationship with SA through vocabulary. Evaluation of these results in the context of research on the impacts of SES and vulnerable living conditions on psychological function may allow for the development of more effective clinical, political, and social interventions to support psychosocial health among socially vulnerable populations.

Introduction

Social adaptation (SA) encompasses an ability to interact with others in a manner that aligns with sociocultural norms [1]. Socially vulnerable populations exhibit reduced access to economic and social resources necessary to withstand the impacts of external stressors [2, 3, 4, 5]; this thwarts SA. The number and magnitude of stressors experienced by these persons combined with their insufficient access to resources to manage stress creates conditions for poor mental health and chronic stress [6, 7]. Furthermore, living in vulnerable conditions, particularly as a child, may be a driver for reduction in performance of functions associated with the prefrontal cortex—that have been independently associated with SA—such as social cognition (SC) (includes decision-making, emotional processing, Theory of Mind (ToM), and empathy), fluid intelligence (FI), crystallized intelligence (CI), and executive functions (EF) [7, 8, 9, 10, 11, 12]. Given the behavioral control exhibited by these cognitive functions, it has been suggested that adolescents living in poverty who exhibit deficits in these functions may partake in resultant maladaptive behaviors that thwart SA [13, 14, 15, 16, 17, 18, 19, 20]. The dynamics, precedents, and interactions of these cognitive functions in the context of SA and social vulnerability, however, are not yet fully understood. By elucidating the ways in which these cognitive concepts work together and separately in predicting social outcomes, we might better understand the role of specific variables in predicting SA. This information may allow for the design of more effective intervention programs to support psychosocial health among vulnerable populations.

Existing studies have investigated EF in relation to ToM (a component of SC) and FI against the context of SA to build models that more accurately reflect the synergies and determinants of these processes. In addition to the role of EF impairments in yielding maladaptive behavior [15, 16, 18, 19, 20], these impairments are also related to reduced functioning in ToM [21]. In the sample investigated by Colvert et. al (2008), subjects exhibiting cognitive dysfunction related to EF and ToM were significantly more likely

to have been subjected to deprived environmental conditions earlier in life [21]. This provides further indication of the role of socioeconomic status (SES) and early living conditions in determining cognitive capacities that affect SA.

Similar to EF, intelligence develops in childhood and exhibits environmental effects related to SES and early living conditions [22, 23]. Poverty in childhood is associated with reduced literacy levels that exhibit a negative impact on FI [11]. Additionally, concerns related to poverty consume mental resources, leaving fewer to allocate toward other tasks [17]. Brydges, Reid, Fox, & Anderson (2012) found a single factor model of EF—whose capacity seems to be similarly influenced by SES—that robustly predicted FI and CI capacity [24]. Though FI has not been shown to determine the expression of social cognitive abilities (including ToM), there exists evidence to suggest that this expression may be mediated by CI [25]. Given this background, intelligence seems to relate to SA both directly and indirectly. Directly, FI seems to support analysis and adaptation to changing social situations. Indirectly, CI seems to aid in perspective-taking abilities, experience, and expression which support SA.

Empathy, a component of SC, must also be considered in this context. EF has been shown to exhibit regulatory control over empathy while also serving as its developmental foundation [26, 27, 28]. While EF ability is positively correlated with empathic capacity, this relationship is specifically stronger with cognitive empathy (i.e., understanding what another is feeling) than affective empathy (i.e., feeling what another is feeling) [29, 30, 31, 32, 33]. Cognitive empathy recruits inhibitory control, working memory, and cognitive flexibility while affective empathy only recruits inhibitory control [33]. Despite its siloed and less significant relationship with EF, affective empathy seems to list cognitive empathy as a prerequisite to its function [30]. In keeping with its putative position as a higher-level outcome of its precedents in cognitive empathy, affective empathy has been shown to be directly related to the selection of adaptive social strategy among poor individuals. This has not been shown to be the case for wealthy individuals [34]. Given this context, it is of critical importance to consider EF and empathy in evaluating SA in individuals of low SES.

While prior studies have investigated interactions between the aforementioned cognitive functions (e.g., EF, FI, SC) in isolation and in populations temporarily experiencing low SES, none have investigated the relationships between and predicting roles played by these functions to better understand SA in populations longitudinally impacted by low SES. Based on the literature overview presented previously, we proposed a model in which the relationships between EF, SC, and intelligence are tested simultaneously to investigate their role in predicting SA (see Fig. 1). We expect that EF serves as a cornerstone variable that predicts, on the one hand, aspects of intelligence, and on the other, components of SC. Both factors—intelligence and SC—might contribute to the effect of EF on SA. Based on this structural model and the reviewed literature, we evaluated the following additional hypotheses: i) a higher order factor reflecting the common variance of EF subdomains (i.e., verbal inhibitory control, motor inhibitory control, abstraction, and working memory capacity) is directly related to latent variables reflecting ToM, FI, and affective empathy; ii) ToM is directly related to affective empathy and the latter is directly related to SA; iii) FI is directly related to vocabulary and the latter is directly related to SA (i.e.,

direct effect); iv) FI is indirectly related to SA through vocabulary (i.e., indirect effect). Through evaluation of this model that integrates EF, intelligence, and SC, this paper aims to determine and assign a potential role on behalf of these specific cognitive features in predicting SA in adults living in socially vulnerable conditions since childhood.

Methods

Participants

A total of 226 adults (51.3% female) between ages 18 to 60 took part in this study ($M = 42.00$, $SD = 14.80$) and ages of education with $M = 9.44$, $SD = 3.24$, Range = 0–18. All participants have lived most of their lives in vulnerable socioeconomic contexts according to the Social Protection Sheet of the Ministry of Social Development and Family of the Chilean government [35]. All participants were qualified as a part of the 40th percentile of the lowest income range (stretch 1 of 7) of the Chilean Welfare Program [35]. This socioeconomic qualification depends on: i) the sum of labor, pension, and capital income of all members of the household; ii) the number of household members; iii) characteristics of the household members: age, disability, or dependency; iv) evaluation of goods and services to which a household has access or owns and which allow for inference of its socioeconomic status when compared to the actual income received by the household. Furthermore, most of the participants lived in neighborhoods in Santiago, Chile that have a high social risk index and participated in a social program of the Ministry of Social Development and Family.

This information was obtained through a brief initial semi-structured interview. Participation was voluntary to protect participants' anonymity. The exclusion criteria considered individuals with a visual or hearing impairment who could not participate in the battery of assessments employed in this study. Persons with psychiatric or neurological conditions representing an impediment to the protocol did not participate. All participants provided a signature as proof of their informed consent. The study received prior approval from the ethics committee of the Adolfo Ibañez University (Santiago, Chile) and followed the protocol of the Declaration of Helsinki.

Procedure

All neuropsychological tests, socio-demographic and psychological questionnaires used in this study were administered by licensed clinical social workers and clinical psychologists. Each evaluator made sure that each participant understood the informed consent before administering the tests. Participants were informed that they retained the right to clarify any confusion at any time by asking the examiner directly. The battery of assessments was randomly sequenced for each participant to reduce order bias. Participants took approximately 90 minutes to complete the protocol, including a 15-minute break. Most of the interviews were conducted in the neighborhoods in which the participants lived—typically, in the community meeting house. The field study was carried out prior to the start of the COVID-19 pandemic.

Instruments

The study protocol included:

a) EF measurement with INECO Frontal Screening (IFS) (36, 37). This tool evaluates EF through a diversity of domains: motor programming, conflicting instructions, Go-No Go testing (to measure motor inhibition; M.Inh.), and verbal inhibitory control testing (to measure verbal inhibitory control: V.Inh.); proverb interpretation (to measure abstraction: Abstr.); and backwards digit span, phonological loop, and visuospatial sketchpad testing (to measure working memory capacity: WMC). IFS is a sensitive instrument and has been tested in patients with frontal lobe injuries and neuropsychiatric disorders against healthy controls [37, 38]. It has been used in current populations [36].

b) FI and CI measurement through the Wechsler Adult Intelligence Scale III (WAIS-III) [39] and two subtests: progressive matrices (to measure FI) and vocabulary (to measure CI). WAIS-III has been validated in its assessment of both SC-specific factors [40] as well as intelligence in healthy controls and patients with frontal lobe lesions and neuropsychiatric disorders [41].

c) ToM measurement through the Reading the Mind in the Eyes Test and Mini-Sea. The Reading the Mind in the Eyes Test evaluates ToM through the presentation of 28 pictures of human faces in which only the area around the eyes is visible [42, 43]; emotional state must be interpreted by the participant based on the image. It has been validated for its use in evaluating ToM in healthy populations [44] as well as those who have been shown to exhibit deficits in SC (e.g., people living with schizophrenia, autism, anorexia) [42, 45, 46]. In complement, emotional recognition was tested with the Mini-Sea [47]. This instrument includes two subtests: (i) a facial emotion recognition test (from Ekman pictures; scored from 0 to 15) in which participants are instructed to categorize the emotion that is being expressed; and (ii) a shortened version of the Faux Pas recognition test [48] used to evaluate ToM based on histories that describe everyday social situations.

d) Affective empathy measurement through the Empathy Quotient—a 60-item questionnaire in which 40 questions explore empathy and 20 serve as fillers to avoid an excessive and conspicuous focus on empathy that might trigger biased response [49]. The affective dimension was calculated through a parcel analysis of affective items of empathy [50]. The use of the Empathy Quotient has been validated in healthy populations as well as those with depersonalization symptoms and autism spectrum disorders [51, 52].

e) SA measurement using the Social Adaptation Self-evaluation Scale (SASS). This instrument was developed as a quick and straightforward evaluation that specifically targets the measurement of social motivation and behavior of the examinee [53, 54]. It contains 21 questions that explore job interest,

homework interest, work enjoyment, interest in hobbies, quality of spare time, relationship-seeking behavior (familiar, romantic, and platonic), relationship quality and appreciation, sociability, social attractiveness, social compliance, community involvement, intellectual interest, communication difficulties, rejection sensitivity, vainness, difficulty in coping with resources, and control of surroundings. The use of SASS in evaluating SA has been validated in both healthy populations as well as in patients with Major Depressive Disorder and Bipolar Disorder [55].

Statistical analysis

Structural Equation Modeling (SEM) analysis was used to estimate the proposed model, provide a detailed accounting of measurement errors, and accurately estimate the structural relations between latent factors [56]. Data preparation, analyses, and plotting were conducted with R in RStudio [57] using the following packages: tidyverse [58], lavaan [59, 60] semTools [61] and semPlot [62].

Since the data was not normally distributed, we used maximum likelihood estimation with robust (Huber-White) standard errors; a chi-square (χ^2) statistic was scaled by the Yuan-Bentler correction factor [63]. A full information maximum likelihood estimation method was implemented to account for missing data [64]. For identification and scaling of the model, the variance of each latent variable was fixed to 1. Structural equation modelling adequacy fit indices were used to assess model goodness of fit: the YB χ^2 statistic, the robust comparative fit index (CFI) [65], and the root mean square error approximation (RMSEA) [65]. The YB χ^2 statistic is used as a fit index and it is expected to be as close to zero as possible, thus it is not expected to be significant (i.e., p-value should be > 0.05). The CFI is an index with values from 0 to 1 assessing the extent to which the specified model improves fit over the null model (values > 0.90 considered as adequate fit, values in the range of 0.95–0.99 considered as excellent fit, and a value of 1 considered as exact fit) [66]. The RMSEA indicates the discrepancies between the sample variance-covariance matrix and the model-implied variance-covariance matrix (values > 0.08 considered as poor fit, values in the range of 0.05–0.08 considered as adequate fit, and values ≤ 0.05 considered as good fit) [56]. Finally, Monte Carlo simulations were used to construct confidence intervals for the indirect effects [67].

Results

The fit of the model to data was excellent (see Panel B of Fig. 1). The structural model and standardized model parameters are shown in Fig. 1 (factor loadings are shown in Table 1). The EF factor was specified as a second-order factor in which seemingly distinct but related factors (i.e., WMC, Abstr.: V.Inh., and M.Inh.) are accounted for by one common underlying higher-order factor [68]. The factor loadings for all first-order factors (i.e., WMC, Abstr. V.Inh, and M.Inh) were statistically significant ($p < 0.01$, see Table 1). As expected, EF was significantly related to ToM and FI ($p < 0.01$; hypothesis 1). However, EF was negatively, yet marginally related to affective empathy ($p = 0.094$; hypothesis 1, see Fig. 1). Concerning the second hypothesis, ToM was marginally related ($p = 0.051$) to affective empathy and contrary to our prediction, the latter was negatively related to SA ($p < 0.05$). FI was strongly related to CI ($p < 0.001$) and the latter was related to SA ($p < 0.01$; hypothesis 3). In this model we also tested the hypothesis that the

prediction of FI to SA may be through CI. To this aim, we estimate the direct and indirect effects of FI on SA. The direct effect is the influence of FI on SA *controlling for* CI. The indirect effect is the influence of FI on SA *through* CI (As Kline (2015) affirmed, “indirect effects are always part of mediation, but they are not synonymous. This is because mediation refers to causal hypotheses...” [69]. For this reason, we avoided the use of the term mediation and used only the statistical term, “indirect effect.” The establishment of mediation in cross-sectional designs is quite difficult). As panel A of Fig. 1 displays, the direct effect was weak and nonsignificant (direct effect = 0.02, $p = 0.867$, see the value of the dashed black line in Fig. 1). The standardized indirect effect was small (0.28) and reliable. Monte Carlo simulations for constructing confidence intervals of the unstandardized indirect effect revealed that they did not include zero (see panel C of Fig. 1). This finding suggests that the effect of FI on SA is completely through CI (hypothesis 4). That is, persons with better FI exhibited higher scores in CI, which in turn predicted higher levels of SA.

Table 1
Factor loadings for the observed variables in the SEM model.

Latent variables	Observed variables	Factor loading
Working memory capacity (WMC)	Spatial Working Memory (IFS)	0.599
	Backward Digits Span (IFS)	0.711
	Verbal Working Memory (IFS)	0.377
Abstraction (Abstr.)	Proverb 1 (IFS)	0.469
	Proverb 2 (IFS)	0.532
	Proverb 3 (IFS)	0.279
Verbal inhibitory control (V.Inh.)	Sentence 1 (IFS)	0.560
	Sentence 2 (IFS)	0.607
	Sentence 3 (IFS)	0.749
Motor inhibitory control (M.Inh.)	Motor programming (IFS)	0.727
	Conflict instructions (IFS)	0.668
	Go-No go (IFS)	0.668
Theory of mind (ToM)	Parcel 1 (Mini-Sea)	0.601*
	Parcel 2 (Mini-Sea)	0.639
	Parcel 1 (RME)	0.619
	Parcel 2 (RME)	0.659
Fluid intelligence (FI)	Parcel 1 (WAIS matrix reasoning)	0.771
	Parcel 2 (WAIS-III matrix reasoning)	0.771
	Parcel 3 (WAIS-III matrix reasoning)	0.710
Crystallized intelligence (CI)	Parcel 1 (WAIS-III vocabulary)	0.733
	Parcel 2 (WAIS-III vocabulary)	0.813
	Parcel 3 (WAIS-III vocabulary)	0.876
Affective empathy	Parcel 1 (EQ scale)	0.651
	Parcel 2 (EQ scale)	0.369

Note. Parcels were constructed for tests with many items. IFS = INECO frontal screening test; RME = Reading the Mind in the Eyes Test; WAIS-III = Wechsler Adult Intelligence Scale III; EQ scale = Empathy Quotient; SASS = Social Adaptation Self-evaluation Scale. *The model included a covariance parameter between the residual variances of Parcels 1 and 2 of Mini Sea. All factor loadings were statistically significant ($p < 0.05$).

Latent variables	Observed variables	Factor loading
	Parcel 3 (EQ scale)	0.504
Social adaptation (SA)	Parcel 1 (SASS)	0.815
	Parcel 2 (SASS)	0.750
	Parcel 3 (SASS)	0.681

Note. Parcels were constructed for tests with many items. IFS = INECO frontal screening test; RME = Reading the Mind in the Eyes Test; WAIS-III = Wechsler Adult Intelligence Scale III; EQ scale = Empathy Quotient; SASS = Social Adaptation Self-evaluation Scale. *The model included a covariance parameter between the residual variances of Parcels 1 and 2 of Mini Sea. All factor loadings were statistically significant ($p < 0.05$).

[ADD FIGURE 1]

Figure 1: Structural equation modelling social adaptation of vulnerable populations. Main results. A) Structural equation model; B) Model fit, values in brackets denote 95% confidence intervals; C) Monte Carlo simulations of the distribution of unstandardized indirect effect of fluid intelligence (FI) on social adaptation (SA) through crystallized intelligence (CI), values in brackets denote 95% confidence intervals. Variables in circles are unobserved (latent) factors explaining observed (manifest) variables (not shown). Arrows indicate the hypothesized pathways with numbers as the standardized regression estimates. Dashed lines indicate that the effects were not statistically significant. WMC: working memory capacity; Abstr.: abstraction; V.Inh : verbal inhibitory control; M.Inh: motor inhibitory control; EF: executive function; ToM: theory of mind; FI: fluid intelligence; Affective empathy: affective empathy; SA: social adaptation; M: marginal effect.

Discussion

This study was conducted to evaluate the dynamics of specific cognitive features—EF, SC, and intelligence—in predicting SA among a population that has sustained low SES over their lifetime. In evaluating our SEM, EF was found to be positively related to both ToM and FI which were positively associated with SA but negatively related to affective empathy. Affective empathy was also positively and independently related to ToM, yet negatively related to SA in this sample population. Finally, it was determined that the role of FI in predicting SA is indirect and exists completely through CI. These novel findings are thought to serve as potential bases to inform the design of more targeted and effective psychosocial interventions to improve SA among vulnerable populations.

We hypothesized that EF plays a primary, cornerstone role in predicting SA through its relation to SC and intelligence in people living in socially vulnerable conditions. Upon evaluation of this SEM, we found confirmation that EF predicts SA through two relationships: (1) a positive correlation between EF and ToM (a component of SC) was directly associated with SA and (2) a positive correlation between EF and FI was indirectly associated with SA through CI.

This first relationship was expected: SC (ToM and empathy) together with EF have been shown to play a crucial role in the regulation of social interaction [70, 71]. Impairment in SC has also been observed among individuals with mental health disorders [72] and neurodegenerative diseases [73] as well as in delinquents [74] and ex-combatants [75, 76]. Impairments in socio-affective variables—specifically, low internal locus of control, self-esteem, and high stress—have been described among individuals living in vulnerable environments [77, 78]. These correlations further demonstrate the plausibility of the roles of SC and EF in predicting SA in socially vulnerable populations identified in this study.

Paradoxically, EF exhibited a negative correlation with affective empathy—a component of SC that was inversely related to SA in this population. This runs contrary to the findings of Sun et. al., 2019 whose data suggest that poor individuals who exhibit greater affective empathy also exhibit greater coping strategies that support SA [34]. The non-replication of Sun et. al., 2019 may stem from differences in the sample populations. This study focused on adults living in socially vulnerable conditions, mostly since childhood. This seems relevant given that certain areas of disproportionately low SES can be perceived as territorial traps for the most disadvantaged. In these areas, financial and professional opportunities can be scarce and resources to progress are inaccessible to most. The population recruited in this study exhibits low social mobility. Typically, several generations of their families have remained in the same place. According to an OECD report in 2019, the high levels of inequality in Chile tend to hamper income and social mobility [79]. For instance, it could take six generations for descendants of a family located in the lowest 10% of the income distribution to reach the average income compared to only four to five generations on average in all OECD countries [79]. This is also reinforced by Delaunay (2007) who states, "in Chile, the propensity to move, whether it is migration or daily mobility, increases in general with the socioeconomic level of the people, from which it follows that those of the lower strata have few options to use migration as a resource to get out of poverty" [80]. Sun et. al (2019) focused on people of low SES at the time the study was conducted with no control for maintenance or duration of SES [34]. Extended duration of impoverishment with origins in childhood may play a role in reversing the socially protective effects provided by affective empathy in populations living in poverty whose SES has sustained over their life course. In this context, and contrary to what is stated by Sun et al. (2019), it is important to consider the findings of Cameron et. al (2019) who examined cognitive taxation occasioned by empathy [81]. A strong preference to avoid empathy was observed and tended to feature conceptions of empathy as being more effortful and aversive and less efficacious than an alternative course of action [81]. People who live in conditions of high ecological demand (e.g., poverty, chronic social stress, risk contexts, etc.), then, may prefer to conserve cognitive resources, in part, by foregoing cognitive empathy (not affective empathy). In turn, this may thwart SA. Moreover, EF may be indicated in the inhibition of empathy-related behaviors and the avoidance of empathy-involved situations in this population, though this explanation requires further research among controlled populations of varying SES for validation.

Additionally, the finding that EF predicts FI and CI and that both explain SA was expected as the relationship between intelligence and SA has been tested previously [9, 10]. Literature has supported a positive correlation between working memory, executive attention, and FI [82, 83]. Working memory is understood to play a role in the manipulation of information required for social interaction [71]. Many

studies have suggested that living in vulnerable conditions might impair working memory—and thus, the ability to socialize effectively—via competing activation of aggressive responses [84, 85]. Other research, however, including that of Diamantopoulou et. al (2007), has failed to support a relationship between aggression and impairments in EF after controlling for conditions such as ADHD [86], though this condition has been shown to exhibit more substantial risk and prevalence among children of low SES [87].

Recently, Huepe & Salas (2013) suggested that the elucidation of prefrontal cortex functions such as FI and perspective changing is crucial for understanding psychosocial adaptation mechanisms [88]. We observed a more significant role for FI in comparison to other dimensions incorporated in the model, including its counterpart, CI. While it has been suggested that lower levels of education and overall socioeconomic deprivation could limit the use of FI [10], other lines of research have suggested that intelligence itself is a predictor of poverty and health inequalities [89, 90]. The combined role of this domain remains elusive; whether intelligence can be considered as a driver or an outcome of living in vulnerable conditions is unclear. Our results suggest that FI is more strongly associated with SA, given its relation to CI. Further research on the function and interaction of intelligence as it relates to SA may help to support the position of intelligence as a target for therapeutic exercise to improve psychosocial wellbeing in vulnerable populations. Systematic work in vulnerable contexts suggests that despite the limited capacity for improvement exhibited by cognitive functions such as FI and EF in childhood, developing therapeutic programs that favor empathy, the use of FI and some cognitive functions (such as decision-making control) allow for greater SA [91, 92].

The methods and findings described above present several limitations. First, the Social Adaptation Self-evaluation Scale (SASS) used to measure SA in participants incorporates issues related to social desirability bias into our results. Despite the above, the instrument showed good psychometric indicators and the results were consistent with what was expected (predictive validity). Notwithstanding, future research on this topic should employ SA measurement methods that encompass aspects of peer evaluation to provide comparison and reduce this bias.

Additionally, participants recruited for this study did not include individuals with higher SES levels. Though conclusions were made based on the data set presented by our study, putative explanations provided by comparison to previous peer-reviewed research of populations with differing SES and living conditions require further research to substantiate. In future research, a more exhaustive and diverse sample population should be recruited to include those who have sustained high SES over their lifetime, those who lived with low SES in childhood and later lived with high SES, and those who lived with high SES in childhood and later lived with low SES. Research of this kind might yield more accurate comparisons, claims, and explanations of etiology in controlling for factors not directly isolated in this study that may impact cognition and SA.

Conclusions

The results presented by this study support the validity and significance of EF, SC, and intelligence in predicting SA among adults living in vulnerable conditions since childhood. Specifically, the findings suggest that EF plays a fundamental role in the manifestation of SA in this population. Further longitudinal research among populations of varying SES—in both level and duration sustained—is required to validate the potential explanations suggested by the findings of this study and to inform effective intervention methods to promote psychosocial health among people living in vulnerable conditions across life stages.

Declarations

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Author contributions

N.S. and D.H. designed the study; N.S and D.H. coordinated clinical and neuropsychological assesment; D.H. N.T. O.R-V and AI analyzed the data; D.H. N.T. O.R-V. A.I. and M.S. wrote the manuscript; All authors contributed to revising the final version of the manuscript.

Competing interests

The authors declare no competing interests.

Data availability

For requesting access to the full database that support the manuscript, please write to the corresponding authors.

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Figures

Figure 1

Structural equation modelling social adaptation of vulnerable populations. Main results. A) Structural equation model; B) Model fit, values in brackets denote 95% confidence intervals; C) Monte Carlo simulations of the distribution of unstandardized indirect effect of fluid intelligence (FI) on social adaptation (SA) through crystallized intelligence (CI), values in brackets denote 95% confidence intervals. Variables in circles are unobserved (latent) factors explaining observed (manifest) variables (not shown). Arrows indicate the hypothesized pathways with numbers as the standardized regression estimates. Dashed lines indicate that the effects were not statistically significant. WMC: working memory capacity; Abstr.: abstraction; V.Inh : verbal inhibitory control; M.Inh: motor inhibitory control; EF: executive function; ToM: theory of mind; FI: fluid intelligence; Affective empathy: affective empathy; SA: social adaptation; M: marginal effect.