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Back to the drawing board: Rethinking potential predictors of preschool executive function in low-income South Africa

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Abstract

This study aimed to explore cross-sectional associations between executive function (EF), and community and household factors (household SES, caregiver education, home learning environment, caregiver/child interaction, caregiver wellbeing, and exposure to community violence) in a sample of children from very low-SES settings in Cape Town, South Africa. Results revealed that children exposed to higher levels of violence perform worse on inhibition tasks. No other associations were significant, highlighting the need to reassess how researchers can better understand these settings and the effects on EF development.

Keywords: executive function; preschool; low-socioeconomic status; violence

Introduction

The preschool period is a vital stage for development in all domains, including cognition and early learning. Therefore, studying and understanding how this development occurs and what influences it essential. Up until recently, most of our understanding of early cognition came from predominantly WEIRD (Westernised, Educated, Industrialized, Rich and Democratic) settings the findings of which are only generalizable to a very small percentage of the world's population (Ghai, 2021; Muthukrishna et al., 2020). This sparked a movement in the research community and specifically within Psychology, to include more diverse populations and settings. Indeed, this is a positive and much needed movement for research however, researchers are going to have to do more than merely adapting or building on WEIRD research. Executive function research for example, has only recently started mounting in non-WEIRD settings including low- and middle-income countries (LMICs) in the

global South. Even within these non-WEIRD settings, it is important to note that research findings may differ by country, community, culture, and/or religion (Ghai, 2021).

Current research from WEIRD contexts has pointed towards socioeconomic status (SES) as one of the major factors influencing cognitive development, such that children from lower SES backgrounds are at a higher risk for poor cognitive development compared to their higher SES counterparts. Executive function (EF), a higher order cognitive skill, has been intrinsically linked to SES and has even been identified as the mediating factor between SES and academic readiness (Fitzpatrick et al., 2014; Lawson & Farah, 2017). This suggests that children from low-income settings in LMICs such as South Africa are at risk for poor EF development. However, recent research in low SES settings in South Africa have shown some surprising results, and EF skills within these settings appear to be strong relative to Australian normative data (Howard & Melhuish, 2017). Even more surprising, South African low SES children outperformed the highest SES children in an Australian sample (Howard et al., 2020). A similar trend has been seen in other cross-cultural studies where non-Western samples seem to perform better than Western counterparts on measures of cognition (Lamm et al., 2018; Lan et al., 2011).

Considering the importance of early EF for academic achievement, and many other important life outcomes (Moffitt et al., 2011; Welsh et al., 2010), we need to understand both the risk and protective factors for EF development, particularly in vulnerable children from low-SES settings. Examples of risk and protective factors for EF that have been identified in WEIRD literature include home, family, and community factors. Examples of these include

caregiver education, number of siblings, parenting style, access to educational resources, access to early care and education programmes, and exposure to stressors such as violence, and household SES (Micalizzi et al., 2019; Rhoades et al., 2011). Many low-SES children in South Africa cannot access early childhood care and education programmes and are therefore considered especially vulnerable and at a higher risk for poor EF development. Moreover, previous findings of strong EF skills in South African children despite their low-SES background needs to be explored further. A first step is to assess the community and household factors that have been shown to influence EF development in WEIRD/high-income country literature. Therefore, this study aims to explore cross-sectional associations between EF, and community and household factors (household SES, caregiver education, home learning environment, caregiver/child interaction, caregiver wellbeing, and exposure to community violence) in a sample of children from very low-SES settings in Cape Town, South Africa.

Methods

Study sites

The current study forms part of a short-term longitudinal study that aimed to understand the barriers and potential of early childhood education in low-income South Africa. Participants were recruited from four low-income communities within the Cape Town Metropolitan area. Two of the communities are classified as an urban township and are made up of mostly informal housing. Overcrowding is an issue in these communities with population densities of 16,957.67 per km² and 10,120.31 per km². Other challenges include high rates of unemployment, food insecurity, alcohol abuse, crime and HIV/AIDS. The other two communities are part of what is referred to as the 'Cape Flats' and is made up of both formal and informal housing. The population density varies within the suburbs from which participants were recruited (between 4255.94 per km² and 16553.99 per km²). Gang activity and drug abuse are major challenges in these communities, in addition to high rates of unemployment, crime and food insecurity.

Participants

Participants included preschool-aged children who were not accessing early childhood care and education services. In year one of the study (2020), children 3-5 years old, along with their primary adult caregiver (>18 years old) were recruited. A total sample of 243 children (mean age 4 years, 8 months, range 2 years, 9 months – 5 years, 10 months, 51.9% female), and their caregivers (72% mother; 4.5% father; 4.9%aunt; 16.9% grandmother; 1.6% other) were recruited.

Measures

Caregiver questionnaire The caregiver questionnaire included subsections with demographic details, child exposure to community violence, caregiver/child interaction, caregiver wellbeing, home learning environment, household assets, and household income. The *Child Exposure to Community Violence Checklist (CECV; Martin et al., 2013)* was used to assess the child's exposure to violence in the past year. This includes 29 questions about whether a child has witnessed general violent/criminal acts, experienced family and non-family violence and feelings/experiences of not being safe. The questions are answered on the scale including the options: never; once; twice; three to ten times; more than ten times; don't know. This yields a total score of which a higher number indicates increased exposure to community violence.

The *Parenting and Family Adjustment Scales* (PAFAS; Sanders et al., 2014), a 30-item inventory, was used to assess caregiver/child interaction and caregiver wellbeing. Each item is rated on a four-point scale from 0 (not true of me at all), or 3 (true of me very much), asking the participant about the past four weeks. This yields a total score, as well as subscales namely, parental consistency, coercive parenting, positive encouragement, parent-child relationship, family adjustment and parental adjustment. For each subscale, items are summed to provide scores with a higher score indicating higher levels of dysfunction.

The Home Learning Environment (HLE; (Dawes et al., n.d.) survey was used to evaluate factors within the home environment that influence learning. This includes reading, playing, singing, talking and engaging in activities with the child as well as the availability of resources such as books or toys. *Household assets, and household income* were assessed using selected items from the National Income Dynamics Survey that is used across South Africa (http://www.nids.uct.ac.za). The caregiver questionnaire was designed to be administered in approximately 30 minutes.

Executive function EF was assessed using iPad-based direct assessments from the Early Years Toolbox (EYT;(Howard & Melhuish, 2017). Measures assessing the three core components of EF were selected, namely: Go/No-Go (inhibition), Card Sorting (shifting) and Mr Ant (working memory). The *Go/No-Go* task consists of 'go' (catch a fish by tapping the screen) and 'no-go' trials (avoid the sharks by resisting tapping the screen), presented 80% and 20% of the time respectively. Inhibition was indexed by an impulse control score that represents the product of the Go and No-Go proportional accuracy, thereby representing the strength of the pre-potent response in relation to their ability to overcome this response.

The *Card Sorting* task requires children to sort stimuli according to a changing sorting rule. The first phase (pre-switch phase) requires participants to sort stimuli (i.e., blue rabbits, red boats) by colour. After six trials, children are informed that the sorting rule has changed (post-switch phase) and they must now sort the stimuli according to shape. The third phase (border phase) is reached if the participant sorts at least five stimuli correctly during both the pre- and post-switch phases. In the border phase, stimuli are either

presented with or without a black border; if there is a black border, stimuli must be sorted according to colour or, if there is no black border, stimuli are to be sorted by shape. Shifting was indexed by the number of correct sorts that occurred after the pre-switch phase.

The *Mr Ant* task asks participants to remember the spatial location of stickers on a cartoon ant. The cartoon ant, called Mr Ant, is presented with one or more stickers on the screen for five seconds. This is followed by a blank screen presented for five seconds, and then an image of Mr Ant without stickers on which children indicate where the stickers were by tapping the relevant spatial locations on Mr Ant. Working memory is indexed by a point score that awards: one point for each consecutive level in which a child successfully performs at least two of the three trials (beginning from level one); and then, from the first level a child completes only one trial correctly, a third of a point for each correct trial thereafter.

Procedure

All testing was conducted by trained research assistants fluent in the home language of the participants. The children participated in the tasks individually at either their home or a testing site. Study data were collected and managed using REDCap electronic data capture tools hosted at [Institution] (Harris et al., 2009, 2019). Caregivers received grocery vouchers for completing the questionnaire and again after child testing. Children received stickers and bubbles for their participation.

Statistical analyses

Results were analysed using IMB SPSS Statistics 27. Shapiro-Wilk tests for normality were conducted and some variables of interest did deviate significantly from normality. Therefore, median and interquartile ranges were reported in addition to mean and standard deviations. Bivariate correlations were explored using Spearman's rank-order. Linear regressions were conducted to determine the family and household factors accounted for significant variance in EF.

Ethics approval

The procedures for this study were approved in advance by the Human Research Ethics Committee (Medical) at the University of Witwatersrand (reference: M200104). Written informed consent was provided by all participants (parent/caregiver consent for children).

Results

Table 1 presents the mean and standard deviation as well as the median and interquartile range for each variable of interest.

Table 1: Variables of interest

Household factors	
Caregiver education total	10.14 ± 2.14
Children in household	3 ± 1.53; 3 (2-4)
Total in household	5.86 ± 2.31; 5 (4-7)
Parenting scales (PAFAS subscales)	
Parental consistency	6.25 ± 2.07; 6(5-7)
Coercive parenting	5.5 ± 2.66; 5(4-7)
Positive encouragement	2.63 ± 1.75; 3(1-4)
Parent-child relationship	2.42 ± 2.44; 2(0-5)
Parental adjustment score	5.59 ± 2.79; 6(3-8)
Family relationships	3.4 ± 2.52; 3(2-6)
Parenting scales total	25.8 ± 8.15; 25(20-31)
Home learning environment	
Frequency of home learning activities	10.16 ± 3.01; 10(8-13)
Time to spend with child	4.02 ± 1.74; 4(2-6)
Books in the house	Yes = 31.7%
How many books	3.44 ± 2.56; 3(2-4)
Child exposure to community violence	13.06 ± 10.21; 10(6-19)
Household SES	
Household asset score	7.8 ± 2.9; 8(6-10)
Monthly household income bracket *(USD 1 = ZAR 15.29)*	R750 or less: 7.2% R750-R1500: 31.4% R1500-R3000: 36.4% R3000-R6000: 19.9% R6000-R11000: 4.2% R27000 or more: 0.4%
Executive function	
Inhibition	0.59 ± 0.24; 0.65(0.39-0.81)
Shifting	7.73 ± 2.15; 8(6-9)
Working memory	1.55 ± 0.81; 1.67(1-2)

Note: Caregiver education total was calculated by taking highest grade achieved and adding one if the answer to completing tertiary education was yes and 0 if the answer was no.

For caregiver education, only 25.9% of the caregivers completed secondary education (Grade 12), with an average grade achieved being 9.98 ± 2.02. Only 15.6% of the caregivers completed any tertiary education and of those 31 (83.8%) had received a certificate, five (13.6%) a diploma,

and one (2.7%) a degree. Caregiver education total was calculated by taking highest grade achieved and adding one if the answer to completing tertiary education was yes.

Spearman Rank associations revealed significant associations between some household and community factors and inhibition, but no associations were found for shifting and working memory. For inhibition, significant associations were found for total time spent with the child, number of books in the home, and exposure to community violence. Therefore, these were included as independent variables in a regression model predicting inhibition while controlling for child age, gender, and household SES (asset score).

The results from the linear regressions are shown in Table 2. After controlling for child age, sex, and household SES (model 1), model 2 explained 42% of the variance in inhibition scores. The child exposure to community violence score was the only factor that remained significantly associated with inhibition such that children who were exposed to more violence (a higher score) performed worse on the inhibition task.

Table 2: Linear regressions (N=212)

	ß	95% CI	P value
Model 1			
Child age	.313	0.77 – 1.86	**<0.001***
Child sex	.068	-0.29 – 0.95	0.299
Household assets	.078	-12.83 – -3.63	0.239
Model 2			
Child age	.348	0.09 – 0.20	**<0.001***
Child sex	.037	-0.04 – 0.08	0.565
Household assets	.084	-0.04 – 0.02	0.200
Time spent with child	-.105	-0.03 – 0.004	0.128
Having books in the home (1=Yes)	-.126	-0.13 – 0.005	0.071
CECV total	-.134	-0.006 – 0.00	**0.044***

Note: CECV = child exposure to community violence. * = p<0.05

Discussion

This study aimed to explore associations between EF, community, and household factors in this sample of very low-SES children to identify possible risk and protective factors for EF development. The results revealed that child exposure to community violence was the only factor that was significantly (negatively) associated with inhibition, while there were no significant associations for shifting or working memory. This is the first study to show a potential effect of exposure to violence on inhibition in young children in South Africa, and these findings builds on previous research in low-SES settings in high-income countries (Cará et al., 2019; Gudiño, 2013) and extends this finding to preschool-age, low-SES South African children. This is not surprising given that South Africa is a country with high levels of violence, to the extent that violence, injuries and trauma are included in the quadruple burden of disease in South Africa (Stats SA, 2017). There is also evidence that exposure to violence in South Africa starts early, with almost half of the preschool-age children having experienced some form of violence – mostly physical punishment by parents (Richter et al., 2018) and another study with children between eight and 13 years of age from Cape Town reporting witnessing high levels of community violence (Shields et al., 2008, 2009).

The detrimental effects of exposure to violence on EF are well known. Evidence has shown both behavioural (paying more attention to negative cues, difficulty regulating emotions and behaviour) as well as structural effects on brain regions associated with emotion processing, attention and EF (Raver & Blair, 2016). In line with the results from this study, inhibition in particular appears to be affected by exposure to violence (Cará et al., 2019; Gudiño, 2013; Zucchelli & Ugazio, 2019). Considering the risk of inhibition deficits on academic, behavioural and social-emotional outcomes, this warrants further investigation in South African settings.

The finding that none of the other household or community factors that were included were associated with EF may speak to the complexity of the environment in these settings, and that the measures used in this study are not fully capturing this complexity. Or that there are other factors not previously identified in research from WEIRD settings that play a significant role in non-WEIRD settings, and are not currently being captured. Similarly, another study with the same sample did not find any associations between the home learning environment and numeracy skills [reference removed]. It is likely that the broader context and the daily lives of the children in this study differ vastly from the context and daily lives of children in WEIRD settings. On average, the children from the current sample performed within or above the Australian norms (Howard & Melhuish, 2017) for their age in inhibition and cognitive flexibility. This is in line with previous work from South Africa (Cook et al., 2019; Howard et al., 2020) showing that despite a low socioeconomic status, and in this sample in particular, no access to early education and care programmes, development of EF skill is occurring. While the results from this study suggest a potential negative impact of exposure to violence on inhibition, there may be other factors in the home and community environment that are protective or promotive of EF that were not measured or captured in this study. Therefore, identifying the potential protective factors in addition to risk factors for development is necessary but will require a deeper and more nuanced understanding of non-WEIRD settings. For example, qualitative interviews that

were conducted with some of the caregivers from the current study revealed that many of the children, even at this young age, have autonomy over their day in that they decide how they will spend their day rather than their activities being facilitated or closely monitored by a caregiver or teacher (Draper et al., 2022). It is possible that this unstructured, child-led time might have more of an influence on EF development compared to factors measured, such as home learning activities or books in the home.

South Africa, and even different communities within South Africa, represents a range of diverse contexts with unique challenges and strengths. While we may be slowly starting to explore the effect of violence on development in South Africa, the influence of other household and community factors on EF requires further research. It has been well established that EF is the emergence of skills in using control in order to meet goals (Doebel, 2020). Therefore, to better understand EF development and performance in low-SES South African settings, it is essential to fully explore the knowledge, beliefs, norms, values, and preferences that are acquired with development in these settings (Doebel, 2020). For this reason, researchers from South Africa and other non-WEIRD countries need to return to the proverbial drawing board, armed with the insights gained from this and previous research, and explore how to arrive at a richer understanding of the settings from the perspective of the children and families in these settings. Future studies could achieve this by employing qualitative and ethnographic research methods prior to designing questionnaires and assessment tools.

Acknowledgments

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