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THE CHILDHOOD EXECUTIVE FUNCTIONING INVENTORY (CHEXI): PSYCHOMETRIC PROPERTIES AND ASSOCIATION WITH ACADEMIC ACHIEVEMENT IN KENYAN FIRST GRADERS

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Abstract
The Childhood Executive Functioning Inventory (CHEXI) was developed by Swedish researchers for rating EF skills among 4-12 year-old children. Today the CHEXI has been adopted and used in many studies internationally. This study aims to determine the psychometric properties of the (CHEXI) and the association of Executive Function (EF) skills with academic achievement in the Kenyan culture. Grade one children aged 6 - 11 years were evaluated by teachers for EF skills using the CHEXI. Later direct assessment of academic achievement based on standardized tests was administered in a classroom setting. We used both Exploratory and Confirmatory Factor Analysis to test the measurement model of the CHEXI and construct the latent factors. The two-factor model, tapping on working memory and inhibition, fitted the data consistent with the literature. The CHEXI also had excellent reliability values and a strong measurement invariance based on gender (boys vs. girls). Since the CHEXI demonstrated strong psychometric properties, it was found appropriate for the Kenyan culture. The results confirmed the relation between EF and academic achievement. High total EF difficulties were associated with low academic achievement. EF can predict school performance in the Kenyan context.

Keywords: Executive Function Difficulties; CHEXI; Psychometrics; School Achievement; Kenya

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Introduction

Educational researchers have always been concerned with academic performance and the variables that enhance it (Cortés et al., 2019). The new century has witnessed the emergence of a new group of variables. The first group of these variables includes institutional (school, school organization, teachers), instructional (content, methods, tasks) and socio-environmental (family, friends, colleagues). The second group include motivational (self-image, goals, values) and cognitive (intelligence, learning styles) variables (Vermunt & Endedijk, 2011). Cognitive variables such as Executive Functions (EF) has received much attention after the realization of its critical role in school readiness (Blair & Razza, 2007), school success (Duncan et al., 2007), mental health (Diamond, 2005), physical health (Zelazo et al., 2016) and socio-emotional competence (Rhoades et al., 2009) among children. Other significances of EF in life include job success (Bailey, 2007), marital harmony (Eakin et al., 2004), public safety (Denson et al., 2013) and quality of life (Brown & Landgraf, 2010). Some meta-analytic studies have also reported an association between EF and academic achievement (*see* Cortes et al., 2019 for a review). This association between EF skills and early school readiness factors supports enhancing those skills to promote school readiness, especially for children from different socioeconomic backgrounds (*e.g.*, Sasser et al., 2017). Some studies support that children from low SES have poor EF skills (Hackman et al., 2015; Obradović & Willoughby, 2019). However, a study by Cook et al. (2019) that compared children from low and middle as well as high income SES in Australia and South Africa reported that the subsample from highly disadvantaged children from low SES outperformed in two out of three EFs the children from middle and high income in Australia. This indicates a possibility of EF protective and promotion practices in Low and Middle-Income Countries (LMIC). Nonetheless, more than 250 million children in LMIC, especially in sub-Saharan Africa, suffer from environmental deprivation, malnutrition and illness that affect their cognitive development (Lu et al., 2016; Obradović & Willoughby, 2019; Willoughby et al., 2019). Additionally, EF depends on the prefrontal cortex, which is vulnerable to environmental factors such as poverty, loneliness and stress (Arnsten, 2015; Casey et al., 2018) rampant in LMICs. Nonetheless, most EF studies have been done in high-income countries, and very little is known about EF in sub-Saharan countries such as Kenya (Willoughby, Piper, Kwayumba, et al., 2019; Willoughby et al., 2021). The few assessments in LMICs have used laboratory measures (*see* Obradović & Willoughby, 2019 for a review), although there is demand for EF ratings by teachers, parents, and other researchers (Camerota et al., 2018). To the best of our knowledge, we are not aware of any study that has used EF ratings in Kenya. Further, studies have consistently reported that EF contributes to reading and mathematics across age groups, specifically working memory (*e.g*., Christopher et al., 2012; Vandenbroucke et al., 2017). Other studies have reported that inhibition is related to math and reading achievement (*e.g*., Vandenbroucke et al., 2017) while others did not (*e.g*., Blair & Razza, 2007; Lee et al., 2012). These contradicting results call for more studies using different samples sizes, children ages, assessment methods and data analysis (Jacob & Parkinson, 2015). Despite these differences, neuroimaging research indicates that all EF components are important for learning (Sung & Wickrama, 2018). Therefore, scholars are keen on identifying various contextual factors that influence children's EF development (Schirmbeck et al., 2020). According to Hartanto et al. (2019), some of these factors include bilingualism, socioeconomic status and parental scaffolding. Academic performance as a construct is indicated by the quantitative and qualitative values that a student obtains after the process of teaching and learning. This indicates the ability of the brain to facilitate this process (Vermunt & Endedijk, 2011). For this reason, Zelazo and Carlson (2012) suggested that Executive Functions (EF) should be studied since it is vital in language development, processing and organization of received information. Also, EFs can be improved throughout life (Diamond, 2013, Diamond & Ling, 2019; Gothe & McAuley, 2015)

EF is a "top-down cognitive inputs that facilitate decision making by maintaining information about possible choices in working memory and integrating this knowledge with information about the current context to identify the optimal action for the situation" (Willcutt et al., 2005, p. 1336). Despite different definitions in the literature, researchers agree that EF has three components: inhibition control, working memory and cognitive flexibility (Blair & Razza, 2007; Diamond & Ling, 2019; Zelazo et al., 2016). However, inhibitory control and working memory are the most central (Miyake et al., 2000). Inhibitory control allows one to choose one task amongst other competing tasks or impulsive thoughts to meet the desired goal. It includes self-control, selective attention, unwanted behaviour or instinct and interference control (Diamond, 2013; Diamond & Ling, 2019; Friedman & Miyake, 2004). On the other hand, working memory entails holding information in mind, updating and working with it, whereas cognitive flexibility relates to switching between tasks and flexibly adjusting due to new rules or demands (Diamond, 2013). Good working memory is associated with sound reasoning and problem-solving abilities, while cognitive flexibility to creativity or "thinking outside the box" and inhibitory control to patience before making a decision (Diamond & Ling, 2019). Indeed, authors have indicated that poor executive functioning or impairment is associated with Attention-Deficit Hyperactivity Disorder (ADHD) (Willcutt et al., 2005) and linked to poor academic achievement (Molfese, 2001).

Many methods have been used to measure executive functions in literature, either behaviour-based or performance-based tasks. For performance-based tasks, the most common tasks include different variations of Stroop task such as colour/word, day/night, large/small; digit span; go/no-go task; trail making task; army individual test battery; n-back task (*see* Carlson, 2005; Baggetta & Alexander, 2016 for a review) and peg-tapping task (*e.g.*, Welsh et al., 2010). Performance-based tasks are the gold standard in the assessment of executive functions. Unfortunately, most of these direct assessments involving paper and pencil are cumbersome and require trained examiners who are mostly not available in LMICs (Willoughby et al., 2019). Several computer-based assessments have been used to assess EFs, including the CANTAB (Homack et al., 2005), Executive Function Touch (Willoughby et al., 2019), and FOCUS (Finding Out Children Unique Strength; Józsa et al., 2017). While the performance-based assess the underlying cognitive abilities, the rating scales evaluate the application of these cognitive skills in diverse areas such as the home and school. The two measures are tapping different cognitive levels; reflective and algorithmic level. The reflective is concerned with the goals of the system and their relevant beliefs, while algorithmic measures how the brain processes information (Toplak et al., 2013). In fact, studies have shown that assessment of EF using laboratory measures and ratings have small correlations (*e.g.*, Camerota 2018; Catale et al., 2015), indicating that both assess different aspects of EFs (Willcutt et al., 2005). Additionally, ratings can be used to assess many participants and capture information over an extended period (Józsa & Józsa, 2020; Thorell et al., 2013). The most commonly used and researched questionnaire is the family of Behavioral Rating Inventory of Executive Functions (BRIEF: Roth et al., 2014) scales which has 86 items. A much simpler one with 24 items, although not widely used, is the Childhood Executive Functioning Inventory (CHEXI: Thorell & Nyberg, 2008). The BRIEF has one advantage since it has normalized data that researchers can compare, but unfortunately, it is too long, and it comes at a cost compared to the CHEXI that has 24 items and is freely available online (Camerota et al., 2018). Besides, the BRIEF is mainly used to identify learners that might develop ADHD in future (Thorell & Nyberg, 2008). Another instrument used to assess EF and famous in the field of temperament is the Children's Behaviour Questionnaire (CBQ; Rothbart et al., 2001). This tool has subscales measuring attentional focusing, impulsivity and inhibitory control. A fourth Instrument is a Five-to-Fifteen questionnaire covering EFs, Perception, Language, Motor Skills, Memory and Learning. Finally is the Executive Skills Questionnaire (ESQ; Dawson & Guare, 2010) that identifies both areas of strengths and weaknesses in EF skills.

Objectives

The objectives of the current study are three-fold: (*i*) Determine the factor structure of *Childhood Executive Functioning Inventory* (CHEXI; Thorell & Nyberg, 2008); (*ii*) Determine measurement invariance of the CHEXI based on gender; (*iii*) Examine the association of EF and academic achievement among Kenyan first graders.

Method

Participants

After getting the Institutional ethics review approval and authority to conduct the study in Kenya we recruited 526 grade one pupils aged between 6 to 11 years (*M*=7.8 years, *SD*=1.16; 259 boys, 267 girls) in 27 schools. All schools consented to participate in this study. A total of 33 teachers assisted by three research assistants rated the pupils and administered direct assessment tests. At the time of the study, all pupils were typically normal. Measures of parental education indicated that 66% had completed primary education, 23% secondary, 9% diploma, and 2% had university degrees. The parents were mostly subsistence farmers, and others engaged in small businesses. Additionally, Kenya has 42 different languages but English and Kiswahili are the official languages according to the Constitution (Republic of Kenya, 2010). Therefore, English is used as a medium of instruction for all classes and subjects except Kiswahili. For this reason, all teachers are well versed in English and competent as independent users of the language. Kiswahili is mostly used during informal discussions between individuals of different tribes or those who are not fluent in English. Nonetheless, all teachers are fluent and competent in both English and Kiswahili languages.

The Childhood Executive Functioning Inventory (CHEXI)

The CHEXI (Thorell, & Nyberg, 2008) was developed based on Barkley's (1997) hybrid model that identified working memory, inhibition and regulation as the major deficits in children with ADHD. The CHEXI English version is a 24-item questionnaire that is simpler to fill and freely available online (https://chexi.se/onewebmedia/CHEXI_ENG.pdf). It has four priori subscales: working memory (11 items), *e.g.* "*Has difficulty understanding verbal instructions unless he/she is also shown how to do something";* inhibition (6 items), *e.g.* "*Has difficulty holding back his/her activity despite being told to do so*; planning (4 items), *e.g.* "*Has difficulty with task or activities that involve several steps"* and regulation (5 items), *e.g.* "*Seldom seems to be able to motivate him-herself to do something that he/she does not want to do*". For each statement, the child is rated from 1- definitely not true to 5 definitely true. When scoring the CHEXI, subscale 1, working memory is represented by the total scores of items 1, 3, 6, 7, 9, 19, 21, 23, 24; subscale 2, planning 12, 14, 17, 20; subscale 3 regulation, 2, 4, 8, 11, 15 and subscale 4, inhibition 5, 10, 13, 16, 18, 22. Participants with EF difficulties will have high scores (Camerota et al., 2018). Despite the four subscales, factor analysis in kindergarten children identified two factors, working memory (including working memory and planning) and inhibition (including inhibition and regulation). This signifies that working memory and inhibition as the most basic EFs (Catale et al., 2015; Miyake et al., 2000). For this study, the CHEXI English version was adopted as it is.

Academic achievement

A standardized test developed and validated by the Kenya National Examination Council in partnership with World Bank and Global Partnership for Education was used to assess the academic achievement of grade 1 pupils after the transition to grade one. In Kiswahili, the test assessed comprehension (12 items), language use (13 items) and writing (10 items). In mathematics, the examination assessed shape identification (4 items), number naming, producing sets (3 items), quantity discrimination (4 items), and putting together (addition) (2 items), take away (subtraction) (2 items), mental addition, and measurement (5 items). The English language test assessed dictation (2 items), language use (13 items), writing

(10 items), and reading comprehension (10 items). All exam items were obtained from grade one textbooks approved by the Kenya Institute of Education.

Procedure

We stratified primary schools into two types, private and public in a large coastal county in Kenya to ensure each category of schools is represented proportionately in the sample. For public schools, we randomly selected 15 schools and 12 in the private schools category. Using the class nominal register, we used systematic random sampling to select 20 pupils while counterbalancing for gender. If a class had 60 pupils, after every third pupil on the list became part of the sample. Following Fajrianthi et al. (2020) guidelines for the adaptation of questionnaires, teachers assisted by three research assistants rated the pupils in a school setting for EF skills using the CHEXI (Thorell & Nyberg, 2008). The teachers filled out the CHEXI in English. The direct assessment tests were administered two weeks after the EF ratings in accordance to the Ministry of Education protocols on COVID-19 prevention. In all the 27 schools the direct assessments were administered in three days, starting with Mathematics, English and later Kiswahili following the Governments examination calendar and guidelines. In strict adherence to the marking scheme, each item was awarded 1 if got correctly and 0 for otherwise. Total scores were calculated individually per subtest. In the third week the marks were collated and linearly transformed to percentage points per subject, Maths x/20 x 100pp, English and Kiswahili x/35 x 100pp.

Analytic plan

Data analysis employed two main steps. Firstly, to obtain reliabilities, means, standard deviations and correlations, IBM SPSS 23 was used. The internal consistency reliability (Crbα; Chronbach alpha) and composite reliabilities (CR; Raykov, 1997) were used to judge the instrument's reliability. Values above 0.70 indicated good reliabilities (Hair et al., 2014). Secondly, to establish validity, the exploratory factor analysis was computed. The data set was checked to see if the variable system was appropriate for factor analysis using the Kaiser-Meyer-Olkin (KMO) index (Kaiser, 1970). To establish the validity of the CHEXI, Confirmatory Factor Analysis (CFA) was computed using AMOS version 24. The following model fit indices and their cut off were adopted to assess the model fit: Root Mean Square Error of Approximation (RMSEA)<0.08, Tucker-Lewis Index (TLI)≥ 0.90, and CFI≥ 0.90) (Schreiber et al., 2006; Schumacker & Lomax, 2016).

To determine the predictive ability of the CHEXI multiple regression was employed in IBM SPSS 23.

Results

Descriptive statistics and validity

Descriptive statistics

The mean for all the items in the CHEXI scale ranged from 2.79 (*SD*=0.89) to 3.35 (*SD*=1.04), with an overall mean of 2.91 (*SD*=1.06).

Exploratory Factor Analysis

The internal structure of CHEXI was tested by EFA using Principal Component Analysis with Varimax rotation. The KMO index was high at .96, with a significant score on Bartlett's Test of Sphericity (χ^2=8353.51, $p<.0001$), indicating that the data is reliable and suitable for factor analysis. Initial analysis identified three factors with Eigenvalues above 1 accounting for 62.03% of the variance. On close inspection of the Eigenvalues, the scree plot showed that it broke after the second component. Based on this, we retained the two-factor structure of CHEXI.

Confirmatory Factor Analysis

To examine the goodness of fit of the two-factor solution of the CHEXI (Thorell & Nyberg, 2008), with no missing data, CFA with Maximum Likelihood estimation was used. Initially, a four-factor model was identified with acceptable model indices (Table 1). However, discriminant validity was poor because AVE's square root for working memory was less than its correlation with planning, regulation, and inhibition. Also, working memory and planning were statistically indistinguishable and highly correlated *r*=.95. Similarly, also inhibition and regulation had a high correlation *r*=.79. We, therefore, collapsed the four-factor model to two; working memory and planning put together and inhibition and regulation, also together similar to Camerota et al. (2018) and Józsa and Józsa (2020). This model with adjustment of the modification indices fitted well with a χ^2 (3239.40) = 1090, $p<.001$, CMIN / DF = 2.972, CFI = 0.946, SRMR = 0.043, RMSEA = 0.027 which is an excellent model. Since all the items had variance above 30%, this also suggests good reliability (Bollen, 1989). This model's factor loading was also above the acceptable factor weight, confirming convergent validity (Hair et al., 2014).

Table 1. Model Fit Indices for CHEXI factor structure

Model	Model description	CMIN/DF	SRMR	CFI	TLI	RMSEA
	CHEXI factors					
1	4 Factors (WM, PLAN, INH, REG)	3.227	.042	.938	.930	.065
2	2 Factors (WM, INH)	3.864	.046	.914	.930	.064
3	2 Factors (WM, INH) w/correlated errors	2.972	.041	.950	.940	.027

Note: CFI=comparative fit index; INH=inhibition; PLAN=planning; REG=regulation; RMSEA=root mean square error of approximation; SRMR =standardized root mean square residual; TLI=Tucker Lewis Index; WM=working memory

However, factor loadings for item 10, *"Gets overly excited when something special is going to happen (e.g., going on a field trip, going to a party)"* and 13, "*Has difficulty holding back his/her activity despite being told to do"* were low at 4.37 and 4.39, respectively (Table 1) but above the threshold. Maybe item 10 was low since teachers could not draw current examples of children engaged in parties or field trips due to the current pandemic situation.

Table 2. Standardized factor loadings of the CHEXI items rated by the teachers

	Items	A priori scale	Factor loadings
	Working memory		
1	Has difficulty remembering lengthy instructions	WM	.781
3	Seldom seems to be able to motivate him/herself to do things something that he/she does not want to do.	WM	.825
6	When asked to do several things, he/she only remembers the first or last	WM	.802
7	Has difficulty coming up with a different way to solving a problem when he/she get stuck	WM	.771
9	Easily forget what he/she is asked to fetch	WM	.784
12	Has difficulty planning for an activity (e.g. remembering everything necessary for a field trip or things needed for school.)	PLAN	.738
14	Has difficulty carrying out activities that require several steps (e.g. for younger children, getting completely dressed without reminders; for older children, doing homework independently.)	PLAN	.710
17	Has difficulty telling a story about something that has happen so that others may easily understand	PLAN	.709
19	Has difficulty understanding verbal instruction unless he/she is also shown how to do something	WM	.817
20	Has difficulty with tasks or activities that involve several steps.	PLAN	.806
21	Has difficulty thinking ahead or learning from experience	WM	.833
23	Has difficulty doing things that require mental effort, such as counting backwards.	WM	.801
24	Has difficulty keeping things in mind while he/she is doing something else.	WM	.823

Note: WM=working memory; PLAN=planning; INHIB=inhibition; REG=regulation

Table 2. Standardized factor loadings of the CHEXI items rated by the teachers - *continued*

	Items	A priori scale	Factor loadings
	Inhibition		
2	Seldom seems to be able to motivate him/herself to do things something that he/she does not want to do.	REG	.610
4	Has difficulty following through on less appealing tasks unless he/she is promised a type of reward for doing so.	REG	.755
5	Has the tendency to do things without thinking of what could happen	INHIB	.681
8	When something needs to be done, he/she often distracted by something more appealing.	REG	.768
10	Gets overly excited when something special is going to happen (e.g. going on a field trip, going to a party)	INHIB	.439
11	Has clear difficulties doing things he/she finds boring.	REG	.730
13	Has difficulty holding back his/her activity despite being told to do.	INHIB	.437
15	In order to be able to concentrate, he/she must find the task appealing	REG	.726
16	Has difficulty refraining from smiling or laughing in a situation where it is inappropriate	INHIB	.504
18	Has difficulty stopping activity immediately upon being told to do so. For example, he/she need to jump a couple of extra time or play on a computer little bit longer after being told to stop.	INHIB	.674
22	Act in a wilder way compared to other children in the group (e.g. at a birthday party or during a group activity)	INHIB	.511

Note: WM=working memory; PLAN=planning; INHIB=inhibition; REG=regulation

Following the Fornel-Lacker criterion, 1981, the square root of 0.626 (AVE) is higher than the correlation of inhibition and working-memory (r = .80), suggesting an acceptable discriminant (divergent) validity. Also, Construct Reliability (CR) for working memory was .93 and inhibition .90, all above .50, indicating good convergence validity (Hair et al., 2010).

Reliability

Internal consistency was computed for both working memory and inhibition subscales. Both scales have high reliabilities: working memory (α = .95); inhibition (α = .86). The total reliability of the CHEXI was .95. All these values were above the threshold of .70 (Gliner & Morgan, 2017).

Measurement invariance of the CHEXI across gender

Measurement invariance evaluates the psychometric equivalence of a construct across groups before testing means differences due to changes over time (Putnick & Bornstein, 2016). Such groups include child genders (Hong et al., 2003), cultural groups (Senese et al., 2012) and across time (Widaman, 2010). We, therefore, tested whether the CHEXI measures the same construct across gender, boys and girls. To achieve assessment of measurement invariance, we computed a series of competing models from configural invariance through metric invariance to scalar invariance (Putnick & Bornstein, 2016) using AMOS 24. Following Cheung and Rensvold (2002), a model demonstrates measurement invariance if the ΔCFI ≤ 0.01 (Table 3).

Table 3. Measurement invariance of the CHEXI across gender

Model	X^2 (*df*)	CFI	RMSEA (90%CI)	SRMR	Model comp	ΔX^2 (Δ*df*)	ΔCFI	ΔRMSEA	ΔSRMR
M1 Configural invariance	1309.5 (490)	.903	0.056 (0.053-0.060)	.058	-	-	-	-	-
M2 Metric Invariance	1328.5 (512)	.903	0.055 (0.052-0.059)	.069	M1	19.0 (22)	0	-.001	.011
M3 Residual Invariance	1350 (534)	.903	0.054 (0.050-0.058)	.067	M2	22.15 (22)	0	.001	-.002
M4 Scalar invariance	1626 (558)	.894	0.060 (0.057-0.064)	.080	M3	276 (24)	0.009	.006	.020

Note: *N*=526; group 1- Boys *n*=258; group 2-Girls *n*=268; **p*≤.05; ***p*≤.01

School type, Gender and Age differences

We assessed the children's EF skills after transitioning to grade one based on school type, gender and age differences (Table 4). Schools were classified based on management and ownership into public and private schools. The Ministry of Education manages the public schools on behalf of the government, and they are free, while individuals manage private schools as a business and charge fees. Independent-samples *t*-tests showed that there was a significant difference in the total EF scores for public (M = 70.23, SD = 17.0) and private schools (M = 61.20, SD = 16.30), t (524) = 6.13 p < .001), Cohen d = 0.53. Note that the higher the EF score assessed by CHEXI, the higher the EF difficulties (Camerota et al., 2018). Additionally, the academic achievement of private schools was much higher compared to public schools (Table 4). Nonetheless, there was no significant differences in gender; scores for boys (M = 67.1, SD = 18.0) and girls (M = 65.8, SD = 16.6); t (524) = 0.862 p = .389, d = 0.07 in both type of schools.

Table 4. Means and Standard Deviations for CHEXI Ratings for each type of school

	Public school		Private school	
	Boys	Girls	Boys	Girls
	M (SD)	*M (SD)*	*M (SD)*	*M (SD)*
Background variables				
Gender (n)	156	149	102	119
Age (years)	8.04(1.24)	7.80(1.07)	7.60(1.22)	7.59(1.04)
EF Skills				
Working memory	38.88(11.20)	40.35(10.53)	35.33(12.44)	33.44(10.26)
Inhibition	30.81(7.63)	30.45(6.84)	27.79(6.47)	26.09(5.33)
Total EF	69.69(17.51)	70.80(16.41)	63.13(18.02)	59.54(14.54)
Academic achievement				
Math	62.98(19.90)	60.62(19.31)	75.25(15.24)	77.16(14.93)
English	50.42(21.22)	49.84(19.78)	60.89(23.46)	66.63(22.93)
Kiswahili	52.40(22.77)	52.31(22.55)	61.90(24.29)	67.31(23.20)
Mean of 3 subjects	55.27(18.17)	54.26(17.09)	66.01(17.49)	70.37(17.58)

We tested if EF is significantly different by age among the first graders. To achieve this, we classified the students into three groups based on their ages: 5-6 (n = 51), 7-8 (n = 371), and above 9 (n = 103). Analysis of variance (ANOVA) showed that there was a significant difference among the different age groups in the same class, total EF (F = 5.919, p < .001). Post hoc analysis using Bonferroni indicated a significant difference between 5 - 6 and 7- 8 age groups p < .001 but not between 7- 8 and above 9 age groups p = .127. Consequently, 5-6 age group had the highest EF difficulty (M = 72.75, SD = 18.7), followed by 7-8 (M = 66.60, SD = 16.75) and lastly above 9 (M = 62.74, SD = 17.51) age category.

Association of Executive Function and academic achievement

We also investigated whether there is an association between EF and academic achievement (Table 5). The results indicated that there was a moderate negative correlation of Math and working memory (r = - .28, p < .001), English (r = - .41, p < .001), and Kiswahili (r = -.35, p <.001). For inhibition Math (r = - .318, p < 0.001), English (r = -.34, p < .001), and Kiswahili (r = -.28, p < .001) were also negatively correlated. Further, total EF had a moderate and significant negative correlation with academic achievement (r = -.417, p < .001). Therefore, on average students who had high EF difficulties had low scores in academic achievement (Table 5).

Table 5. Bivariate correlations of Executive Functions and academic achievement

		1	2	3	4	5	6	7	8	9
1	Age									
2	Sex	-.069								
3	Type of sch.	-.140**	.049							
4	Math	-.090*	.004	.372**						
5	English	.064	.060	.301**	.548**					
6	Kiswahili	-.013	.059	.257**	.501**	.735**				
7	Acad. Ach.	-.010	.050	.356**	.772**	.899**	.889**			
8	Inhibition	-.047	-.079	-.266**	-.318**	-.335**	-.281**	-.362**		
9	WMemory	-.154**	-.009	-.229**	-.279**	-.414**	-.352**	-.411**	.757**	
10	Total EF	-.121**	-.038	-.259**	-.312**	-.408**	-.346**	-.417**	.903**	.965**

Note: *. *p*<.05;**. *p*<.001; Type of Sch. – Type of school the child attended either public or private school; Acad. Ach-Academic Achievement is the average of Math, English and Kiswahili scores; WMemory – Working Memory; Total EF – the sum of working memory and inhibition.

We also determined the predictive value of the CHEXI. The linear regression results indicated that total EF explained a significant proportion of variance in academic achievement score, $R^2 = .17$, F (1, 525) =110.01, $p < .001$. The regression coefficient (β = -.46) indicated that an increase in one total EF score corresponded to a decrease in the academic achievement score by 0.46 points.

Discussion

EF assessment has a huge application in education and clinical studies. For this reason, measuring EF is gaining much attention both in Kenya and internationally. The majority of tools assessing EF have used performance-based assessments that require trained examiners to administer. Such examiners are not available in most LMICs (Willoughby et al., 2019). Therefore, a good, reliable and affordable tool that is easy to administer and interpret is appropriate for LMIC regions. Although the original intention of the CHEXI was to assess EF difficulties among children and youth for educational purposes, new evidence has established that the CHEXI can also diagnose children who are at risk of getting ADHD (Camerota et al., 2018). Additionally, CHEXI has been validated in other cultures, including Hungary (Józsa & Józsa, 2020), the US (Camerota et al., 2018), France (Catale et al., 2013, Catale, Meumelans, & Thorell, 2015) and Turkey and Portugal, (Thorell & Catale, 2014). The current adaptation add to the list of already existing validations. The Kenyan sample's factor structure had a high KMO index of .96, signifying a reliable factor structure. The final factor structure of the Kenyan adaptation of the CHEXI retained a two-factor model: working memory and planning combined, and regulation and inhibition also combined similar to Camerota et al. (2018), Catale et al. (2013), Thorell and Nyberg (2008). Moreover, the Kenyan version had a variance of 62%, explaining the factor structure, which was comparable to the Hungarian version of 61% (Józsa & Józsa, 2020). These variances are higher than the original development by Thorell and Nyberg (2008) of 41%. Regarding reliability, internal consistency and construct reliability values were above the threshold of .60 (Gliner et al., 2017), indicating that the CHEXI was reliable for the Kenyan sample. Smilar reliability values were also reported in the Hungarian adaptation. We also determined the measurement invariance of the CHEXI across gender (boys vs. girls) in the Kenyan context. The CHEXI demonstrated a strong invariance like the US version (Camerota et al., 2018). Further, EF assessed with the CHEXI significantly correlated with academic achievement, similar to Thorell and Nyberg (2008). This indicates the predictive validity of the CHEXI (Thorell et al., 2013). Indeed, these result support studies that claim EF is a significant predictor of academic achievement (*e.g.*, Christopher 2012; Vandenbroucke et al., 2017). Other studies have reported that EF is related to academic achievement because it affects the learners' motivational and affective attitudes towards learning (*e.g.*, Sung & Wickrama, 2018). Despite the grade one children being peers in the same class, their EF was significantly different by age and school type but not by gender. There are several reasons children in private schools in Kenya outperform children from public schools in EF development. Firstly, the teacher-student ratio is highly in favour of private schools (1:24) against public schools (1:53) in urban areas and much higher in the rural areas (Republic of Kenya, 2019). Fewer students per teacher coupled with a class with essential teaching resources enhance a warm teacher-child relationship devoid of stress, anxiety and fear. According to sociological and attachment theory, this relationship determines the level of engagement, resulting in better approaches to learning, socio-emotional adjustment, and cognitive skills development (Ainsworth, 1989; Bronfenbrenner & Morris, 2006). Secondly, most parents who can afford private schools have a higher SES than those taking their children to public schools. Higher SES has also been shown to support EF's enhancement due to parental scaffolding and quality of life (Brown & Landgraf, 2010; Casey et al., 2018). This is in line with calls for individualized intervention strategies to enhance school readiness (Barret et al., 2017). Strategies to improve EF include cognitive training programs (Aksayli et al., 2019), classroom curricula that target EF (Solomon et al., 2018), high-quality instructional practices and classroom management procedures

(Bierman et al., 2008; Raver et al., 2011). Others with big impacts on EF in children include martial arts, mindfulness and Montessori teaching (Diamond & Ling, 2016). Moreover, effective teaching practices, curriculum support and fostering better approaches to learning are useful in closing the gap of at-risk children (Sung & Wickrama, 2018). Duncan et al. (2018) reported that EF and approaches to learning are similar or related. Others also indicated that EF and mastery motivation are important components of approaches to learning (*e.g*., Berhenke et al., 2011; Buek, 2019; Józsa et al., 2017). To assess mastery motivation to complement EF during the assessment of approaches to learning, the preschool Dimension of Mastery Questionnaire (DMQ) has also been validated for the Kenyan sample (Amukune et al., 2021). Despite, the unique strength of combining both direct assessments of school achievement and teachers' EF ratings, this study had some limitations. One of them is that the ratings were only done by teachers. Parents also have a lot of information regarding their children especially at home. Similar ratings by parents could have provided alternative source of information. Therefore, there is need to translate the English version of CHEXI to Kiswahili language, that is well understood by parents who are not well versed in English.

Conclusion

Given the significance of EF assessment, quick and effective methods must be devised, especially for the LMICs. The CHEXI demonstrated strong psychometric properties and is therefore suitable to assess EF skills in Kenyan culture. Additionally, the two-factor structure tapping working memory with 13 items and inhibition 11 items were retained, which is consistent with the literature (*e.g*., Camerota et al., 2018; Catale et al., 2013, Catale, Meumelans, & Thorell, 2015; Józsa & Józsa, 2020; Thorell & Catale, 2014). Therefore, a new validation of the CHEXI has joined this growing list. Further, the CHEXI has significant application in identifying children with EF difficulties. This can help provide individualized intervention to children with poor academic achievement due to EF difficulties. Further, children of the 5-6 age category and attending public schools had greater EF difficulties than their counterparts from private schools in this study sample. Therefore, there is a need for further research to identify possible causes of poor EF skills in public schools in the study area.

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References

Ainsworth, M. S. (1989). Attachments beyond infancy. *American Psychologist*, *44*(4), 709-716.

Aksayli, N. D., Sala, G., & Gobet, F. (2019). The cognitive and academic benefits of Cogmed: A meta-analysis. *Educational Research Review*, *27*, 229-243.

Amukune, S., Calchei, M., & Józsa, K. (2021). Swahili version of the Dimensions of Mastery Questionnaire: Adaptation and psychometric properties. *Electronic Journal of Research in Educational Psychology* (In Press).

Arnsten, A. F. (2015). Stress weakens prefrontal networks: Molecular insults to higher cognition. *Nature Neuroscience*, *18*(10), 1376-1385.

Baggetta, P., & Alexander, P. A. (2016). Conceptualization and operationalization of executive function: Executive function. *Mind, Brain, and Education*, *10*(1), 10-33. https://doi.org/10.1111/mbe.12100

Bailey, C. E. (2007). Cognitive accuracy and intelligent executive function in the brain and business. *Annals of the New York Academy of Sciences*, *1118*(1), 122-141.

Barkley, R. A. (1997). *ADHD and the nature of self-control*. Guilford Press.

Berhenke, A., Miller, A. L., Brown, E., Seifer, R., & Dickstein, S. (2011). Observed emotional and behavioral indicators of motivation predict school readiness in Head Start. *Early Childhood Research Quarterly*, *26*(4), 430-441. https://doi.org/10.1016/j.ecresq.2011.04.001

Bierman, K. L., Nix, R. L., Greenberg, M. T., Blair, C., & Domitrovich, C. E. (2008). Executive functions and school readiness intervention: Impact, moderation, and mediation in the Head Start REDI program. *Development and Psychopathology*, *20*(3), 821-843.

Blair, C., & Razza, R. P. (2007). Relating effortful control, executive function, and false belief understanding to emerging math and literacy ability in kindergarten. *Child Development*, *78*(2), 647-663.

Bollen, K. A. (1989). *Structural equations with latent variables*. Wiley.

Bronfenbrenner, U., & Morris, P. A. (2006). The bioecological model of human development. In R. M. Lerner & W. Damon (Eds.), *Theoretical models of human development. Handbook of child psychology*, 6th ed., Vol. 1 (pp. 793-828). Wiley.

Brown, T. E., & Landgraf, J. M. (2010). Improvements in executive function correlate with enhanced performance and functioning and health-related quality of life: Evidence from 2 large, double-blind, randomized, placebo-controlled trials in ADHD. *Postgraduate Medicine*, *122*(5), 42-51.

Camerota, M., Willoughby, M. T., Kuhn, L. J., & Blair, C. B. (2018). The Childhood Executive Functioning Inventory (CHEXI): Factor structure, measurement invariance, and correlates in US preschoolers. *Child Neuropsychology*, *24*(3), 322-337.

Casey, B., Cannonier, T., Conley, M. I., Cohen, A. O., Barch, D. M., Heitzeg, M. M., Soules, M. E., Teslovich, T., Dellarco, D. V., & Garavan, H. (2018). The adolescent brain cognitive development (ABCD) study: Imaging acquisition across 21 sites. *Developmental Cognitive Neuroscience*, *32*, 43-54.

Catale, C., Lejeune, C., Merbah, S., & Meulemans, T. (2013). French adaptation of the Childhood Executive Functioning Inventory (CHEXI): Confirmatory factor analysis in a sample of young French-speaking Belgian children. *European Journal of Psychological Assessment*, *29*(2), 149-155. https://doi.org/10.1027/1015-5759/a000141

Catale, C., Meulemans, T., & Thorell, L. B. (2015). The childhood executive function inventory: Confirmatory factor analyses and cross-cultural clinical validity in a sample of 8-to 11-year-old children. *Journal of Attention Disorders*, *19*(6), 489-495.

Carlson, S. M. (2005). Developmentally sensitive measures of executive function in preschool children. *Developmental Neuropsychology*, *28*(2), 595-616.

Cheung, G. W., & Rensvold, R. B. (2002). Evaluating goodness-of-fit indexes for testing measurement invariance. *Structural Equation Modeling*, *9*(2), 233-255.

Christopher, M. E., Miyake, A., Keenan, J. M., Pennington, B., DeFries, J. C., Wadsworth, S. J., Willcutt, E., & Olson, R. K. (2012). Predicting word reading and comprehension with executive function and speed measures across development: A latent variable analysis. *Journal of Experimental Psychology: General*, *141*(3), 470-488. https://doi.org/10.1037/a0027375

Cook, C. J., Howard, S. J., Scerif, G., Twine, R., Kahn, K., Norris, S. A., & Draper, C. E. (2019). Associations of physical activity and gross motor skills with executive function in preschool children from low-income South African settings. *Developmental Science*, *22*(5), e12820.

Cortés Pascual, A., Moyano Muñoz, N., & Quilez Robres, A. (2019). The relationship between executive functions and academic performance in primary education: Review and meta-analysis. *Frontiers in Psychology*, *10*, 1582.

Dawson, P., & Guare, R. (2010). *Executive skills in children and adolescents: A Practical Guide to Assessment and Intervention.* Guilford Press.

Denson, T. F., Mehta, P. H., & Tan, D. H. (2013). Endogenous testosterone and cortisol jointly influence reactive aggression in women. *Psychoneuroendocrinology*, *38*(3), 416-424.

Diamond, A. (2005). Attention-deficit disorder (attention-deficit/hyperactivity disorder without hyperactivity): A neurobiologically and behaviorally distinct disorder from attention-deficit/hyperactivity disorder (hyperactivity). *Development and Psychopathology*, *17*(3), 807-825.

Diamond, A. (2013). Executive functions. *Annual Review of Psychology*, *64*, 135-168.

Diamond, A., & Ling, D. S. (2016). Conclusions about interventions, programs, and approaches for improving executive functions that appear justified and those that, despite much hype, do not. *Developmental Cognitive Neuroscience*, *18*, 34-48. https://doi.org/10.1016/j.dcn.2015.11.005

Diamond, A., & Ling, D. S. (2019). Review of the evidence on, and fundamental questions about, efforts to improve executive functions, including working memory. In A. Diamond & D. S. Ling (Eds.), *Cognitive and working memory training* (pp. 143-431). Oxford University Press. https://doi.org/10.1093/oso/9780199974467.003.0008

Duncan, G. J., Dowsett, C. J., Claessens, A., Magnuson, K., Huston, A. C., Klebanov, P., Pagani, L. S., Feinstein, L., Engel, M., Brooks-Gunn, J., Sexton, H., Duckworth, K., & Japel, C. (2007). School readiness and later achievement. *Developmental Psychology*, *43*(6), 1428-1446.

Eakin, L., Minde, K., Hechtman, L., Ochs, E., Krane, E., Bouffard, R., Greenfield, B., & Looper, K. (2004). The marital and family functioning of adults with ADHD and their spouses. *Journal of Attention Disorders*, *8*(1), 1-10.

Fajrianthi, Wang, J., Amukune, S., Calchei, M., & Morgan, G. A. (2020). Best practices in translating and adapting DMQ 18 to other languages and cultures. In G. A. Morgan, H.-F. Liao, & K. Józsa (Eds.), *Assessing mastery motivation in children using the Dimensions of Mastery Questionnaire (DMQ)* (pp. 225-249). Szent István University.

Friedman, N. P., & Miyake, A. (2004). The relations among inhibition and interference control functions: A latent-variable analysis. *Journal of Experimental Psychology: General*, *133*(1), 101-135.

Gothe, N. P., & McAuley, E. (2015). Yoga and cognition: A meta-analysis of chronic and acute effects. *Psychosomatic Medicine*, *77*(7), 784-797.

Gliner, J. A., Morgan, G. A., & Leech, N. L. (2017). *Research Methods in Applied Settings: An integrated approach to design and analysis* (3rd ed.). Routledge/Taylor & Francis.

Hackman, D. A., Gallop, R., Evans, G. W., & Farah, M. J. (2015). Socioeconomic status and executive function: Developmental trajectories and mediation. *Developmental Science*, *18*(5), 686-702.

Hartanto, A., Toh, W. X., & Yang, H. (2019). Bilingualism narrows socioeconomic disparities in executive functions and self-regulatory behaviors during early childhood: Evidence from the early childhood longitudinal study. *Child Development*, *90*(4), 1215-1235.

Hair Jr, J. F., Sarstedt, M., Hopkins, L., & Kuppelwieser, V. G. (2014). Partial least squares structural equation modeling (PLS-SEM): An emerging tool in business research. *European Business Review*, *26*, 106-121.

Homack, S., Lee, D., & Riccio, C. A. (2005). Test Review: Delis-Kaplan executive function system. *Journal of Clinical and Experimental Neuropsychology*, *27*(5), 599-609.

Hong, S., Malik, M. L., & Lee, M.-K. (2003). Testing configural, metric, scalar, and latent mean invariance across genders in sociotropy and autonomy using a Non-Western sample. *Educational and Psychological Measurement*, *63*(4), 636-654.

Jacob, R., & Parkinson, J. (2015). The potential for school-based interventions that target executive function to improve academic achievement: A review. *Review of Educational Research*, *85*(4), 512-552.

Józsa, G., & Józsa, K. (2020). A Gyermekkori (CHEXI) és a Felnőttkori (ADEXI) Végrehajtó Funkció Kérdőívek magyar nyelvre történő adaptációja. [Hungarian adaptation of the Childhood Executive Functioning Inventory

(CHEXI) and the Adult Executive Functioning Inventory (ADEXI)]. *Magyar Pedagógia, 120*(1), 47-69. https://doi.org/10.17670/MPed.2020.1.47

Józsa, K., Barrett, K. C., Józsa, G., Kis, N., & Morgan, G. A. (2017). Development and initial evaluation of an individualized moderately challenging computer-tablet mastery motivation measure for 3-8 year-olds. *Hungarian Educational Research Journal*, *7*(2), 106-126.

Kaiser, H. F. (1970). A second generation little jiffy. *Psychometrika*, *35*(4), 401-415. https://doi.org/10.1007/BF02291817

Lee, K., Ng, S. F., Pe, M. L., Ang, S. Y., Hasshim, M. N. A. M., & Bull, R. (2012). The cognitive underpinnings of emerging mathematical skills: Executive functioning, patterns, numeracy, and arithmetic. *The British Journal of Educational Psychology*, *82*(1), 82-99. https://doi.org/10.1111/j.2044-8279.2010.02016.x

Lu, C., Black, M. M., & Richter, L. M. (2016). Risk of poor development in young children in low-income and middle-income countries: An estimation and analysis at the global, regional, and country-level. *The Lancet Global Health*, *4*(12), e916-e922. https://doi.org/10.1016/S2214-109X(16)30266-2

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: A latent variable analysis. *Cognitive Psychology*, *41*(1), 49-100.

Molfese, V. J. (2001). *Developmental variations in learning: Applications to social, executive function, language, and reading skills*. Psychology Press.

Obradović, J., & Willoughby, M. T. (2019). Studying executive function skills in young children in low- and middle-income countries: Progress and directions. *Child Development Perspectives*, *13*(4), 227-234.

Piper, B., Merseth, K., & Ngaruiya, S. (2018). Scaling up early childhood development and education in a devolved setting: Policy making, resource allocations, and impact of the Tayari school readiness program in Kenya. *Global Education Review*, 5(2), 47-68.

Putnick, D. L., & Bornstein, M. H. (2016). Measurement invariance conventions and reporting: The state of the art and future directions for psychological research. *Developmental Review*, *41*, 71-90.

Raver, C. C., Jones, S. M., Li-Grining, C., Zhai, F., Bub, K., & Pressler, E. (2011). CSRP's impact on low-income preschoolers' pre-academic skills: Self-regulation as a mediating mechanism. *Child Development*, *82*(1), 362-378.

Raykov, T. (1997). Estimation of composite reliability for congeneric measures. *Applied Psychological Measurement*, *21*(2), 173-184. https://doi.org/10.1177/01466216970212006

Republic of Kenya. (2010). *Constitution of Kenya, 2010*. Office of the Attorney General.

Republic of Kenya. (2019). *Basic education statistical booklet*. Ministry of Education. https://www.education.go.ke/images/Approved_Basic_Education_Statistical_Booklet_2019_approved_compressed.pdf

Rhoades, B. L., Greenberg, M. T., & Domitrovich, C. E. (2009). The contribution of inhibitory control to preschoolers' social-emotional competence. *Journal of Applied Developmental Psychology*, *30*(3), 310-320.

Roth, R. M., Isquith, P. K., & Gioia, G. A. (2014). Assessment of executive functioning using the Behavior Rating Inventory of Executive Function (BRIEF). In S. Goldstein & J. A. Naglieri (Eds.), *Handbook of executive functioning* (pp. 301-331). Springer.

Rothbart, M. K., Ahadi, S. A., Hershey, K. L., & Fisher, P. (2001). Investigations of temperament at three to seven years: The Children's Behavior Questionnaire. *Child Development*, *72*(5), 1394-1408.

Sasser, T. R., Bierman, K. L., Heinrichs, B., & Nix, R. L. (2017). Preschool Intervention can promote sustained growth in the executive-function skills of children exhibiting early deficits. *Psychological Science*, *28*(12), 1719-1730. https://doi.org/10.1177/0956797617711640

Senese, V. P., Bornstein, M. H., Haynes, O. M., Rossi, G., & Venuti, P. (2012). A cross-cultural comparison of mothers' beliefs about their parenting very young children. *Infant Behavior and Development*, *35*(3), 479-488. https://doi.org/10.1016/j.infbeh.2012.02.006

Schirmbeck, K., Rao, N., & Maehler, C. (2020). Similarities and differences across countries in the development of executive functions in children: A systematic review. *Infant and Child Development*, *29*(1), e2164.

Schreiber, J. B., Nora, A., Stage, F. K., Barlow, E. A., & King, J. (2006). Reporting structural equation modeling and confirmatory factor analysis results: A review. *The Journal of Educational Research*, *99*(6), 323-338. https://doi.org/10.3200/JOER.99.6.323-338

Schumacker, R., & Lomax, R. (2016). *A Beginner's guide to structural equation modeling*. Routledge.

Solomon, T., Plamondon, A., O'Hara, A., Finch, H., Goco, G., Chaban, P., Huggins, L., Ferguson, B., & Tannock, R. (2018). A cluster randomized-controlled trial of the impact of the Tools of the Mind curriculum on self-regulation in Canadian preschoolers. *Frontiers in Psychology, 8,* Article 2366.

Sung, J., & Wickrama, K. A. S. (2018). Longitudinal relationship between early academic achievement and executive function: Mediating role of approaches to learning. *Contemporary Educational Psychology*, *54*, 171-183. https://doi.org/10.1016/j.cedpsych.2018.06.010

Thorell, L. B., Eninger, L., Brocki, K. C., & Bohlin, G. (2010). Childhood Executive Function Inventory (CHEXI): A promising measure for identifying young children with ADHD? *Journal of Clinical and Experimental Neuropsychology*, *32*(1), 38-43.

Thorell, L. B., & Nyberg, L. (2008). The Childhood Executive Functioning Inventory (CHEXI): A new rating instrument for parents and teachers. *Developmental Neuropsychology*, *33*(4), 536-552.

Thorell, L. B., Veleiro, A., Siu, A. F., & Mohammadi, H. (2013). Examining the relation between ratings of executive functioning and academic achievement: Findings from a cross-cultural study. *Child Neuropsychology*, *19*(6), 630-638.

Toplak, M. E., West, R. F., & Stanovich, K. E. (2013). Practitioner review: Do performance-based measures and ratings of executive function assess the same construct? *Journal of Child Psychology and Psychiatry, 54*(2), 131-143.

Vandenbroucke, L., Verschueren, K., & Baeyens, D. (2017). The development of executive functioning across the transition to first grade and its predictive value for academic achievement. *Learning and Instruction*, *49*, 103-112. https://doi.org/10.1016/j.learninstruc.2016.12.008

Vermunt, J. D., & Endedijk, M. D. (2011). Patterns in teacher learning in different phases of the professional career. *Learning and Individual Differences, 21*(3), 294-302.

Widaman, K. F., Ferrer, E., & Conger, R. D. (2010). Factorial invariance within longitudinal structural equation models: Measuring the same construct across time. *Child Development Perspectives*, *4*(1), 10-18.

Willcutt, E. G., Doyle, A. E., Nigg, J. T., Faraone, S. V., & Pennington, B. F. (2005). Validity of the executive function theory of attention-deficit/hyperactivity disorder: A meta-analytic review. *Biological Psychiatry*, *57*(11), 1336-1346.

Willoughby, M. T., Piper, B., King, K. M., Nduku, T., Henny, C., & Zimmermann, S. (2021). Testing the efficacy of the red-light purple-light games in preprimary classrooms in Kenya. *Frontiers in Psychology*, *12*, Article 633049. https://doi.org/10.3389/fpsyg.2021.633049

Willoughby, M. T., Piper, B., Kwayumba, D., & McCune, M. (2019). Measuring executive function skills in young children in Kenya. *Child Neuropsychology*, *25*(4), 425-444. https://doi.org/10.1080/09297049.2018.1486395

Willoughby, M. T., Piper, B., Oyanga, A., & Merseth King, K. (2019). Measuring executive function skills in young children in Kenya: Associations with school readiness. *Developmental Science*, e12818.

Zelazo, P. D., Blair, C. B., & Willoughby, M. T. (2016). *Executive function: Implications for education* (NCER 2017-2000). National Center for Education Research, Institute of Education Sciences, U.S. Department of Education. http://ies.ed.gov/.

Zelazo, P. D., & Carlson, S. M. (2012). Hot and cool executive function in childhood and adolescence: Development and plasticity. *Child Development Perspectives*, *6*, 354-360. https://doi.org/10.1111/j.1750-8606.2012.00246.x

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