

Correlates of Executive Function and Reading Comprehension among Seventh Graders IN Itezhi-Tezhi District, Zambia

Namakando Namushi, Pelekelo P. Kabundula, Sylvia Mwanza-Kabaghe (PhD).

Department of Educational Psychology, Sociology and Special Education, The University of Zambia.

Received: 20 December 2022; Revised: 06 January 2023; Accepted: 16 March 2023;

Published: 15 April 2023

ABSTRACT

The aim of the paper was to determine the association between executive function and reading comprehension among seventh graders in Itezhi-tezhi District, Zambia. The study utilized a correlational research design. Simple and stratified random sampling techniques were used to select a total of 216 respondents comprising pupils and parents. Data were collected using the following testing tools: Behavioral Rating Inventory for Executive Functions second edition (BRIEF2), Delis-Kaplan Executive function system (D.KEFS), Digit Span (DS), Reading Comprehension Assessment Tool (RCAT), Kaufman's Pattern Reasoning Test (K-PRT), Biographic Data Form (BDF), Home Literacy Environment Questionnaire (HLEQ) and School Literacy Environment Checklist (SELC). Data were analyzed using the Stata version14 to perform correlations. The results demonstrated that there was both positive and negative statistically significant correlation ($p < 0.001$) among the three core skills of executive function (Inhibitory control; Cognitive flexibility and Working memory on objective measures using Digit Span (DST) and Delis-Kaplan Executive function system (D.KEFS). Whereas, on the subjective measures of executive function, the three core skills exhibited statistically negative correlation at different levels (Inhibitory control, $r = -0.21$, $p = 0.03$), Cognitive flexibility, $r = -0.22$, $p = 0.02$) and Working memory, ($r = -0.22$, $p = 0.02$). Further, a positive and negative statistically significant correlation was also noted with Task monitor ($r = 0.19$, $p = 0.05$) and Organization of material ($r = -0.25$, $p = 0.01$). However, an insignificant difference was observed in Self-monitor ($r = -0.06$, $p = 0.54$), Emotional control ($r = -0.03$, $p = 0.72$), Initiate ($r = -0.18$, $p = 0.07$), Plan and organize ($r = -0.18$, $p = 0.06$) as aspects of executive function skills which indicated no statistically correlation with reading comprehension.

INTERPRETATION: Executive function skills correlated highly with reading comprehension among the seventh graders, though a home and school environment need to promote early stimulation for executive function skills and create a reading culture.

Key words: Executive Function, Working Memory, Inhibitory Control, Cognitive Flexibility and Reading Comprehension.

INTRODUCTION

Multiple studies have shown the importance of executive function among people in both developed and developing countries (Zelazo, Blair and Willoughby, 2017, Mwanza-Kabaghe, 2015, Mwanza-Kabaghe, Mubanga, Matafwali, Kasonde-Ng'andu and Bus, 2015, Bull and Lee, 2014, Barkley, 2012, Flook and Smalley, 2010, St Clair-Thompson and Gathercole, 2006). Executive functions consist of several brain-based skills that help people to organize, act on information, initiate, perform tasks and solve current problems. There is understanding and agreement amongst scholars that the core or most basic executive function skills include working memory, inhibitory control and cognitive flexibility (shift) (Diamond, 2013, Best and Miller, 2010, Friedman, Miyake, Corley, Young, DeFries, and Hewitt, 2006, Witzki and Howerter, 2000, Miyake, Friedman, Emerson, Witzki, Howerter and Wager, 2000). The implication is that these three

core components of Executive function are dissociable implying that in practice, it is impossible to test one component to the complete exclusion of others. For instance, Inhibitory control involves being able to control one's attention, behaviour, thoughts or emotions to override strong internal predispositions or external lures, and instead do what is more appropriate or needed at a given time. (Miyake et al., 2000). Without inhibitory control, one would be at the mercy of impulses, old habits of thought, action or stimuli in the environment. Working memory is necessary and responsible for making sense of written work or spoken language be it a sentence, a paragraph, passage or doing mathematics mentally, translating instructions into action, incorporating new information into thinking, considering alternatives, and mentally relating information to derive a general principle (Müller and Kerns, 2015). Children with dyslexia show deficits on working memory tasks in both verbal and visual domains (Reiter, Tucha and Lange, 2005). Cognitive flexibility helps a reader to actively shift focus between many things, such as word and text meanings, letter-sound information, and syntactic (sentence grammar). This has demonstrated that Cognitive flexibility has a direct and unique association with reading comprehension attainment. (Kieffer, Vukovic and Berry, 2013). Executive function has been widely recognised and researched in terms of underpinning successful goal-directed tasks, and is linked to educational attainment in literacy, mathematics and academic achievement. (Zelazo, Blair and Willoughby, 2017, Mwanza- Kabaghe, 2015, Bull and Scerif, 2001; McClelland et al. 2007, St. Clair-Thompson and Gathercole, 2006, Alexander, Entwisle and Dauber, 1993). However, the Southern and Eastern African Consortium for monitoring Education Quality (SACMEQ) report, (2016) and some Zambian studies done in the area of reading (Mulenga, 2017, Tambulukani, 2015, Chansa- Kabali, 2014, Mutale, 2013, Matafwali, 2010; Mwambazi, 2011, Nkosha, 2011; Chazangwe, 2011, Mbewe, et. al 2016) have shown low reading levels among Zambian learners especially at primary school level. We therefore, sought to correlate executive function skills and reading comprehension among the seventh graders in Itezhi-tezhi District, Zambia based on the overwhelming evidence that executive function is a boost and predict reading and writing skills (Blair, Zelazo, and Greenberg, 2005; Mwanza-Kabaghe, 2015; Zelazo et.al, 2017).

METHODS AND MATERIALS

Participants: Eligible participants were seventh graders who were recruited from public primary schools in Itezhi-tezhi district.

Inclusion/Exclusion Criteria: Only grade seven pupils and their parents/caregivers were included in the present analysis.

Procedures: Participants completed selected tasks from Delis-Kaplan Executive function system (D.KEFS), Behavioral Rating Inventory for Executive Functions (BRIEF2) and Digit Span (DS) to assess executive function skills, Reading Comprehension was measured using Reading Comprehension Assessment Tool (RCAT), while background variables were measured as follows, general intelligence: Kaufman's Pattern Reasoning Test (K-PRT), Home literacy: Home Literacy environment questionnaire: Social economic status: Biographic data form and School literacy environment: School Literacy Environment Checklist. Supervision was provided by the researcher's supervisor who was based in Lusaka via telephone and physical site visits. The assessments were conducted by the researcher himself for a period of three months.

Sample Size: For this study, a total sample size of 216 respondents (n=108 Pupils; n=108 Parents) were recruited from six public primary schools in Itezhi-tezhi district.

Statistical Methods: Statistical analyses were performed using Stata 14 to perform (Pearson's r) for continuous variables and (Spearman's ρ) for categorical variables as appropriate.

Ethics Statement: This study was approved by the University of Zambia Humanities and social Sciences

Research Ethics Committee (UNZAHSSREC). Informed consent and parental permission were obtained in accordance with UNZAHSSREC requirements.

RESULTS

Sample characteristics: A total of 216 respondents (Children: $n=108$; Parents/caregivers: $n=108$) were enrolled, completed and analyzed in the study. Respondents' age, sex, social economic status, Home literacy, School literacy environment, a neighborhood of residence, primary language, and grade level has been indicated. (Table 1). In order to establish the relationship between executive function and reading comprehension among seventh graders, the correlation was performed on both objective and subjective measures of executive function and reading comprehension.

Correlation of objective measures of executive function skills and reading comprehension

When the core executive function skills were correlated with reading comprehension, the study indicates that there is a statistically significant correlation between the core executive function skills and reading comprehension ($p<0.001$) (Table 2). This implies that children in the study who had good executive function skills equally performed significantly well on reading comprehension.

Correlation of subjective measures of executive function skills and reading comprehension

On the subjective measures of executive function, the results also demonstrated a statistically significant correlation at various levels between reading comprehension and the core skill of executive function skills (Table 3). For instance, Inhibitory control and reading comprehension correlated at ($r= -0.21$, $p=0.03$), Shift ($r= -0.22$, $p=0.02$), Working memory ($r= -0.22$, $p=0.02$), (Task monitor ($r= -0.19$, $p=0.05$) and Organization of materials ($r= -0.25$, $p=0.01$). However, a difference was noted with Self-monitor ($r= -0.06$, $p=0.54$), Emotional control ($r= -0.03$, $p=0.72$), Initiate ($r= -0.18$, $p=0.07$), Plan and organize ($r=-0.18$, $p=0.06$) which indicated no statistically significant relationship with reading comprehension.

DISCUSSION

To establish the relationship between executive function and reading comprehension among seventh graders, a correlation was performed on both objective and subjective measures of executive function skills. The results on objective measures of executive function skills indicate that there is a statistically significant relationship between reading comprehension and core executive function skills ($p<0.001$). This finding demonstrated a link between working memory, cognitive flexibility inhibitory control and reading comprehension. This is consistent with a growing body of literature demonstrating tight links between executive functioning and reading comprehension (Mwanza-Kabaghe, 2015; Kamza, 2017; Best, 2010; Esopo, 2018; Jager and Condy, 2017; Osuji, 2017; Spaul and Pretorius, 2014, Vei, 2003) which investigated intensively the relationship between executive function and reading abilities among learners and reported a significant relationship between executive function reading abilities. EF and reading comprehension hold a strong relationship and have little to do with rote memorizing or learning facts. EF has more to do with reasoning, problem solving and using the knowledge acquired from rote memory to make inferences and solve problems (Adams, Mwanza-Kabaghe, Mbewe, Kabundula, and David, 2019). Reading comprehension is a highly demanding task that requires coordination of various EF domains. This entails that the core executive skills (working memory, inhibitory control and cognitive flexibility) were all important in influencing reading comprehension and therefore, the relevant authorities in the ministry of general education must desire to tailor the education activities in line with the demand of the three core skills of executive function. Similarly, the finding of the study on the correlation between an objective measure of Executive function and reading comprehension is supported by Baddeley (1996)'s multi-

component model (theory) which asserts that different executive function domains such as working memory, inhibitory control and cognitive flexibility contribute differently and simultaneously during cognitive processing. A capacity limitation or processing inefficiency in one or more of these executive function domains contributes to variability in reading performance. The theory also indicates that the phonological loop (PL) and visuospatial sketchpad (VSSP) are distinct brain regions involved during reading comprehension. The relationship between the three core executive function skill and reading comprehension as demonstrated by the findings of this study clearly prove the theoretical claims of Baddeley’s theory. This entails that Baddeley’s multi component (model) theory is useful and should be utilized by scholars because it has demonstrated a link between executive function and reading comprehension among seventh graders in school. This entails that executive function is an important component as it helps not only in influencing reading comprehension but also other goal directed tasks, therefore, this study is a step in the right direction as it has provided insightful information on reading which can be used in schools for decision making on the relationship between executive function and comprehension among the seventh graders. As school authorities endeavor to improve reading levels, special attention should be given to EF stimulation at an early age because it has been established that there is a correlation between EF and reading comprehension. Policy makers should eradicate poor reading levels using a holistic approach those targets both stimulations of executive function domains and improvement of other external factors known to be threats to reading abilities. This could be one clear solution needed in Zambia where reading levels are extremely poor.

CONCLUSION

In conclusion, establishing the relationship between EF skills and reading comprehension among seventh graders was another component that was very cardinal in this study. Therefore, to establish the relationship between EF and reading comprehension among seventh graders, the correlation was executed on both objective and subjective measures of executive function. Objective measures of executive function skills indicated a statistically significant relationship between reading comprehension and the three core executive function skills ($p < 0.001$). This entails that EF is an important component as it helps not only in predicting reading comprehension but also in other goal directed tasks, therefore, this study is a step in the right direction as it has provided insightful information to be used in schools for decision making on the relationship between executive function and reading comprehension among the seventh graders. When subjective measures of EF were correlated with reading comprehension, the study found a statistically significant relationship at various levels between reading comprehension and the three core executive function skills. For instance, inhibitory control ($r = -0.21, p=0.03$), Cognitive Flexibility ($r = -0.22, p=0.02$), Working memory ($r = -0.22, p=0.02$), Task monitor ($r = -0.19, p=0.05$) and Organisation of materials ($r = -0.25, p=0.01$). However, a difference was noted with Self-monitor ($r = -0.06, p=0.54$), Emotional control ($r = -0.03, p=0.72$), Initiate ($r = -0.18, p=0.07$), Plan and organise ($r = -0.18, p=0.06$) which indicated no statistically significant relationship with reading comprehension.

Table 1: Sample Characteristics

VARIABLES	FREQUENCY (%)
Gender (Boys)	54 (50)
(Girls)	54 (50)
Age (mean) (S.D)	13 (1.3)
General intelligence (mean) (S.D)	11.3 (4.7)
Home literacy (Exposed Homes)	23 (21)
(Non-exposed Homes)	85 (79)

Participant's Reading comprehension Levels	
(Below average: 0-5 Marks)	45 (42)
(Average: 6-10 Marks)	47 (44)
(Above average: 11-15 Marks)	16 (15)
Socio-Economic Status (High ses)	0 (0)
(Middle ses)	24 (22)
(Low ses)	84 (78)
Residence (Staying within School)	22 (20)
(Staying outside School)	86 (80)
Primary Language (Tonga)	37 (34)
(Ila)	36 (33)
(Nyanja)	16 (15)
(English)	0 (0)
(Others)	15 (18)
School Reading materials (Available and accessible)	72 (67)
(Available but not accessible)	36 (33)

Table 2: Correction of Objective measures of executive function skills and reading Comprehension

	Variables	Instrument	Correlation Co-efficient	P-Value
READING COMPREHENSION	Inhibitory control and Working memory	D.KEFS (Condition1)	-0.78	<0.001
	Working memory	D.KEFS (TMTc2)	-0.82	<0.001
	Working memory	D.KEFS (TMTc3)	-0.83	<0.001
	Cognitive flexibility	D.KEFS (TMTc4)	-0.86	<0.001
	Motor Speed	D.KEFS (TMTc5)	-0.70	<0.001
	Working memory	Digit Span Forward	0.82	<0.001
	Inhibitory control	Digit Span Backward	0.76	<0.001
	Cognitive flexibility and Working memory	Digit Span Sequencing	0.78	<0.001
	Inhibitory control	Pencil Taping Test (Opposite Taping)	0.77	<0.001

Table 3: Correction of Subjective of executive function skills and reading comprehension

Behavioural Rating Inventory for Executive Functions (BRIEF2)			
Variables		Correlation Co-efficient	P-Value
READING COMPREHENSION	Inhibit (Inhibitory control)	-0.21	0.03
	Self-monitor	-0.06	0.54
	Shift (Cognitive flexibility)	-0.22	0.02
	Emotional control	-0.03	0.72
	Initiate	-0.18	0.07
	Working memory	-0.22	0.02
	Plan and organise	-0.18	0.06
	Task monitor	-0.19	0.05
	Organisation of materials	-0.25	0.01

REFERENCES

- Adams, H. R, Mwanza-Kabaghe S, Mbewe, E. G, Pelekelo, P. Kabundula, & David, B. (2019). The HIV-Associated Neurocognitive Disorders in Zambia (HANDZ) Study: Protocol of a research program in pediatric HIV in sub-Saharan Africa. *J HIV AIDS Infect Dis.* <https://doi.org/10.1101/19003590>.
- Alexander, K.L., Entwisle, D.R. & Dauber, S.L. (1993). First Grade Classroom Behaviour: Its Short-term and Long-term Consequences for School Performance. *Child Development*, 64(3), 801–814.
- Baddeley, A. D. (1996). The central executive: A concept and some misconceptions. *Journal of the International Neuropsychological Society*, 4, 523–526.
- Barkley, R. A. (2012). *Executive functioning and self-regulation: Extended phenotype, synthesis, and clinical implications.* New York: Guilford Publications.
- Best, J. R., & Miller, P. H. (2010). A Developmental Perspective on Executive Function. *Child Development*, 81, 1641-1660.
- Best, J.B, (2010). *The Contribution of Working Memory Components to Reading Comprehension in Children.* Masters Dissertation. Columbia, University of Victoria.
- Blair, C., Zelazo, P. D., & Greenberg, M. T. (2005). The measurement of executive function in childhood. *Developmental Neuropsychology*, 28, 561–571. http://dx.doi.org/10.1207/s15326942dn2802_1
- Bull, R. & Scerif, G. (2001). Executive Function as a Predictor of Mathematics Ability: Inhibition, Switching, and Working Memory. *Developmental Neuropsychology*, 19, 273– 293
- Bull, R., & Lee, K. (2014.). Executive Functioning and Mathematics Achievement. *Child Development Perspectives*, 8(1): 36-41.
- Chansa-Kabali. T. (2014). *The Acquisition of Early Reading Skills: The Influence of the Home Environment in Lusaka, Zambia.* PhD Thesis, Lusaka, University of Zambia.
- Chazangwe, V. (2011). *An investigation into the factors for poor performance of grade twelve pupils in reading comprehension.* Masters Dissertation. Lusaka, University of Zambia.
- Diamond, A. (2013). Executive Functions. *Annual Review of Psychology*, 64, 135-168.
- Esopo. K. et al (2018). Measuring self-efficacy, executive function, and temporal discounting in Kenya. *Behaviour Research and Therapy*, Volume 101, Pages 30-45
- Flook, L., Smalley, S. L., Kitiil, J. M., Galla, B. M., Kaiser-Greenland, S., Locke, J. . . . Kasari, C. (2010). Effects of mindful awareness practices on executive functions in elementary school children. *Journal of Applied School Psychology*, 26, 7095.

14. Friedman, N. P., Miyake, A., Corley, R. P., Young, S. E., DeFries, J. C., & Hewitt, J. K. (2006). Not all executive functions are related to intelligence. *Psychological Science*, 17(2), 172-179.
 15. Jager.P. & Condy.J. (2017).The influence of executive function challenges on the behavioural adaptation of one learner with autism spectrum disorder. *South African Journal of Childhood Education*. 10, 2223-7674
 16. Kamza, A. (2017). Developmental patterns of relationships between inhibitory control and reading skill in early-school children. Contribution to a special issue on Executive Functions and Children's Literacy Development. *International Association for Research in L1-Education*. 17, 1-23.
 17. Kieffer, M. J., Vukovic, R. K., & Berry, D. (2013). Roles of attention shifting and inhibitory control in fourth-grade reading comprehension. *Reading Research Quarterly*, 48 (4), 333–348.
 18. Matafwali, B. (2010). The Relationship between Oral Language and Early Literacy Development: A Case of Zambian Languages and English. Ph.D. Thesis. Lusaka, University of Zambia.
 19. Mbewe E, Matafwali B, Mwanza-Kabaghe S. Teachers', pupils' and parents' perceptions on the use of Chinyanja as a medium of instruction in selected lower primary schools in Lusaka District, Zambia. *Int J Human Soc Sci Res*. 2016;3(11):25-35.
 20. McClelland, M. M., Cameron, C. E., Connor, C. M., Farris, C. L., Jewkes, A. M., & Morrison, F. J. (2007). Links between behavioral regulation and preschoolers' literacy, vocabulary, and math skills. *Developmental Psychology*, 43, 947-959.
 21. 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.
 22. Mulenga. S.M. (2017). An Establishment of the Grade Four Learners' Ability in Reading Appropriately Phonic and Sight Words in English Language in Schools in Lusaka. *Masters Dissertation*, Lusaka, University of Zambia.
 23. Müller, U. & Kerns, K. (2015). The Development of Executive Function. In L.S. Liben, U. Müller and R.M. Lerner (Eds.), *Handbook of Child Psychology and Developmental Science*, Vol. 2: Cognitive Processes (7th Ed.) (pp. 571-623). Hoboken, NJ: Wiley.
 24. Mutale, K. (2013). Challenges faced by grade twelve learners in reading comprehension: a case of a school in Kafue district. *Masters Dissertation*. Lusaka, University of Zambia.
 25. Mwanamukubi. L. (2013). Reading Difficulties in Grade Six Learners and Challenges Faced By Teachers in Teaching Reading: A Case of Chadiza and Chipata Districts, Zambia. *Masters Dissertation*. Lusaka, University of Zambia.
 26. Mwanza-Kabaghe et al, (2015). *Zambian Pre-Schools: A boost for Early Literacy: English language Research*. Vol 4 No. 4. Research Press.
 27. Mwanza-Kabaghe, S. (2015). *Preschool, Executive Functions and Oral Language as Predictors of Literacy and Numeracy Skills in First Grade*. Ph.D. Thesis, Lusaka, University of Zambia.
 28. Nkossa, C. D. (2011). Effects of the discourse analysis strategy and the conventional approach on pupils' performance in reading comprehension in Bemba. *Masters Dissertation*. Lusaka, University of Zambia.
 29. Reiter, A. Tucha, O. Lange, KW. (2005). Executive Functions in Children with Dyslexia. *Frontiers in Psychology*. 11:116–131
- Southern African Consortium for Monitoring Educational Quality. (2016). *Analysis of Education Research Data for Policy Development: The Zambian Case*. Paper prepared by IIEP and Zambia, Ministry of Education.
30. St Clair-Thompson, H. L., & Gathercole, S. E. (2006). Executive functions and . *Quarterly Journal of Experimental Psychology*, 59, 745-759.
 31. Tambulukani, G. K. (2015). *First Language Teaching of initial Reading: Blessing or Curse for the Zambian Children under Primary Reading Programme?* PhD Thesis, Lusaka, University of Zambia.
 32. Veii, K. R. H. (2003). *Cognitive and linguistic predictors of literacy in Namibian Herero- English bilingual school children*. Unpublished PhD Thesis, University of Surrey, United Kingdom,

33. Vei, K. R. H. (2003). Cognitive and linguistic predictors of literacy in Namibian Herero- English bilingual school children. Unpublished PhD Thesis, University of Surrey, United Kingdom,
34. Zelazo, P. D., Blair, C. B., & Willoughby, M. T. (2017). Executive function: implications for education (NCER 2017–2000) Washington, DC: National Centre for Education Research, Institute of Education Sciences, United States of America.

About authors: Namakando Namushi and Pelekelo P. Kabundula are both PhD students at the University of Zambia, Department of Educational Psychology, Sociology and Special Education. Dr. Sylvia Mwanza-Kabaghe (PhD) is a Senior Lecturer at the University of Zambia, Department of Educational Psychology, Sociology and Special Education.