Validation of the ADHD-Behaviour Rating Scale for early childhood teacher use in South African classrooms

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ABSTRACT

We tested the construct validity of scores from the ADHD Behaviour-Rating Scale (ADHD-BRS: Merrell & Tymms. 2001) within South African early childhood classrooms in three of the eleven official languages, English, Afrikaans and isiXhosa. In-service teachers (*n*=109) from 112 schools in the Western Cape Province completed the ADHD-BRS for 1771 Grade 1 children (girls = 50%, median age = 7.39 years). Rasch analysis and Confirmatory factor analysis (CFA) results indicated evidence for the validity of the ADHD-BRS scores. There was evidence that the language of learning and teaching (LoLT) groups differed enough to require separate analysis. Regardless of language or gender, higher scores on inattention predicted lower reading and numeracy scores across groups.

Key Words: Attention-deficit hyperactivity disorder (ADHD); ADHD Behaviour-Rating Scale (ADHD-BRS); early childhood development, South Africa; Rasch modelling; validation

INTRODUCTION

Attention-Deficit Hyperactivity Disorder (ADHD) in young children requires screening tools that yield reliable and valid scores for educational support (Du Plessis, 2015). ADHD is a neurodevelopmental disorder with one or more of the following symptoms: inattention, hyperactivity and impulsiveness (APA, 2013). The behaviours are severe enough for diagnosis when they interfere with normal, expected development. It is often diagnosed in early childhood by specialists, although less so in developing country settings with their reduced learner support and psychological systems (Cook et al., 2019; Mwaba, Roman & Topkin, 2015). Teachers have complex and challenging experiences of handling ADHD in their classrooms and need to collaborate with professionals (Lopes, Eloff, Howie & Maree, 2009).

Children with ADHD tend to under-achieve in mathematics, reading and language in the absence of early diagnosis and targeted interventions (Baweja, Mattison, & Waxmonsky, 2015; Saudino & Plomin, 2007). We explored the reliability and validity of scores from the ADHD Behaviour-Rating Scale (ADHD-BRS: Merrell & Tymms, 2001), a widely used measure

to screen children's behaviour for the likelihood of having attention deficit hyperactivity disorder.

Low socioeconomic status, race, ethnicity and not speaking the language of learning at home is associated with a higher likelihood of an ADHD diagnosis normed on middle-class Western English speaking children (Carastathis, 2016). Children from developing countries with severe economic disadvantages, and less social capital support, may face more learning barriers (Alloway & Cockcroft, 2014). In-service teachers of schools in developing countries are often ill resourced and not trained to provide specialised learning support to children with ADHD (Meyer, Eilertsen, Sundet, Tshifularo, & Sagvolden, 2004; Mokobane, Pillay & Meyer, 2020). Teachers also have limited access to screening measures validated for South African children (Honneth, 1996; Matias, 2019; Moody, 2017).

To provide South African schools with such a screening tool, we explored the construct validity of the ADHD-BRS. The predictive validity was assessed by investigating the relationship between high ADHD scores and literacy and numeracy achievement for boys and girls from three different South African language communities.

METHOD

Participants and research setting

Schools with early childhood classrooms were selected using stratified random sampling. The sample consisted of 112 schools with in-service teachers (n = 109, female =100%) and Grade 1 children (n = 1771, girls = 50%). The sample was stratified by the language of learning and teaching (LoLT): Afrikaans, English and isiXhosa (Figure 1).

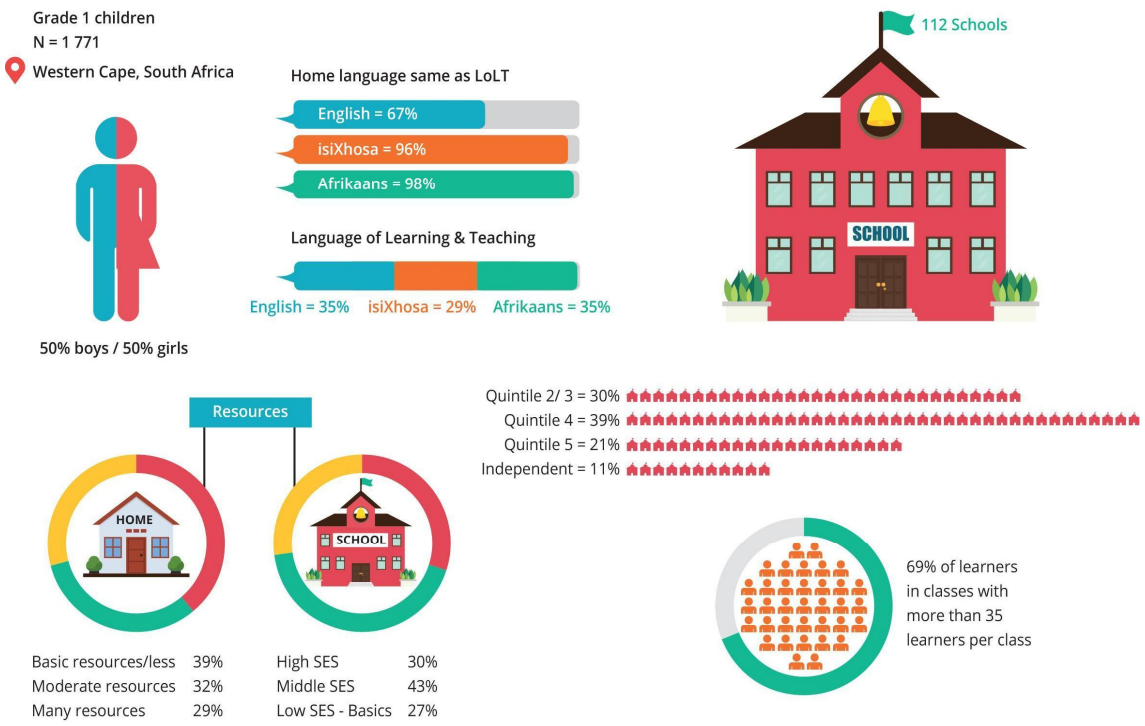

Figure 1: Characteristics of the Grade 1 sample

Approximately 30% of the schools were from low-resource communities who receive additional government funding and support compared to fee-paying schools based on the amended

national norms and standards for school funding (Van Dyk & White, 2019).

Measures

Our measures were translated from English into Afrikaans and isiXhosa, using the forward-backwards method (Tymms, Howie, Merrell, Combrinck & Copping, 2017). We briefly describe each of the measures.

ADHD measure. The *ADHD-BRS* measures the triad of inattention (nine items), hyperactivity (six items) and impulsiveness (three items). Each symptom is rated on a six-point scale (never = 0 to always = 5). Previous studies (Merrell, Sayal, Tymms, & Kasim, 2017; Merrell & Tymms, 2005) reported high internal reliability and test-retest scores from the ADHA-BRS (α = 0.97 and α = 0.98, respectively). In the present study, we observed Cronbach's alpha values as follows: inattention (0.967), hyperactivity (0.955) and impulsiveness (0.767).

Literacy and numeracy measure. The Grade 1 children were assessed using *The International Performance Indicators in Primary Schools (iPIPS)* item bank. The tests were designed with Computer Adaptive Testing (CAT) to estimate the children's scores.

Socio-demographics measure. Parents or legal guardians completed their child's socio-demographic information. The questions included socio-economic indicators, such as access to

basic resources like electricity, running tap water, flushing toilets, children's books and internet connections (Mtsatse & Combrinck, 2018).

Ethical considerations

The University of Pretoria and the Western Cape Department of Education (WCED) granted ethics clearance for the study. The school principals permitted the study to be conducted in their schools. Parents or legal guardians signed consent forms for their children to participate.

Data analysis

We implemented Rasch analysis and Confirmatory Factor Analysis (CFA) for the construct validity analysis. After that, we performed a regression analysis to predict literacy and numeracy scores from the ADHD scores. For the Rasch analysis, we utilised the RUMM 2030 (Rasch Unidimensional Models for Measurement) software package (Andrich, Sheridan, & Luo, 2009; Rasch, 1980). Confirmatory Factor Analysis (CFA) was done using the IBM Amos software (Arbuckle, 2019a; Arbuckle, 2019b).

RESULTS AND DISCUSSION

Table 1 shows the descriptive statistics of the continuous variables. The final column indicates the significance of

independent t-tests to compare boys and girls per language of learning and teaching (LoLT).

Table 1: Descriptive statistics of continuous variables & significance between genders

		Boy		Girl		*p*
		Mean	S.D.	Mean	S.D.	
English as LoLT	Reading	63.19	13.08	64.27	11.72	.702
	Numeracy	62.96	12.18	62.59	10.72	.580
	Hyperactivity	1.85	1.28	1.37	1.05	.000**
	Inattention	2.41	1.24	1.85	1.17	.000**
	Impulsivity	1.73	1.39	1.30	1.19	.000**
isiXhosa as LoLT	Reading	50.96	13.76	56.51	13.79	.000**
	Numeracy	54.08	13.10	57.36	13.47	.003*
	Hyperactivity	2.27	1.09	1.74	0.96	.000**
	Inattention	2.69	1.14	2.18	1.11	.000**
	Impulsivity	2.17	1.13	1.62	1.03	.000**
Afrikaans as LoLT	Reading	53.25	12.32	55.65	12.63	.028*
	Numeracy	54.05	11.68	52.41	11.09	.091
	Hyperactivity	2.31	1.27	1.65	1.14	.000**
	Inattention	2.67	1.33	2.20	1.29	.000**
	Impulsivity	2.08	1.28	1.56	1.19	.000**

*$p<0.05$; **$p<0.01$

Construct validity: Rasch Analysis

The analysis for the three constructs of hyperactivity, inattention and impulsivity is presented in Table 2.

Table 2: Item fit residuals per item and differential item functioning for gender and language

Item	Description	Location	SE	FitResid	Prob FitResid	DIF Gender	DIF Language
Inattention							
Q1	Careless	-0.741	0.025	1.494	0.000244*		
Q2	Inattentive	-0.305	0.024	-7.541**	0.000*		
Q3	Does not Listen	0.164	0.024	5.535**	0.003		*Non-uniform DIF
Q4	Abandons Tasks	-0.009	0.024	-9.067**	0.000*		*isiXhosa scored higher
Q5	Disorganised	0.025	0.024	-13.060**	0.000*		*isiXhosa scored higher
Q6	Avoids Engaging Tasks	0.114	0.024	1.729	0.603	*Boys scored higher	*isiXhosa scored higher
Q7	Loses Equipment	0.522	0.023	15.370**	0.000*		
Q8	Distracted External Stimuli	-0.127	0.025	8.088**	0.002	*Boys scored higher	*All languages, isiXhosa scored lowest
Q9	Forgetful	0.358	0.025	-5.612**	0.000001*		*isiXhosa scored higher
Impulsiveness							
Q10	Fidgets	-0.405	0.023	5.774**	0.000*	*Boys scored higher	*All languages, isiXhosa scored lowest
Q11	Leaves Seat	-0.040	0.023	-4.731**	0.000*	*Boys scored higher	*isiXhosa scored higher
Q12	Runs Excessively	0.445	0.024	-0.964**	0.000*	*Boys scored higher	*isiXhosa scored higher
Hyperactivity							
Q13	Noisy	-0.102	0.023	2.721**	0.869	*Boys scored higher	*isiXhosa scored higher
Q14	Over-Active	0.182	0.023	5.970**	0.002		*Non-uniform DIF
Q15	Talks Excessively	-0.607	0.023	3.396**	0.003	*Girls scored higher	*Non-uniform DIF
Q16	Blurts out answers	0.155	0.023	3.350**	0.057		
Q17	Problem waiting turn	0.227	0.023	-9.675**	0.000*		
Q18	Interrupts	0.145	0.022	-6.036**	0.000*		

*Significant with Bonferroni correction; ** Large fit residual (+/- 2.500)

The analysis used stacked data from both beginning-of-year and end-of-year assessments. The chi-square was significant for all three constructs (p = 0.00), indicating that, overall, the data did not fit the Rasch model. Statistically significant items with large fit residuals (±2.5) were considered potentially problematic (Andrich & Marais, 2019). Nine of 18 items showed both high fit residuals and significant misfit to the model. We retained the six-point scale because fewer children are expected at the extreme ends of the scale, and we found ordered categories.

The constructs of hyperactivity, inattention and impulsivity had high-reliability coefficients for items (> 0.90) and persons (> 0.80). After closer inspection, misfitting items for each construct were detected and a lack of measurement invariance was identified for both gender and LoLT. Despite having the same underlying trait scores, boys were more likely to be rated highly for several items; the same was found for isiXhosa LoLT children. After consulting subject matter experts and the body of scholarship, we concluded that the ADHD constructs function differently for boys and girls, and for respective language groups (Millenet et al., 2018). Measurement invariance does not hold if the construct is not understood in the same way for different groups within a population (Combrinck, 2020). Conducting separate analyses for gender and language of learning improved the models and warrants further qualitative research.

Earlier epistemological surveys reported a lack of cultural differences on ADHD ratings and similar prevalence across groups (Meyer, 1998; Meyer et al., 2004). Studies which investigated the validity of ADHD instruments focused on predictive validity in the South African context (De Milander, Schall, De Bruin & Smuts-Craft, 2020; Mabaso, Richter & Hsiao, 2016). However, these studies did not assess the instruments' internal reliability and validity with modern psychometric theory. The internal reliability and validity should be investigated when teachers from different backgrounds have divergent perceptions of behaviour and symptoms of ADHD and its severity (Kern, Amod, Seabi, Vorster & Tchounwou, 2015). Acknowledging limitations in previous instruments (Aase, Meyer & Sagvolden, 2006; Meyer et al., 2004) enabled us to investigate the psychometric properties of the ADHD triad (APA, 2013). We found, in contrast to previous studies (Meyer et al., 2004), differences in ADHD constructs across language groups. In our study, we did not focus on prevalence but did find that prevalence differed among language groups, with the Afrikaans LoLT group reporting the highest prevalence for an ADHD classification (7%), in comparison with the English LoLT group (3%) and the isiXhosa LoLT group (5%). The overall prevalence is close to reported studies for South Africa, a reported prevalence of 5% with some ADHD combination classification (Vogel, 2014).

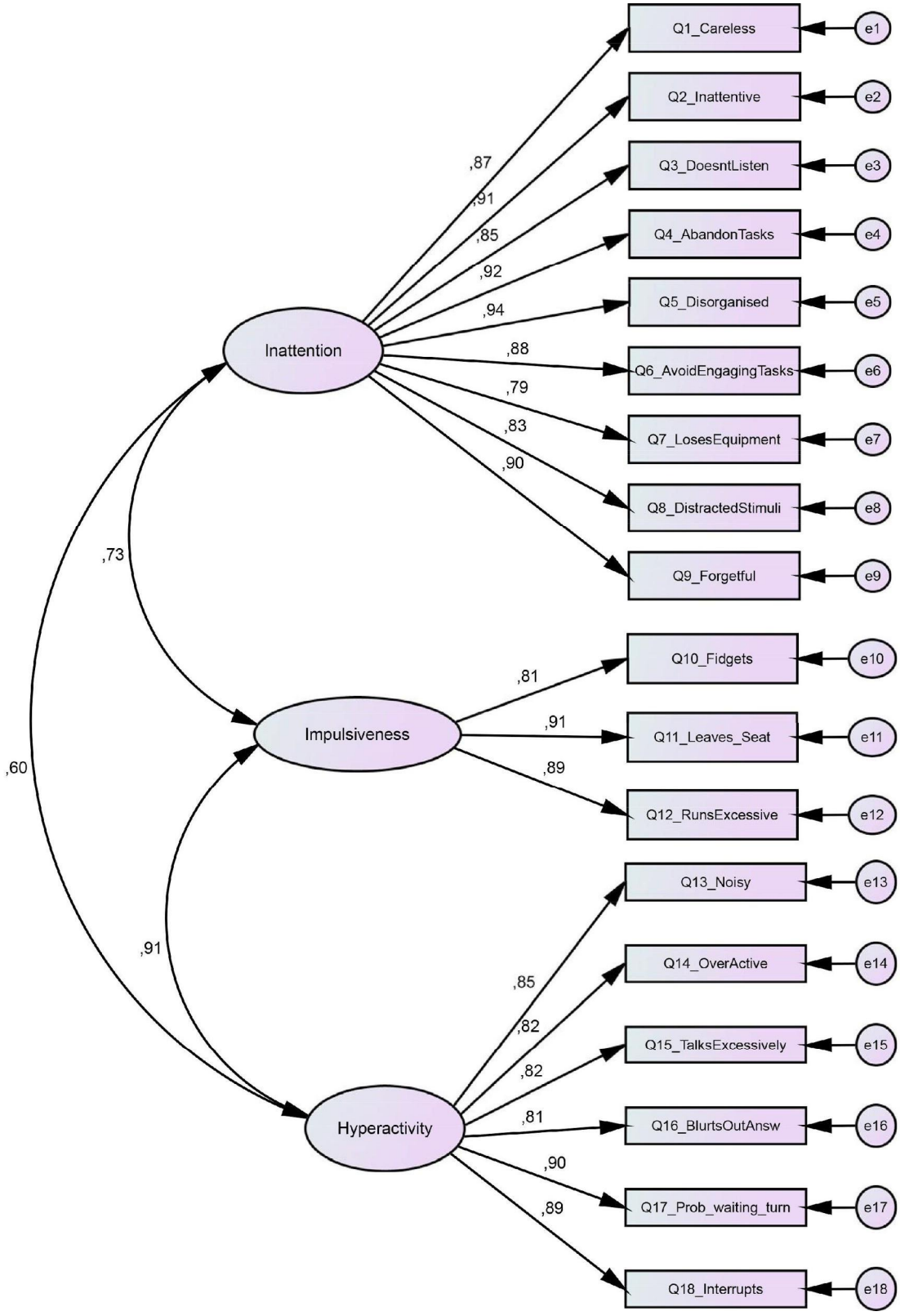

Figure 2: Confirmatory Factor Analysis of ADHD items per construct

Confirmatory Factor Analysis

CFA findings show the items loaded well onto the triad of ADHD latent traits, namely inattention, impulsiveness and hyperactivity (see Figure 2).

The latent traits were strongly correlated; for example, inattention and impulsiveness (r = 0.730, p = 0.000), provided evidence for the entire ADHD construct. The CFA had a significant chi-square, χ^2 = 4564.498 (p = 0.000), which indicates that the model can be improved. The normed fit index (NFI = 0.929) was above the specified 0.900 as required. The goodness of fit (GFI) value was 0.849, close to the ideal value of 1.000. The RMSEA of 0.103 was higher than the desired value of 0.08. However, the CFI (0.931) and the TLI (0.919) values accorded with the guideline value of higher than 0.90. Large modification indices (MI) were found, but there were no theoretical reasons to correlate error terms. Separate models for gender and language groups reduced the chi-square value and improved the model fit without reducing item loadings, providing further evidence that the groups were heterogeneous. Items loaded highly and significantly onto their latent traits and CFA further indicated acceptable model fit statistics except for a significant chi-square and RMSEA. When gender and language groups were analysed separately in the CFA, both the chi-square and model fit statistics improved. The inattention construct had

a negative, moderate and significant association with both reading and numeracy when background variables were held constant. Screening for any type of ADHD also correlated with lower achievement on both reading and numeracy and the regression models provided evidence for the predictive validity of the ADHD-BRS. Based on our evidence, the ADHD-BRS is considered appropriate for South African use, as long as the gender and language of learning groups are analysed separately. The finding aligns with the studies of Asherson et al., (2012), Lopes et. al. (2009) and MacDonald et al. (2019) who researched how cultural differences influences in-service teachers perception of ADHD symptoms. Differences in perceptions of ADHD constructs can result in higher scores among some groups (Bevaart et al., 2014; Imada, Carlson & Itakura, 2013; Morgan, Hillemeier, Farkas & Maczuga, 2014). Our findings also indicate different perceptions of the in-service teachers who screened and rated the children. It is again noted that in-service teachers, from diverse cultural groups, have varied understandings, perception and approach to children with ADHD in the classroom (Bevaart et. al., 2014; Lopes et al., 2009). How children with ADHD carry themselves in social situations may also play a role in how they are perceived as skills such as regulating their emotions are acquired and reinforced at home and in school (Breaux, McQuade, Harvey & Zakarian, 2018). The differences across cultural/linguistic groups

(Afrikaans, English and isiXhosa) warrant further investigation. Researchers should consider the perceptions, education and frame of reference of in-service teachers who screen and rate for ADHD symptoms together with how children are socialised in unique ethnic, school and home environments.

Predicting literacy and numeracy scores from ADHD scores

The standardised regression coefficients (β) and their significance levels for the iPIPS reading and numeracy scores is showed in Table 3. Overall, the reading model produced R^2 = 0.32, while the numeracy model produced R^2 = 0.28. Both models explain a moderate amount of variance – approximately a third of the reading and numeracy scores variance.

Predictors that were statistically significant but had negligible effect sizes were gender, learning in Afrikaans and schools with many physical and people resources. Learning in English had a small but significant relationship with reading scores (β = 0.118, p = 0.00). A high inattention score is the one predictor that had a moderate, negative relationship with reading scores (β = -0.468, p = 0.00) and numeracy scores (β = -0.476, p = 0.00).

The negative effect of ADHD ratings was less influential in English LoLT schools than other languages of learning. The isiXhosa girls showed significantly higher mean scores for both reading and numeracy than the isiXhosa boys.

Table 3: Multiple linear regression model predicting the end of year reading & numeracy scores

	Reading *β*	***S.E.***	***p***	**Numeracy *β***	***S.E.***	***p***
Constant	61.701	1.876	0.000**	65.250	1.783	0.000**
Gender (boy/ girl)	0.023	0.504	0.260	-0.056	0.530	0.007*
Learners per class (less than 35/ more)	-0.034	0.609	0.146	-0.017	0.641	0.480
Language (LoLT) English	0.118	0.795	0.000**	0.079	0.836	0.011*
Language (LoLT) Afrikaans	0.026	0.666	0.297	-0.071	0.701	0.000**
SES school has moderate resources	0.034	0.833	0.204	0.030	0.877	0.281
SES school has many resources	0.097	1.285	0.015*	0.034	1.352	0.403
SES home has moderate resources	0.046	0.836	0.068	0.022	0.880	0.401
SES home has many resources	0.117	1.257	0.003*	0.117	1.323	0.003*
Quintile 4 schools	0.055	1.240	0.066	0.026	1.304	0.405
Quintile 5 schools	0.104	0.854	0.000**	0.110	0.898	0.000**
Independent schools	0.053	1.031	0.096	0.063	1.085	0.055
Attended Grade R (no/yes)	0.013	0.578	0.563	0.019	0.608	0.386
Hyperactivity	0.061	0.474	0.188	0.069	0.499	0.145
Inattention	-0.468	0.287	0.000**	-0.460	0.302	0.000**
Impulsivity	0.043	0.364	0.253	0.027	0.383	0.476

*$p<0.05$; **$p<0.01$

Inattention as a predictor of lower reading and numeracy outcomes aligns with Garner et al.'s (2013) research. They reported that in-service teacher ratings were higher when screening for inattention and were significantly correlated with academic impairment. Castagna, Calamia, Roye, Greening and Davis (2019) found that inattention shared comorbidity with lower executive functioning and anxiety in young children. Inattention, hyperactivity, and impulsivity predict certain behaviours; for example, hyperactivity/impulsivity is a predictor

of substance abuse (Chang, Lichtenstein & Larsson, 2012). Unravelling the effects of the triad symptoms is crucial for understanding risk factors associated with each combination of diagnosis. The current study contributes to understanding the unique impact that high inattention scores have on young children's academic achievement and indicates it as a potential risk factor.

Implications for research and practice

The ADHD-BRS can be used in South Africa when the scores for gender and different language groups are analysed independently. Further qualitative research is needed to understand why: (1) ADHD is perceived as being different for gender and language of learning groups, (2) why the effect of ADHD ratings do not affect English LoLT learners in the same way as other language groups, and (3) why in-service teachers in ill-resourced schools with LoLT other than English, tend to rate more learners highly on the ADHD constructs (see Figure 3).

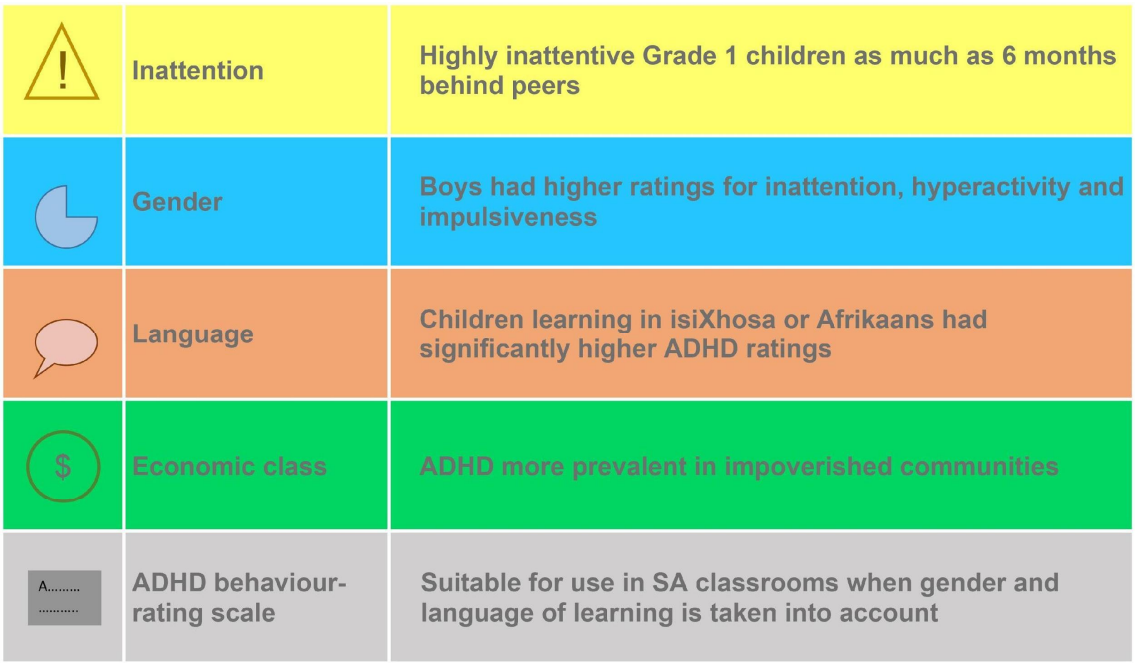

Figure 3: Main findings from the study

Limitations of the study and suggestions for further research

We conducted the study in one of the nine South African provinces, with only three of the 11 official language groups. The findings cannot be generalized to the other eight South African language groups. The presence of cultural differences in ADHD ratings requires more qualitative investigation to understand if they should be attributed to in-service teacher perceptions of ADHD and/or socialisation differences among groups. Future research should investigate how in-service teachers from diverse backgrounds interpret the severity of inattention, hyperactivity and impulsivity. More research is needed to understand socialisation differences between ethnic groups and how this relates to the ADHD triad.

Conclusion

Both gender and the language of learning and teaching (LoLT) are associated with ADHD and lower reading and numeracy achievement. Factors such as socio-economic status, gender and home language intersect to aggravate the disorder. The findings align with other national studies, which found that poverty, gender, school location and ethnicity intersect so that boys from rural or township schools learning in an African language comprise the most vulnerable group (Howie et al., 2017; Reddy et al., 2016; Reygan & Steyn, 2017; Van der Berg & Hofmeyr, 2018). In-service teachers can use the ADHD behaviour-rating scale (ADHD-BRS) to screen and potentially identify children for referral and proper diagnosis. Interventions should be considered for children with high inattention scores as this predicts significantly lower academic achievement. Interventions should target the most vulnerable groups, especially children in impoverished communities learning in African languages.

Data availability statement

Data not available due to ethical restrictions. Due to this research's nature, participants of this study did not agree for their data to be shared publicly, so supporting data is not available.

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