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DEVELOPMENT OF FUNCTIONAL COGNITIVE SCALE FOR CHILDREN AGED 7-12 YEARS: A NEGLECTED DOMAIN IN PAKISTAN

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ABSTRACT
Several tools have been developed in the west on cognitive and other developmental skills in children. However, in Pakistan, outdated versions of western measures are used to assess the abilities of children. The current study aimed to develop and assess the Functional Cognitive Scale (FCS) for children of age 7-12 years on basis of local norms. A sample of 377 children with mean age = 9.60, SD=1.61 was selected through multistage sampling technique from different public schools of the city of Lahore, Pakistan. FCS was constructed by extracting items from open-ended interviews with parents, teachers, reviewing the literature and curriculum, consulting the experts, and carrying out series of pilot testing. Factor Analysis using maximum likelihood and oblique rotation extracted two sub-factors namely simple cognitive skills and complex cognitive skills. Confirmatory factor analysis revealed a good fit model with a similar factor structure as retained by exploratory factor analysis. FCS was found to have 20-items with sound psychometric properties α= .86, split-half .89, test-retest reliability=.82 with good convergent validity with Wechsler memory subscales. Results are discussed in terms of the need of developing the scale for measuring the functional cognitive abilities of children in their cultural context.
Keywords: Cognitive Skills, psychometric study, local norms, school, 7-12 years

INTRODUCTION
The terms IQ, intelligence, and cognitive abilities have been used alternatively in literature. In the current study, the expression of cognitive skills was used instead of using terms like IQ or Intelligence. IQ has a strong correlation with the scholastic abilities of children irrespective of a person's education, culture, parenting practices, and so on (Akubuilo et al., 2020; Mahmood, 1991). Both concepts depend on the universal and compulsory education of the children, therefore, they seem less applicable in a country like Pakistan, where there are three different systems of education including *government*, *private*, and *madrassa*; having no common grounds, marked differences in teaching methodology, syllabus and evaluation systems (Naeem, Mahmood & Saleem, 2014; Zahra et al., 2020). As IQ and academic achievement are highly correlated, therefore, it may be less applicable in a culture with a poor education-seeking trend (Scorpio et al., 2018).

Cognitive skills refer to *the ways that one remembers, reasons, holds attention, thinks, reads, and learns* (De Ribaupierre, & Lecerf, 2017). They also involve the ability to read, write and use mathematical operations (American Psychiatric Association, 2013). Formal schooling of the child plays a vital role in determining his cognitive performance of various tasks (Borghans, 2015). The term *function* is implied to fulfill a purpose or to have usefulness to something or someone. The functional cognitive skills must be relevant to children's lifestyles and allow them to be successful in their daily activities in and outside the

school (Slaton et al., 1994). Furthermore, these skills must include specific responsibilities expected from them by the people in their surroundings. Assessment in cognitive skills provides a yardstick to measure a child's skill acquisition according to his age (Bellman & Byrne, 2016).

REVIEW OF LITERATURE

Cultures have cognitive styles that differ significantly in ways how cognition is understood. East Asian and Western cognitive development differ due to the interaction children have with symbols, tools, and with the members of their culture (Barrett, 2020). As tests are sensitive to the culture in which they are used, therefore, the process of accurate assessment of cognitive skills is hampered due to the use of inappropriate or irrelevant tools (Rock & Price, 2019). The trend to assess cognitive skills of children is less in third world countries as compared to the west. There is no specific tool with local norms in Pakistan to measure the cognitive skills of children. Obsolete tests and older versions of tests are used to measure the skills of children. Cost issues and training are a few of the reasons that older versions are preferred. For example, Solloson Intelligence Scale-R (SIT; (Nicolson &Hibpshman, 1991) different developmental based tools such as ae Portage Guide to Early Education (PGEE; Bluma et al., 1976), Vineland Adaptive Behavior Scale (VABS; Sparrow et al., 2005) Children's Adaptive Behavior Scale (CABS; Richmond &Kicklighter, 1980) have been used in different institutions and by different practitioners without any standardization. The ability to acquire cognitive skills is dependent on parental practices, cultural and environmental demands, and educational requirements. Therefore, it is unfair to evaluate the abilities of children by comparing them with unstandardized measures for a particular culture.

According to Piaget children, age 7-11+ years are characterized by decentering, involving concrete operations, understanding the concept of reversibility, and demonstrate inductive reasoning, numeracy, and mathematical literacy (Babakr, 2020). It also requires the recognition of shapes, dimensions, symbols, and words. The everyday use of numeracy skills requires attention span, mental control, and memory (Gravemeijer, 2017). In our money-driven society, arithmetic-based cognitive skills help children seek independence and enhance their ability of age-appropriate working, earning, and spending abilities. Kids in today's time are buyers, shoppers, and spenders (McNeal, 1992) therefore, families increasingly allow their children irrespective of their gender to help parents in such domestic responsibilities.

The concept of functional cognitive skills implies that children can use their higher-order abilities to practice age and culture-appropriate tasks. Therefore, the current study aims to develop a culturally relevant tool to measure specific, age, and culture expected cognitive skills of children.

METHOD

The study was carried out in different phases

Item construction phase through the interview

Parents were interviewed to find out the cognitive abilities of children age 7 to 12 years. The purposive sampling technique was used to carry out in-depth interviews of 26 parents of children age 7 to 12 years. The purposive sampling technique was used because the lack of availability of parents restricted the use of a probability sampling technique. They were asked "*what cognitive skills does your child of e.g. 7 years exhibit at school and home*? Teachers were interviewed to gain more information about the cognitive skills of the children. Eight teachers' having16 years of education and a minimum of three years of experience working with public school children were interviewed. While explaining cognitive skills teachers mostly highlighted money handling skills and different mathematical skills. Verbatim were extracted from the interviews. As teachers explained the skills based on the curriculum of the child, therefore, we thoroughly reviewed the curriculum of grades 1-6 which corresponds to age 7-12 years.

The key content of these grades is given in table 1. The contents were developed based on cognitive skills highlighted by Piaget.

Table 1

Sample of Cognitive skills identified through curriculum

Sr#	Cognitive Skills
1.	Concept of Quantity: few, more, little
2.	Size: big/small
3.	Shape
4.	Position: before and after
5.	Number recognition
6.	Seriation
7.	Arithmetic operations
8.	Addition
9.	Subtraction
10.	Multiplication
11.	Time concept
12.	Money Recognition
13.	Money handling

As literature always provided an evidence-based guideline regarding the selection of items therefore commonly used measures to assess cognitive skills in children were also reviewed. The cognition relevant items from Vineland Adaptive Behavior Scales, (VABS-II; Sparrow et al., 2005), Children's Adaptive Behavior Scale (Richmond & Horn, 1980), Portage Guide to Early Education (Bluma et al., 1976), and Developmental Profile-II (DAP-II; Eyubova & Kalibatseva, 2013) were reviewed.

Finally, keeping in view the parent's and teachers' interviews, contents of the curriculum, and review of the literature, items were extracted. These items were based on commonality, cultural preferences (as indicated by parental interviews), and academic skill requirements (as indicated by teachers' interviews). The advantage of taking a parental interview rather than merely relying on literature-based items helped in revealing cultural and linguistic expression.

As a result of the initial step total of 32 items were generated. These items were arranged in an order of increasing difficulty which was determined by keeping in view the sequence of items appearing in different adaptive measures, the grade-wise curriculum of the child, and by the researcher's own clinical experience. Response options 0 and 1 were chosen for evaluating the items.

Content validity and Pilot testing

Three child psychologists having a minimum of three years of experience working with public school children were given the list of items for content validity. It was suggested to change the order of three items and excluding of 12 items found overlapped and/or too easy or too difficult for the given age range. Picture format was suggested for five items to ensure the easy and interesting administration of the scale such as telling time from the clock, money recognition. About 80% agreement was found on pictures selected for five items requiring visual prompts. A final list of 20 items was pilot tested on 10 % of the actual sample taken from public schools

Main study Phase

The departmental ethical committee approved the project for any ethical concerns. Permission was taken from public school authorities as well as participants of the study. A sample of 190 participants including girls and boys with age range 7-12years M_{age}=9.60 *SD* 1.61 were selected for the study. Children having any physical disability or sensory issues were excluded from the study. Out of the total sample, 58% of the participants lived in the nuclear family system and 41 % lived in the joint family system. About 51% of the participants had no idea about their parental education. Measures of the study included Digit Span (measuring attention and immediate recall; Wechsler, 1981), Coding Test (a subtest of Wechsler Intelligence Scale for School Children to measure speed and accuracy; Wechsler, 1955), Mental Control test (to assess attention and information processing; Wechsler, 1987) along with indigenously developed Cognitive Scale.

RESULTS

To find out the underlying factor structure of the cognitive domain exploratory factor analysis was carried out through Maximum likelihood by using Oblique rotation. Further, the Kaiser- Myer-Olkin Measure of Sample Adequacy (KMO) was .88, and Bartlett's test of sphericity was significant ($p<0.001$) as well. Both parameters are used to determine the adequacy of the data which should be $\geq .70$ with alpha level ($p<0.05$; Field, 2013). The number of factors of the scale was determined based on Kaiser's criteria of retaining factor with Eigenvalues >1 (Kaiser, 1994). In addition to it, visual examination of scree plot as suggested by Cattle (1966) was employed to determine the number of factors. Cronbach's Alpha and was found to be .86.

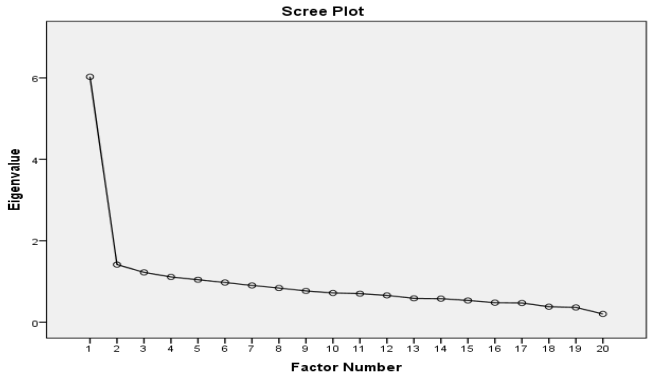


Figure 1: Scree Plot of Cognitive Domain

Two, three, and four-factor solutions were tried however, the two-factor solution was found to be the best fit and more illustrative for the cognitive domain. The two-factor analysis accounted for 57% of the variance explained and the strength of communalities ranged from .30 to .50. The factor loading of all the items was>.30. Items did not suffer from problematic cross-loading except item 8 which was retained to the factor based on its expected association of subfactor according to the researcher's judgment. The factor loadings of 17 items are shown in table 2.

Table 2 *Factor loadings of Cognitive Scale items*

Sr#	Cognitive Scale items	Factor Loading	
		1	*2*
Factor 1:	item		
1.	1	**.30**	00
2.	6	**.56**	.16
3.	7	**.79**	00
4.	8	**-.31**	
5.	13	**.48**	.26
6.	14	**.54**	.15
7.	15	**.52**	.01
8.	17	**.39**	.28
9.	18	**.47**	01
10.	19	**.45**	02
11.	20	**.49**	-.26
Factor 2:			
12.	2	.17	**.61**
13.	4	00	**.55**
14.	5	00	**.37**
15.	8	-.31	**.64**
16.	11	-.17	**.85**
17.	12	00	**.38**
18.	16	.20	**.38**

Note: N= 377. The extraction method was principal axis factoring with Promax rotation Factor loading above .30 is boldface.

Table 2 indicated a two-factor solution of the cognitive domain of the scale. Each factor was labeled according to the commonality of the theme underlying each factor. Two items were dropped as they did not load on any factor.

Factor description

F1: Complex arithmetic skills

This factor comprised of the complex arithmetic skills of which older age children could perform such as the concept of time, multiplication, and ratio questions.

F2: Basic arithmetic's skills/sequencing

This factor comprised of simple skills which children of a younger age could easily perform. This included questions of sequencing, addition, and subtraction.

Confirmatory Factor Analysis (CFA)

CFA being second-order analysis was carried out to validate the factor structure of adaptive domains. To carry out the CFA questionnaire was again administered on 188 children between age ranges 7-12 years. The analysis was carried out using the AMOS software. The CMIN value or Chi-square adjustment text (χ) of Pearson was measured which was 149.222 with p=0.001 being statistically significant. The index of comparative adjustment (CFI), the root mean square, error of approximation (RMSEA), and the Tucker-Lewis index (TLI) are the most relevant indexes as calculated in table 4 (Sánchez-Oliva,2016). The results of the diagram showed standardized values above .10 (Nagy et al., 2017) as all values ranged from 0.24 to 0.74.

Table 3

Confirmatory Factor Analysis of Cognitive Domain (N=188)

	χ^2 (df)	x^2/df	CFI	GFI	TLI	RMSEA	SRMR
Model 1	149.922(76)	1.97	.94	.95	.93	.05	.02

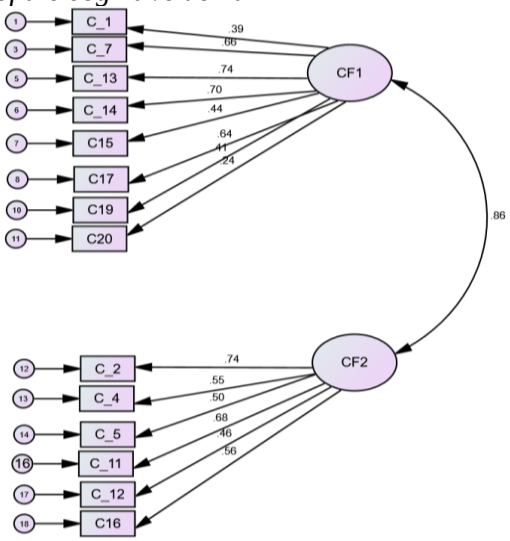
Note. χ^2 = chi-square; CFI = comparative fit index; GFI = goodness of fit index; TLI = tucker lewis index; RMSEA = root mean square error of approximation; SRMR = standardized root means square residual.

The table shows that a good fit model was achieved in the first model tried without adding any further covariance. After carrying out the CFA Cronbach's alpha was rerun and was found to be .83.

The correlation analysis revealed that Cognitive Scale total had significant positive correlation with digit forward(r=.18,p<0.01), digit backward (r=.42, p<0.001), coding score (r=.49,p<0.001), mental control set A (backward counting; r=.53,p<0.001) set B (Alphabets; r.28, p<0.001). Digit forward had significant positive correlation with digit backward score (r=.28,p<0.001) and mental control set A (r=.11, p<0.05). However, digit backward had a highly significant positive correlation with coding score (r=.31, p<0.001), mental control set A (r=.32, p<0.001 and mental control set B r=.21,p<0.001).

The test-retest score of the cognitive scale was found to be .82 and the Guttman split-half reliability coefficient was found to be .84, for the part I .77 and for part II .78 which showed that scale can be used as form A and B.

Figure 2: CFA diagram of the cognitive domain



Note: Root diagram showing acceptable factor loads (standardized values)

DISCUSSION

The current study aimed to develop a functional cognitive skill in children of age 7-12 years. Research pieces of evidence indicated cultural differences among eastern and western individuals and suggested that cultural knowledge shapes the way we think behave and analyze (Wang & Yang, 2019). The factor analysis in the current study revealed two kinds of cognitive skills including *simple* and *complex* skills which correlate well with theories of development. Piaget's theory has well documented the fact that development in children is steady and gradual. Each stage in child development lays the foundation of the later complex skills (Choifer, 2021).

The first-factor *simple cognitive skills* consisted of abilities required during initial years such as recognizing and counting numbers, performing simple arithmetic operations, identifying similarities and differences among shapes, size of objects, and quantities. Further, they learn to manipulate *complex* arithmetic operations and their reasoning and abstract thinking ability are sharpening (Stoltz, 2018). Providing hands-on experience in real-life situations may foster cognitive development in children. Public school children in Pakistan mostly belong to lower or middle socioeconomic status families (Pradhan, et al., 2020). Many children work with their parents after their school time as a result their certain cognitive skills such as handling money, time concept, and other arithmetic abilities, are enhanced. Children from their early years are frequently given the responsibility to buy small daily-use items like groceries. Therefore, the second factor of cognitive skills highlights *street* cognitive skills which are different from what is measured by different intelligence scales (Lara & Saracostti, 2019).

The functional cognitive abilities may be considered as the domain where everyday reasoning is studied. Children also need these skills to shop from their school canteens. Those who work with their fathers sometimes may have to handle buying/selling, and money matters all alone (Ambetsa, 2016).

CONCLUSION

The functional cognitive scale was found to be a reliable scale with sound psychometric properties based on the concept of developmental theories. The items represented the skills that are expected of their age and Pakistani urban culture. It has further highlighted that a significant positive correlation was revealed among cognitive skills, scores of digit span, coding, and mental control.

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