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Cognitive training, cognitive abilities, and behavioural problems among children living below the poverty line in India

Abstract

Population-based studies show association between socioeconomic condition and cognitive performance. The aim of the present study is to identify cognitive strength and weakness, along with behavioural problems in the children living below the poverty line, exploring correlation among them and finally to understand the effect of cognitive training on the identified area of weakness of the children.

The study was conducted in two phases. Phase 1- 23 children aged 9–12 years were assessed using the KABC–II. Behavioural problems were evaluated using the CBCL-TRF. Phase 2- 14 children participated in a cognitive training programme tailored to their individual areas of weakness.

Areas of cognitive strength and weakness along with behavioural problems were identified, correlation was recognized between certain cognitive abilities and behavioural problems, and improvement was noted in the children in the post-intervention measures of cognitive training suggesting that structured cognitive training may facilitate improvement.

Keywords: cognitive ability, cognitive training, behavioural problems, below-poverty-line, children

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Introduction

The world is undergoing rapid changes, with the advent of technology, the systematic jobs will soon be taken over by machines, while the need for skills will gain more weightage. The cognitive capacity of humans requires harnessing with care and commitment more than ever before. India as a developing country meets this new era with its immense potential human resources, shackled by the circumstances that restricts the utilization of their capacities. According to the National Multidimensional Poverty Index, approximately 160 million people in India continue to experience multidimensional poverty.[1] Children growing up in households living below the poverty line (BPL) are particularly vulnerable to developmental disadvantages, placing their cognitive potential at risk of remaining unrealized, the overarching aim of this study in such a setting, is an attempt to explore the role of cognitive intervention among children who lives in the low socio-economic condition in India.

Cognition, broadly includes aspects of learning, capacity of remembering, using the acquired information and comprehending our social world.[2] The aptitude for carrying out mental processes, problem solving, adaptation, comprehension, reasoning, knowledge acquisition, abstract thought, and making connections[3] is termed as cognitive ability. Socioeconomic Status (SES) is an index widely used to define a family's economic and social status in a society. The index combines three factors as a measure of SES: family income, years of education, and occupational status and skills. Association of low family's SES with lower performance across multiple cognitive domains of the child, including memory and executive functioning has been established, and has also been related to differences in brain development.[4–8] Two of the greatest environmental influences on cognition related to SES are exposure to stress and the lack of environmental enrichment and stimulating experiences.[9] Low-SES children have fewer opportunities for learning and positive development of cognitive abilities in that they have less exposure to cognitively challenging tasks in comparison to children from high-SES.[5]

In their review on cognition and low-SES children, Parks et al. included ten academic articles involving some kind of cognitive assessment of these children, of which only one was conducted outside the Western world. The available studies focus primarily on general cognitive ability and academic achievement, which has led researchers to express the need for more studies exploring the specific cognitive abilities of these children, for example, executive functions.[10] This particular study planted in a low-SES community and in India adds an important dimension to the existing literature.

In this context, a study was conducted by Richter and van der Walt that compared South African low-SES children, primarily not schooling with native South African school children as well as with that of the Western norms.[11] The findings indicated a great difference within the group of not schooling low-SES children on the measures of cognitive tests. The mean results of the street children were below Western norms of the cognitive tests that were taken as measures. When compared to the native school children, however, the street children in the study performed at par on them. According to the authors, these cognitive abilities may develop both in school and in a demanding street environment. In another study based on a sample of Colombian street children, Aptekar found that the children performed approximately one standard deviation below Western norm of cognitive test, also with large within group differences.[12]

The effectiveness of Cognitive Training for has been appraised in a number of studies. The majority of the studies speaks of its effectiveness, when it is assessed by conventional tests of general fluid intelligence. Cognitive training involves using cognitive tasks or intellectually demanding activities, with the general goal of enhancing cognitive ability.[13,14] Research in this domain ranges from basic science highlighting the probability of maximizing the brain changes in response to experience to applied work that aims at cognitive

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training to improve the lives of individuals in the real world.[15–18] Since late eighties, various programs to enhance children's cognitive abilities have been developed and published across Europe, especially in Germany, the Cognitive Training for Children being one of them. It was originally designed to enhance children's inductive reasoning ability by Klauer.[19]

In the context of shaping cognitive and behavioural developmental processes across childhood, neural plasticity plays a critical role. It refers to the capacity of the brain to exhibit persistent structural and functional change, can take different forms, including the formation and elimination of synaptic connections, the modification of synaptic weights as well as the reorganization of brain networks and connections.[20] Environmental factors play an important role in such development. The effects of particular external changes in the environment may be particularly high during certain developmental periods, in which children and adolescents show increased sensitivity to specific environmental inputs.[21] Internalizing behaviours like emotional problems and externalizing behaviours like conduct problems are among the most common mental health concerns experienced by children, adolescence and youth worldwide.[22] Poverty increases the exposure of children to various adversities including familial conflicts, economic crisis and reduced access to necessary resources that contribute to their internalizing and externalizing behaviours.[23]

Contemporary research on socioeconomic status and cognitive training

A range of studies have examined the effects of cognitive training on working memory and executive function in children,[22,24] and majority of which concluded that cognitive training is a potential means of improving executive function performance among individuals from low-SES backgrounds. Despite some of these studies being conducted with low-SES populations,[25] very few of them systematically evaluate the relationship between SES and the outcome of the intervention.

A large-scale cluster-randomized study of a childhood intervention was conducted in 2014 compared the effectiveness of cognitive interventions for children from different SES backgrounds. Blair and Raver noted positive improvements in executive function and reasoning compared to a passive control group after cognitive training.[26] Another similar study that focused on reasoning training with a large number of middle school student reported similar improvements in reasoning ability following training among both high- and low-SES children.[27] Both of these studies provide some early evidence that SES necessarily is not a roadblock in benefiting from a cognitive training intervention. Furthermore, it can also be understood from these studies that similar styles of intervention may be helpful for children regardless of SES level, and may even be more effective for those from impoverished backgrounds as it enables them access the resources which is otherwise unavailable to them.

Cognitive training interventions in the Indian context

Research on cognitive training has predominantly been done in the country on an institutional basis. One study, in this area, indicated cognitive deficits can affect students' performance in schools. In the study, an effort to enhance cognitive skills through integration of a neuro-cognitive training called 'Brighter Minds', was made in the government schools of South India during 2017-18. Students went through a pre and post training evaluation, using a mixed methods study design to assess changes in attention, observation and memory, outcome demonstrated statistically significant gains in all the three cognitive traits.[28] Apart from this, skill-based intervention program was conducted by the department of psychology of University of Calcutta on children who were in conflict with law.[29]

In a nutshell, there have been several evidences from the previous research that socio-economic status has significant effect on cognitive functioning, however majority of the work is based on the western population. The novelty of work also lies in the fact that this study is an attempt to build an understanding of the implications of cognitive training on the cognitive abilities of these children living below the poverty line, a research area which has remained relatively untrodden in India. The present study was conducted with the objectives of identifying behavioural problems amongst children living below the poverty line, investigating the pattern of relationship between behavioural problems and cognitive abilities of children living BPL, identification of cognitive strength and weakness of children living BPL, finally to find out the effect of cognitive training on the identified area weaknesses of the children.

Methodology

Parents of 78 children, between the age range of 9 to 12 years, hailing from families bearing BPL cards as per the criterion set by the Government of India or Government of West Bengal, living in suburbs of South Kolkata, were approached for the purpose of the study based on the method of convenient or purposive sampling, among them, 34 parents gave consent for participation. Among the 34 participants who initially agreed to participate in the study, 23 participants completed the entire battery and the questionnaire administered and 14 participants were available to be part of the cognitive training programme and completed it.

Brief description of participants:

Age	Mean	10 years, 6 months, 25 days.
	SD	1.21
Sex	Male	13
	Female	10
Religion	Hinduism	20
	Islam	3
Education level	Continuing with formal education	18
	Dropped out	5
Mother tongue	Bengali	16
	Bhojpuri	5
	Hindi	2

Tools used

Information schedule and, parent and children informed assent and consent form: The information schedule is used to gather socio demographic details of the children including name, age. sex, education, medium of education, and academic details of the child. The informed consents were duly signed both by the participants and their parents.

Kaufman assessment battery for children- second edition (KABC-II) with high Internal Consistency (0.70–0.95), Test-retest reliability (0.70–0.90), Inter-rater reliability (0.90) and strong across content, construct, and criterion domains of validity was used to measure mental processing and cognitive ability on four scales namely sequential processing, simultaneous processing, learning ability, planning ability.[30] Furthermore, an Indian adaptation of the KABC-II demonstrated satisfactory reliability and construct validity among Indian children, supporting its use in assessing cognitive abilities within Indian sociocultural contexts.[31]

In this study, the findings from KABC-II have been interpreted by Luria's model, since the study includes - children from a bilingual background, children whose non-mainstream cultural background may have affected knowledge acquisition.[30]

Previous researches have indicated the impact of SES on cognition has been shown to be largest with respect to verbal and academic ability.[5,7] This model of interpretation, allowed us function with tests that are able to measure capacities such as reasoning and visualization without the impact of language or direct academic knowledge. Luria's theory considers acquired knowledge to lie outside the realm of mental processing.

Child behaviour checklist (CBCL)-teachers report form is a section of the Achenbach System of Empirically Based Assessment (ASEBA) with high Internal Consistency (0.78–0.97), Test-retest reliability (0.85–0.97), Inter-rater reliability (0.60-0.75) and is strong across content, construct, and criterion domains of validity.[32] CBCL being a cross-culturally applicable instrument has been widely used in Indian community and clinical populations to assess behavioural difficulties among children, however there is limited psychometric validation.[33,34]

The CBCL-TRF is completed by teachers and provides an outside-of-home perspective on a child's behaviour, especially in a teaching-learning setting.

Procedure of work

To conduct the study, after obtaining institutional ethical clearance for the work (Certificate No: CUIEC/03/29/2022-23), The study was conducted in two phases:

Phase I: Psychological assessment

A comprehensive survey was conducted to identify suitable areas of work. Through this process, a group was identified that provides voluntary educational support to children on a daily basis in a community setting, and a co-functional unit was set up to conduct the study. The consent was taken from the parents and assent was obtained from the participants.

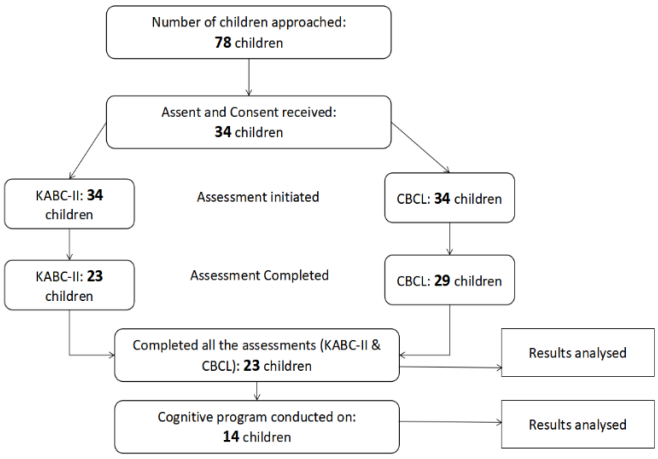
The collection of data began with the information schedule and rapport building with the participants.

Then, the administration of the KABC-II battery was done. The core subtests were given to the children and the data was obtained quantitatively with time limit consideration. This took around 55-90 minutes depending upon the age and cognitive ability of the children. The CBCL was collected from the teachers who were teaching the children voluntarily.

The KABC-II was scored and interim data analysis was performed, to recognize the strength and deficit of each participant.

Post analysis, parental consent and child assent for participation in cognitive training were obtained for 14 children, who subsequently constituted the intervention sample were assigned codes, with which they were referred to throughout the study. The codes were from P1 to P14 and individual areas of weakness (the scale where the participant received least index score) was noted. Importantly, area of training was determined based on relative weaknesses within each participant's individual cognitive profile, rather than solely on whether scores fell within a normative range.

Below is the flowchart depicting the procedure of work.



Phase II: Cognitive training program.

Following that, appropriate cognitive training tasks were decided in an attempt to facilitate enhancement in the identified area of weakness of the participants. The training tasks that were decided were grouped into four groups on four scales and planned on a weekly basis.

The present study is a single-group pre–post intervention design. After the baseline cognitive and behavioural assessment, the children underwent the cognitive training programme and post-intervention assessment. Due to the nature of the study and ethical considerations related to withholding intervention from children identified as having cognitive weakness besides being socio-economically deprived, a control group was not included. Additionally, the randomized controlled trial with a waitlist could not be conducted since the participants are from a crucial developmental age and their psychosocial context is not conducive for delayed intervention.

The programme was conducted daily over a period of twelve weeks (2 weeks orientation followed by 10 weeks of training), with each session lasting approximately 40 to 60 minutes. The sessions followed a standardized intervention protocol and were administered individually by the same interventionist under the supervision of the lead researcher. The training of children was challenging to begin with, given their position in the behavioural problems. It took the researchers two weeks to form appropriate group, engaging the children and develop the orientation towards the training; then children were introduced to the task of letter-number cancellation for two weeks and introduction of the star chart to monitor attendance across the training and a session checklist was completed after each session to ensure adherence to the intervention protocol and consistency of intervention delivery. Once the children were involved, the domain specific task was given, and the children participated in the task as a group. Tasks used were as follows: cancellation task, sequential colouring task, letter number arranging task, sequential recall of sense and non-sense syllables, sorting grains and beads, coding task, board games, semantic recall task, puzzle task. They are described in Table 1. The training program for each of the areas of weakness are depicted in figure 1, 2, 3 and 4 describing the training for Sequential Processing, Simultaneous Processing, Learning Ability and Planning Ability respectively.

Table 1 Description of the task

Training task	Description
Cancellation task	Children had to search for certain target symbols within an array of distractors on a piece of paper and marked the targets as quickly and accurately as possible. The activity aimed primarily to engage sustained attention, selective attention, and visual scanning.
Sequential Colouring task	Children identified numbered shapes and coloured them according to a specified sequence. The task required attention to instructions, and response planning.
Letter number arranging task	In this task, the children were cognitively differentiating the numbers and letters, analyzing them and rearranging them in a given order. This activity involved categorisation, sequencing, and executive control.
Sequential recall of non-sense syllable	In this task, the children practiced remembering the syllables in the exact sequence in which the list was read. This involved, remembering the word as well as the order of the words.
Sorting grains and beads	The children were visually scanning, differentiating the beads or grains based on their shapes/colours/sizes, were simultaneously counting the numbers of grains/beads and placing them in separate groups. This activity required visual discrimination, attention, and coordinated cognitive processing.
Coding task	The children were associating the symbols with the numbers and simultaneously coding them with the correct symbols in the place that were provided. The task engaged associative learning, processing speed, attention, and visuomotor coordination.
Board games	It involved, children calculating the moves, simultaneously noting the moves of the opponent, besides playing two different moves in order to win, thereby planning the moves.
Sequential recall of sense syllables	In this task, the children practiced remembering the syllables in the exact sequence in which the list was read. This involved, remembering the word as well as the order of the words.
Semantic recall task	In this task, the children were learning a list of word in the first place, and associating semantic meanings to the words, which involved, processing of the information using all the functional blocks of Luria.
Puzzle tasks	In this task, the children analysed the different shapes of the jigsaw puzzles and constructed the puzzles, based on the picture provided, planning and integrating the parts together.

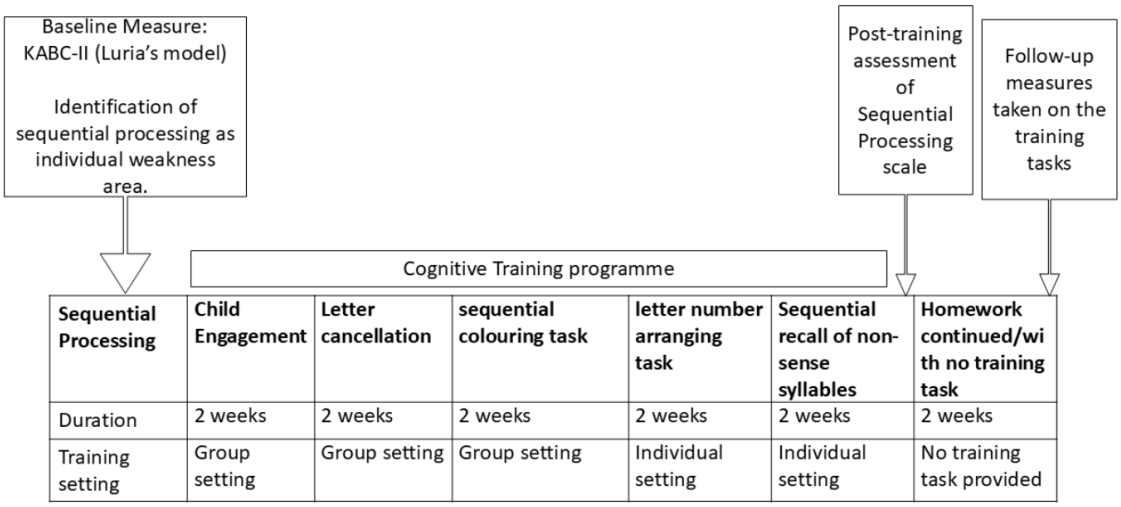


Figure 1 Chart depicting training program for sequential processing.

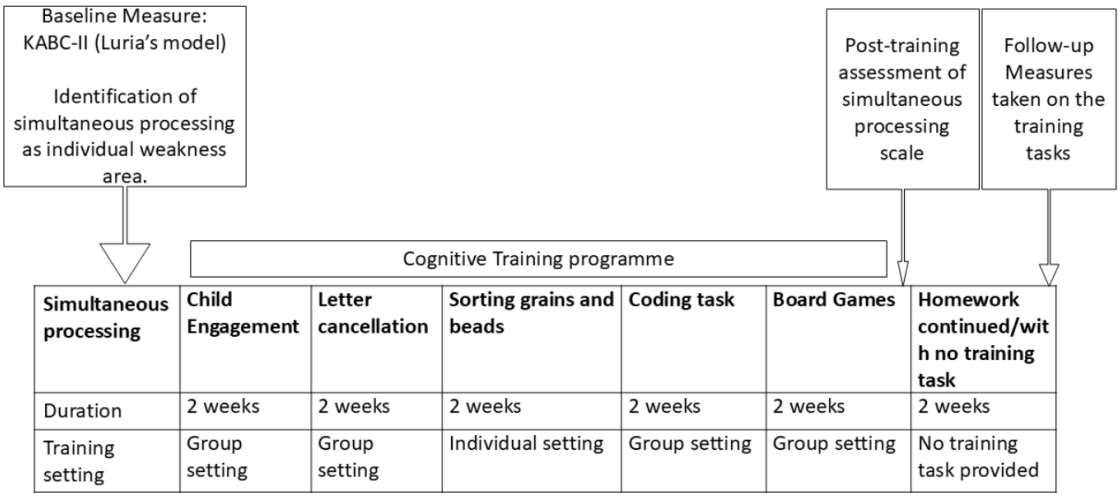


Figure 2 Chart depicting training program for simultaneous processing.

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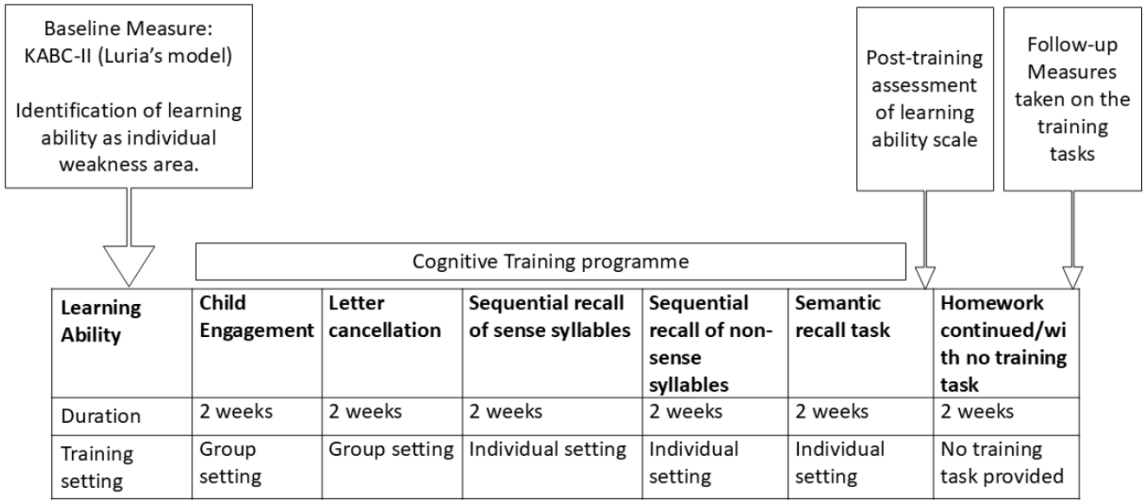
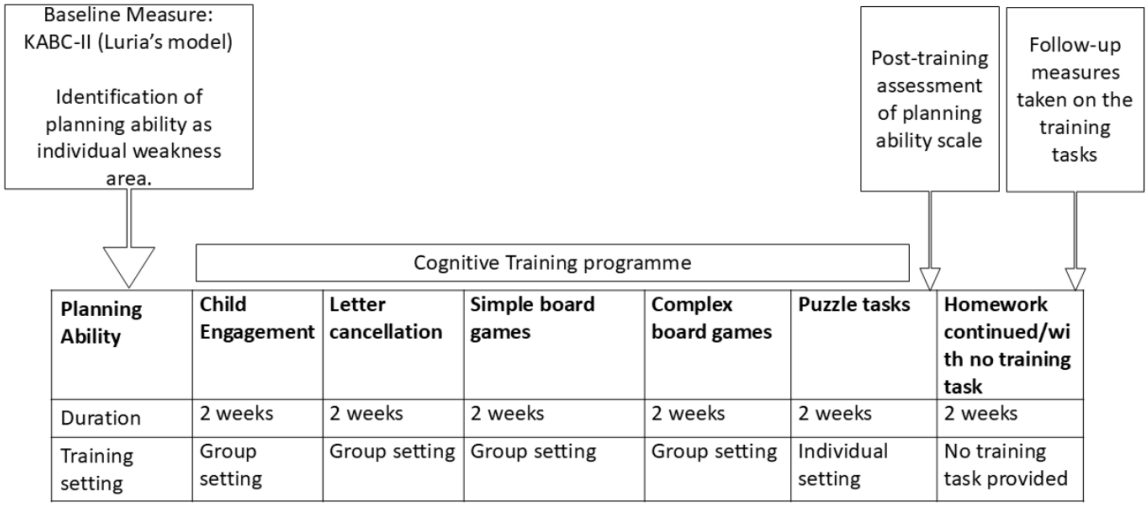


Learning Ability	Child Engagement	Letter cancellation	Sequential recall of sense syllables	Sequential recall of non-sense syllables	Semantic recall task	Homework continued/with no training task
Duration	2 weeks	2 weeks	2 weeks	2 weeks	2 weeks	2 weeks
Training setting	Group setting	Group setting	Individual setting	Individual setting	Individual setting	No training task provided

Figure 3 Chart depicting training program for learning ability



Planning Ability	Child Engagement	Letter cancellation	Simple board games	Complex board games	Puzzle tasks	Homework continued/with no training task
Duration	2 weeks	2 weeks	2 weeks	2 weeks	2 weeks	2 weeks
Training setting	Group setting	Group setting	Group setting	Group setting	Individual setting	No training task provided

Figure 4 Chart depicting training program for planning ability.

Flow chart showing intervention for identified weakness in each scale (Figure 1–4)**:**

Post training, data only on the specific scale of KABC-II was collected and scored. The entire KABC-II was not used as the follow-up measure to avoid the practice effect.[30] Feedback was accordingly provided. The data was subjected to appropriate non parametric statistical analysis.

Results

The Table 2 shows that most children exhibit clinical-level externalizing and overall behavioural problems, while internalizing difficulties largely fall within the normal range.

Table 2 Behavioural problems amongst children living below the poverty line

Domains	Normal range		Borderline		Clinical range	
	F	%	F	%	F	%
Internalizing behaviour	19	82.61	2	8.70	2	8.70
Externalizing behaviour	1	4.35	2	8.70	20	86.96
Total pathology	2	8.70	5	21.74	16	69.57

Frequency: F; Percentage: %; N=23

Higher externalizing problems strongly correlate with poorer cognitive performance across domains, while internalizing problems show weaker, mostly nonsignificant associations with cognition (Table 3).

Table 3 Depicting relationship between behavioural problems with sequential processing (Gsm), simultaneous processing (Gv), learning ability (Glr), planning ability (Gf) and Mental Processing Index (MPI) of children living below the poverty line

Composite scales of CBCL	Gsm	Gv	Glr	Gf	MPI
Internalizing	−0.039	0.24	0.42*	0.30	0.39
Externalizing	-0.49*	-0.32	-0.51**	-0.49*	-0.76**
Total	-0.29	-0.15	-0.27	-0.35	-0.49*

*. p<0.05, **p<0.01 (2 tailed significance)

Most children scored within the average range across all cognitive indexes, but notable weaknesses emerged in Glr and Gf, with virtually no strengths observed in Table 4.

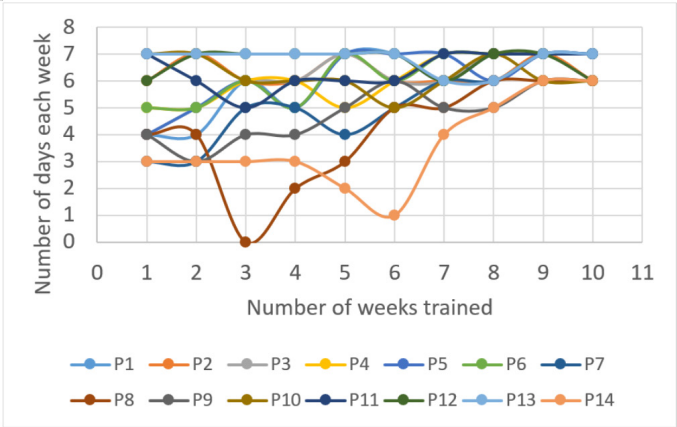


Figure 5 Graph depicting adherence of children to cognitive training plotted with number of days a child attended training per week against the total number of weeks the training was conducted.

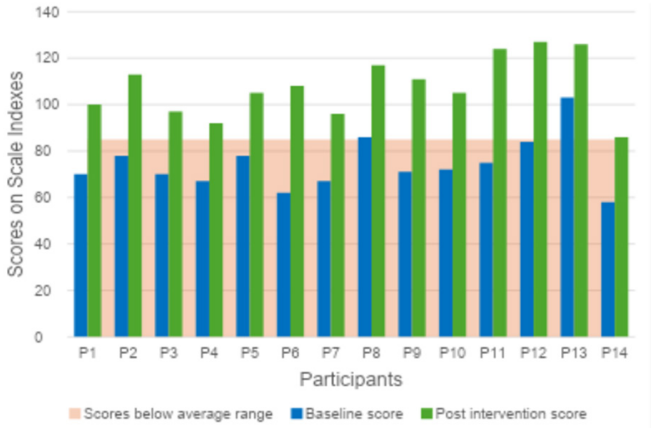


Figure 6 Graph depicting changes in the scores of the children before and after the training program, along with average cut-off score of KABC-II.

Table 4 Cognitive strength and weakness of children living below the poverty line in each scale index of KABC-II

Scale indexes	Strength (Above range)		Weakness (below range)		Average (within range)	
	F	%	F	%	F	%
Gsm	1	4.35	7	30.43	15	65.22
Gv	0	-	9	39.13	14	60.87
Glr	0	-	17	73.91	6	26.09
Gf	0	-	11	47.83	12	52.17

Frequency: F; Percentage: %; N=23

Table 5 Depicting progress of the children after cognitive training

Participant codes	Identified scale	Baseline score	Post intervention score	
P1	Glr	70	100	
P2	Gv	78	113	
P3	Glr	70	97	
P4	Glr	67	92	
P5	Glr	78	105	
P6	Gf	62	108	
P7	Gf	67	96	
P8	Gf	86	117	
P9	Gsm	71	111	
P10	Gf	72	105	
P11	Gf	75	124	
P12	Gv	84	127	
P13	Glr	103	126	
P14	Glr	58	86	
Mean ± SD	-	74.36 ± 11.30	107.64 ± 12.83	
Statistical test		**Z**	***p*-value**	**Effect size (*r*)**
Wilcoxon Signed Rank Test		-3.297	<0.001	0.88

Discussion

Identification of behavioural problems amongst children living below the poverty line

Table 2 indicates that a significant percentage of children living below the poverty line, who were rated by volunteer teachers on the CBCL-TRF fell within the clinical range for externalizing problems, a finding consistent with previous works linking poverty to behavioural difficulties across childhood.[35] The underlying cause includes structural inequalities limiting families' access to resources-economic, social, and political, influencing behaviours of children.[36–38] Over 16% of children were in the clinical or borderline range in context of internalizing problem, and more than 69% scored within the clinical range on the total problem scale, this align with research that early exposure to poverty-related stressors can have negative effects in emotional processing and regulation. Childhood poverty increases the probability of exposure to daily stressors and adverse life events, impairing neurocognitive and socio-emotional development, which might contribute to emotional and cognitive difficulties among developing children, supporting the current results.[38,39]

The relationship between behavioural problems and cognitive abilities of children living below the poverty line

Table 3 indicates no significant correlation between composite scale of internalizing problems of CBCL and sequential processing (Gsm), possibly because sequential processing, that caps working memory and memory span, is affected only by significantly elevated anxiety levels, which were not characteristic of this population.[40] Simultaneous processing also showed no significant correlation with internalizing problems, indicating that mild internalizing features that do not interfere with visual simultaneous processing measured by KABC-II; on contrary, low anxiety can sometimes enhance such processing.[41] An important finding here is a significant correlation between internalizing problems and learning ability, suggesting that low levels of anxiety may enhance learning among children, consistent with earlier findings.[40,41] No significant association was observed between internalizing problems and planning ability could be because planning requires integration of sequential and simultaneous processing. In line with previous researches, the findings suggest that internalizing problems, when mild, are majorly unrelated to fundamental cognitive processing capacities.[42]

The results indicated that composite scale of externalizing problems of CBCL had a significant negative relationship with sequential processing, learning ability, and planning ability. Sequential processing, primarily associated with Luria's Block 2, involves serial ordering and working memory functions.[43,44] Behavioural disinhibition, characteristic of externalizing problems, has been linked to deficits in working memory, such as reduced executive attention and short-term activation capacities, and altered motivational processes, including hypersensitivity to reward and hyposensitivity to punishment.[45–49] Working memory, which governs attention and active maintenance of information,[47,48,50] is crucial for inhibitory control and self-regulation, explaining the negative correlation between sequential processing and externalizing problems.[50,51] No correlation was found between externalizing problems and simultaneous processing, possibly because behavioural ratings (CBCL) capture observable outputs influenced by multiple cognitive systems. Externalizing behaviours were negatively associated with learning ability, consistent with studies linking conduct problems and hyperactivity to impaired learning.[52–54] Learning ability involves integration across all three blocks of Luria's model, while the negative correlation between planning ability and externalizing behaviours reflects executive functioning deficits, supporting earlier findings of an inverse relationship.[55]

No significant correlation was found between the KABC-II, scales and the composite scale of total problems, possibly because internalizing problems were not pronounced in this group. However, the negative trend across all four scales suggested that children scoring higher on total problems tended to perform lower on KABC-II scales. Finally, total problem scores showed a significant negative correlation with MPI, reflecting that broader behavioural difficulties correspond to diminished general mental processing ability.

Cognitive training on the identified weaknesses of the children

Table 4 indicates the scores of the children in each index of KABC-II, which clearly depicts that a high percentage of children scored below the average cut-off. The work proceeded by the identifying the areas of individual weakness of each child, it was determined based on relative weaknesses of each child's cognitive profile, rather than solely on whether scores fell within a normative range. A close observation of the progress of the training depicts that the performance of the children gradually improved (as there was a decrease in time to perform the task and trails required to learn a list) with the passing of each day, in areas where scoring was possible, in areas where scoring was not possible, the improvement was understood from the adherence of the children to the training with the progress of the cognitive training program, Table 5 depicts its reflection in the results of the post intervention test.

Figure 6 further suggest the training was effective for children whose Mental Processing Index (MPI) was below the average range, it was helpful for children whose MPI was in the average range as well as for those whose MPI was above the average range, indicating towards the effectiveness of the training.

The improvement depicted in the sequential processing after the cognitive training program with the sequential processing task, may be interpreted within Luria's neuropsychological framework as reflecting improvements in cognitive processes associated with Block 2,[43,44] or the change in the ability of the children to analyse, code and store information as it came through the sense organs, integrating this information with the aid of maintained arousal, using and processing information one after the other and establishing a connection with planning and organizing behaviour.

Similarly, the changes that were evident in the simultaneous processing scores of the children may be interpreted, within Luria's neuropsychological framework, as improvements in cognitive functions theoretically associated with the changes in Luria's block 3 and block 2,[43,44] which was deliberately mixed in this particular scale of KABC-II. Therefore, the change in the scores can be accounted to the changes that occurred due to the training tasks, evident in the output or the response centre of the brain, which are not directly involved with motor and speech functions, but involves, decision making, generating hypothesis and planning, self-monitoring and programming, dealing with overall efficiency of the brain.

The highest number of children were identified with weakness in learning ability. This can be due to the fact that learning ability of the KABC-II is a scale that taps all the three functional systems of Luria's neuropsychological theory (i.e., arousal, information processing, regulation and planning).[43,44] These findings may be interpreted as reflecting improvements in cognitive functions theoretically associated with all the three blocks, namely, block 1 or the capacity of maintaining arousal which includes mediating attention and concentration, focusing of attention, regulating energy levels and tone of cerebral cortex, recognizing the significance of incoming stimuli, allowing receiving and processing information, block 2 or the capacity to store and code information and it also establishes the connection with block 3, which has already mentioned deals with the overall efficacy of the brain.

Correspondingly, considering the changes that were in the planning ability of the children in the post-intervention data, according to the conceptualization of the KABC may be interpreted as reflecting improvements in cognitive functions theoretically associated with Block 3[43,44] of the functional system of Luria, or the block which involves, decision making, generating hypothesis, planning, self-monitoring and programming besides representing the output or response centre of the brain, or overall higher order functions and efficacy of the brain.[43,44] It should be noted that these interpretations are based on Luria's theoretical framework underlying the KABC-II, the present study focused on cognitive and behavioural performance rather than giving an explanation based on neurobiological mechanisms.

The findings (recorded in Table 5) suggest that cognitive training among children living below the poverty line has an effect on their cognitive functioning in the area of weakness identified and depicts significant improvement. Additionally, from the results and observation, it can be interpreted that the impact of cognitive training was also noted in the children in the cognitive tasks, as implied from the follow-up observations of the participants, two weeks after the cognitive training program ended. Impact of regular cognitive engagement enhance the neuropsychological efficiency; betterment of neuropsychological functioning was observed in the said group; however, the limitation of the current study is that long-term follow-up could not be conducted due to ethical dilemma (having contact with the children of critical developmental age while withholding their further cognitive training), hence the long-term sustainability of the observed gains cannot be stated. Previous research suggests that while cognitive training can produce short-term improvements in targeted cognitive domains, the durability and transferability of these gains may vary and often depend on continued opportunities for cognitive engagement, like schooling, support from caregivers. While continued support may help reinforce acquired skills, persistent socioeconomic adversity and/or traumatic life events may diminish the sustainability of intervention-related improvements.[56,57] Another significant limitation of this pilot study is a small sample size (N=14)

and the absence of a control group, which limit the generalisability and preclude causal inference. Therefore, the observed improvements cannot be attributed solely to the cognitive training intervention, as factors such as re-testing or practice effects, developmental maturation, and non-specific intervention effects cannot be completely ruled out. Future studies with larger samples are needed to establish the efficacy of cognitive training in this population.

The finding is important from the research perspective, since no literature could be obtained on the effects of cognitive training on cognitive functions among the BPL children in India to the best knowledge of the researchers and limited research was found internationally. The present finding goes with the previous findings that cognitive training improves cognitive functioning among children.[58,59]

Conclusion

The most significant finding of this community-based study is the need for clinical assessments at the community level. It highlighted the presence of externalizing problems in the clinical range among a large number of children of the population. Significant correlations were identified between cognitive (KABC-II) and behavioural measures (CBCL)—sequential processing and planning ability negatively correlated with externalizing behaviour, learning ability correlated positively with internalizing and negatively with externalizing behaviour, and the Mental Processing Index showed a negative correlation with externalizing and total problems.

The study revealed that despite children living below the poverty line performed below KABC-II norms when assessed before the cognitive training, showed marked improvement after a 12-week program, each reaching the average range. This emphasises the capacity of the children to attain higher cognitive functioning with adequate training.

The concerned agencies had been actively working to promote the academic and creative exposure among children; however, the gaps between policy and implementation for children in poverty still requires attention. This work is voicing the fact that a well-structured cognitive intervention can enhance cognitive outcomes. The wholesome plan of intervention involves psychoeducating caregivers, which is expected to bring positive changes in the immediate living environment of the children. Similar intervention-based action research could help to bring gradual social change by empowering the children from the weaker section of the society, when conducted on a larger scale. The future lies in the immense cognitive possibilities of the children who upon receiving appropriate training will be capable of using their potential to create a better nation.

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Data availability statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Ethical statement: Ethical approval for the study was obtained from the Institutional Ethical Committee for Bio Medical and Health Research involving Human Participants, University of Calcutta, on 08 February 2023 (Ref No. CUIEC/03/29/2022-23).

Written informed consent was obtained from parents/caregivers of all participating children prior to participation and assent was obtained from the children. All procedures performed in this study were conducted in accordance with the ethical standards of the approving institutional ethics committee and the ICMR guidelines for biomedical and health research involving human participants.

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Conflicts of interest

The authors declare no conflict of interest.

References

1. NITI Aayog. *National multidimensional poverty index: a progress review 2023*. New Delhi: Government of India; 2023.
2. Morgan CT, King RA. *Introduction to psychology*. 3rd ed. New York: McGraw-Hill; 1966.
3. Flavell JH. Cognitive development: Children's knowledge about the mind. *Annu Rev Psychol*. 1999;50(1):21–45.
4. Berk LE. *Child development*. 7th ed. Boston: Allyn & Bacon; 2006.
5. Bradley RH, Corwyn RF. Socioeconomic status and child development. *Annu Rev Psychol*. 2002;53:371–99.
6. Leventhal T, Brooks-Gunn J. The neighborhoods they live in: the effects of neighborhood residence on child and adolescent outcomes. *Psychol Bull*. 2000;126(2):309–337.
7. Noble KG, McCandliss BD, Farah MJ. Socioeconomic gradients predict individual differences in neurocognitive abilities. *Dev Sci*. 2007;10(4):464–480.
8. Sheridan MA, Sarsour K, Jutte D, et al. The impact of social disparity on prefrontal function in childhood. *PLoS One*. 2012;7(4):e35744.
9. Farah MJ, Shera DM, Savage JH, et al. Childhood poverty: specific associations with neurocognitive development. *Brain Res*. 2006;1110(1):166–174.
10. Parks RW, Stevens RJ, Spence SA. A systematic review of cognition in homeless children and adolescents. *J R Soc Med*. 2007;100(1):46–50.
11. Richter L, van der Walt M. The psychological assessment of South African street children. 2003.
12. Aptekar, L. Children of street families: An examination of the psychological and social problems faced by children living on the streets. *Child Dev*. 1989;60(2):435–447.
13. Sala G, Gobet F. Cognitive training does not enhance general cognition. *Trends Cogn Sci*. 2019;23(1):9–20.
14. Sala G, Gobet F. Cognitive training: a field in search of a phenomenon. *Perspect Psychol Sci*. 2023;18(1):125–141.
15. Bavelier D, Levi DM, Li RW, et al. Removing brakes on adult brain plasticity: from molecular to behavioral interventions. *J Neurosci*. 2010;30(45):14964–14971.
16. Deveau J, Jaeggi SM, Zordan V, et al. How to build better memory training games. *Front Syst Neurosci*. 2014;8:243.
17. Biagianti B, Vinogradov S. Computerized cognitive training to improve cognition and functioning in schizophrenia. *Neuropsychol Rev*. 2013;23(1):99–108.
18. Ross LA, Sprague BN, Phillips CB, et al. The impact of three cognitive training interventions on cognitive function and everyday functioning in older adults. *J Aging Health*. 2018;30(3):475–498.
19. Klauer KC. *Denksport für Kinder: Training zur Förderung des induktiven Denkens*. 2nd ed. Göttingen: Hogrefe; 1989.

20. Zatorre RJ, Fields RD, Johansen-Berg H. Plasticity in gray and white: neuroimaging changes in brain structure during learning. *Nat Neurosci*. 2012;15(4):528–36.

21. Andersen SL, Teicher MH. Stress, sensitive periods and maturational events in adolescent depression. *Trends Neurosci*. 2008;31(4):183–191.

22. Klingberg T, Fernell E, Olesen PJ, et al. Computerized training of working memory in children with ADHD—a randomized, controlled trial. *J Am Acad Child Adolesc Psychiatry*. 2005;44(2):177–186.

23. Evans GW, Exner-Cortens D, Kim P, et al. Childhood poverty and blood pressure reactivity to and recovery from an acute stressor in late adolescence. *Psychosom Med*. 2013;75(7):691–700.

24. Diamond A, Barnett WS, Thomas J, et al. Preschool program improves cognitive control. *Science*. 2007;318(5855):1387–1388.

25. Mezzacappa E, Buckner JC. Working memory training for children with attentional problems or from disadvantaged backgrounds. *Dev Sci*. 2010;13(3):479–493.

26. Blair C, Raver CC. Closing the achievement gap through modification of neurocognitive and neuroendocrine function: results from a cluster randomized controlled trial of an innovative approach to the education of children in kindergarten. *PLoS One*. 2014;9(11):e112393.

27. Gamino JF, Motes MM, Riddle R, et al. Enhancing inferential abilities in adolescence: new hope for students in poverty. *Front Hum Neurosci*. 2014;8:924.

28. Bongarala M, Kumar S, Ross R, et al. Impact of a neuro-cognitive intervention on students' cognitive functions: assessments in a government school setting in South India. *J Educ Dev Psychol*. 2019;9(2):62.

29. Das S, Banerjee S, Chatterjee S, et al. Skill-based intervention programme for children in conflict with law: an innovative approach from University of Calcutta. *Int J Res Innov Soc Sci*. 2022;6(7).

30. Kaufman AS, Kaufman NL. *Kaufman assessment battery for children*. Second Edition (KABC-II) Manual. Circle Pines (MN): American Guidance Service; 2004.

31. Malda M, van de Vijver FJR, Srinivasan K, et al. Traveling with cognitive tests: Testing the validity of a KABC-II adaptation in India. *Assessment*. 2010;17(1):107–115.

32. Achenbach TM, Rescorla LA. *Manual for the ASEBA school-age forms & profiles*. Burlington (VT): University of Vermont, Research Center for Children, Youth, & Families; 2001.

33. Malhotra S, Kohli A, Kapoor M, et al. Psychological disturbance among 5- to 8-year-old school children: A study from India. *J Child Psychol Psychiatry*. 1998;39(6):887–896.

34. Singh M. Study of behaviour problems in a paediatric outpatient department. *Med J Armed Forces India*. 2006;62:351–355.

35. Akee RKQ, Copeland WE, Keeler G, et al. Parents' incomes and children's outcomes: A quasi-experiment using transfer payments from casino profits. *Am Econ J Appl Econ*. 2010;2(1):86–115.

36. Adler NE, Stewart J. Health disparities across the lifespan: Meaning, methods, and mechanisms. *Ann N Y Acad Sci*. 2010;1186(1):5–23.

37. McCartney G, Collins C, Mackenzie M. What (or who) causes health inequalities: Theories, evidence and implications? *Health Policy*. 2013;113(3):221–227.

38. Kim P, Evans GW, Angstadt M, et al. Effects of childhood poverty and chronic stress on emotion regulatory brain function in adulthood. *Proc Natl Acad Sci U S A*. 2013;110(46):18442–18447.

39. Javanbakht A, King AP, Evans GW, et al. Childhood poverty predicts adult amygdala and frontal activity and connectivity in response to emotional faces. *Front Behav Neurosci*. 2015;9:154.

40. Martocchio JJ. Effects of conceptions of ability on anxiety, self-efficacy, and learning in training. *J Appl Psychol*. 1994;79(6):819–825.

41. Murray NP, Janelle CM. Anxiety and performance: A visual search examination of the processing efficiency theory. *J Sport Exerc Psychol*. 2003;25(2):171–187.

42. Werry JS, Elkind GS, Reeves JC. Attention deficit, conduct, oppositional, and anxiety disorders in children: III. Laboratory differences. *J Abnorm Child Psychol*. 1987;15(3):409–428.

43. Luria AR. *Higher cortical functions in man*. New York: Basic Books; 1966.

44. Luria AR. *Higher cortical functions in man*. 2nd ed. New York: Basic Books; 1973.

45. Finn PR, Rickert ME, Miller MA, et al. Reduced cognitive ability in alcohol dependence: Examining the role of covarying externalizing psychopathology. *J Abnorm Psychol*. 2009;118(1):100–116.

46. Patterson CM, Newman JP. Reflectivity and learning from aversive events: toward a psychological mechanism for the syndromes of disinhibition. *Psychol Rev*. 1993;100(4):716–736.

47. Conway ARA, Engle RW. Working memory and retrieval: A resource-dependent inhibition model. *J Exp Psychol Gen*. 1994;123(4):354–373.

48. Baddeley AD, Hitch G. *Working memory*. In: Bower GH, editor. The psychology of learning and motivation. New York: Academic Press; 1974;47–89.

49. Fowles DC. The three arousal model: Implications of Gray's two□factor learning theory for heart rate, electrodermal activity, and psychopathy. *Psychophysiology*. 1980;17(2):87–104.

50. Miyake A, Shah P. *Toward unified theories of working memory: emerging general consensus, unresolved theoretical issues, and future research directions*. In: Miyake A, Shah P, editors. Models of working memory: Mechanisms of active maintenance and executive control. Cambridge: Cambridge University Press; 1999;442–82.

51. Barkley RA. Behavioral inhibition, sustained attention, and executive functions: Constructing a unifying theory of ADHD. *Psychol Bull*. 1997;121(1):65–94.

52. Zimmermann F, Schütte K, Taskinen P, et al. Reciprocal effects between adolescent externalizing problems and measures of achievement. *J Educ Psychol*. 2013;105(3):747–761.

53. Gray SAO, Carter AS, Briggs-Gowan MJ, et al. Growth trajectories of early aggression, overactivity, and inattention: Relations to second-grade reading. *Dev Psychol*. 2014;50(9):2255–2263.

54. Reiff MI, Banez GA, Culbert TP. Children who have attentional disorders: Diagnosis and evaluation. *Pediatr Rev*. 1993;14(12):455–464.

55. Olvera RL, Semrud□Clikeman M, Pliszka SR, et al. Neuropsychological deficits in adolescents with conduct disorder and comorbid bipolar disorder: A pilot study. *Bipolar Disord*. 2005;7(1):57–67.

56. Melby-Lervåg M, Hulme C. Is working memory training effective? A meta-analytic review. *Dev Psychol*. 2013;49(2):270–291.

57. Walker SP, Wachs TD, Gardner JM, et al. Child development: risk factors for adverse outcomes in developing countries. *Lancet*. 2007;369(9556):145–157.

58. Scionti N, Cavallero M, Zogmaister C, et al. Is cognitive training effective for improving executive functions in preschoolers? A systematic review and meta-analysis. *Front Psychol*. 2020;10:2812.

59. Wu Y, Xu L, Wu Z, et al. Computer-based multiple component cognitive training in children with ADHD: a pilot study. *Child Adolesc Psychiatry Ment Health*. 2023;17(1):9.