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Impact of Digital Cognitive Remedial Therapy (CRT) for Sustaining Attention Span Among Children with Mild Intellectual Disability (ID) to Develop Communication Skills

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Abstract: *The aim of the current study was to analyze the effectiveness of structured cognitive remedial Therapy (CRT) to sustain attention span among children with Mild Intellectual Disability (ID). The Intellectual Disability is characterized by limitations in intellectual functioning and developmental delays among children. Every child with Intellectual Disability requires individual support as per the developmental needs such as learning problems, attention span and maintaining focus and CRT is the effective therapy to improve attention span and overall functioning. The single subject experimental study design has been employed in the current study. The children with the Mild intellectual Disability has been recruited from the special education schools and the data were collected from hospitals while confirming about their level of mild ID. The sample of N=20 children were recruited in the study. Demographic information and medical information form has been completed before implementing the intervention. Pre and Post analysis has been conducted to check the effectiveness of the intervention among children aged 6 to 13 years with Mild Intellectual disability, Pakistan. The intervention has been implemented while using the Head APP Neurvitals application consisted on 30-40 sessions, with 3 sessions every week per children. The study indicated remarkable improvements in the sustaining attention span among children with mild Intellectual Disability as in the pre intervention scores are lesser (M=73.75: SD = 13.82) in comparison of the post intervention (M=93.95: SD = 5.88). These results suggest substantial improvement in sustained attention span and visual spatial focus as a result of the intervention. The results also indicated significant improvements, with a Tau-U effect size of 0.93 reflecting a strong intervention effect. The Digital Cognitive Remedial Therapy (CRT) showed significant improvement in sustaining attention span which further improves the overall functioning of the children with mild ID.*

Introduction

The term “Intellectual Disability (ID)” refers to a Disability related to the developmental growth of an individual (American Psychiatric Association (APA), 2022). The Intellectual Disability is characterized by

limitations in intellectual functioning known as daily functioning as well (Purugganan, 2018). There are different studies and according to the Diagnostic and Statistical Manual (DSM-V, 2013), lack of intellectual capability to performing acts categorized into two broader aspects in which functioning of an individual refers of learning, reasoning and problem solving aspects, where as the other refers to the adaptive functioning or behavior in which children lacks the understanding of conceptual, social and practical skills (McGuire et al., 2019).

According to the World Health Organization (WHO), and different studies indicated that the prevalence of intellectual Disability from 1990 till 2019 has been increasing rapidly with the estimation of 107.7 Million individuals across the world (World Health Organization WHO, 2011: 2022: Nair et al., 2022). The report of Global Burden of Disease (GBD) indicated that about 1.3% children are in intellectual disability with the higher prevalence rate in Low socio economic countries (GBD, 2019: Feigin, 2022). Evidence suggest that Low Middle Income Counties (LMICs) bear the larger burden of developmental disorders including Intellectual Disability with the range between 2% to 3% (Chaudhry et al., 2018: Maulik, Mascarenhas and Mathers., 2011: Durkin et al., 1998: Zaman et al.,, 1990), after analyzing different factors such as lack of prenatal care, limited access of facilities, malnutrition, environmental factors and lack of early detection facilities (Bitta et al., 2017: Kiani et al., 2019). Furthermore, In Pakistan the prevalence of developmental disorder also significantly highlighted from the past few years (Simister et al., 2020: Pakistan Bureau of Statistic, 2017). Different surveys and population based studies emphasized that Pakistan is one of the highest country having the developmental disorder including ID with the ratio of 2.6 percent (Pakistan Bureau of Statistic, 2017). Different studies conducted in different regions of Pakistan e.g. Punjab, Sindh and KPK consistently indicating the higher level of Intellectual Disability among children aged 2 to 15 years because of the different associated factors such as Low literacy rate, limited health facilities, lack of early detection, poor parental health (Imran et al., 2012: Mirza et al., 2008: Mubbashar et al., 2002:Durkin et al., 1998).

Different studies indicated that every child with ID requires individual support (Chiodo, 2019) according to their needs such as in functional limitations some children requires support in language development, social interaction, motor skills and self-care, whereas the other requires support in academic instructions, slow processing speed, maintaining attention and focus or memorizing the concepts (Bexkens, Maes and Huizenga, 2016: Karande, 2005). Moreover, almost every study emphasize the one main problem among children with ID was impairment in sustaining or maintain attention span also known as executive functioning which is associated with both learning and adaptive functioning (Lindsay & Miller, 2023:Danielsson, 2012: Alloway, 2010: Schuchardt, K., Gebhardt, M., and Mäehler, 2010).

In a systematic review, to improve the executive functioning (attention span, memory and problem solving) among children with ID, Cognitive Remedial therapy (CRT) considered a significant evidence based therapy (Aro et al., 2012). CRT also known as cognitive remedy therapy in which techniques has been utilized to enhance the core cognitive process of the children (Bottino et al., 2014). The core aim of the CRT was to strength the children's underlying cognitive architecture which further enhances the learning, adaptive behavior, emotional regulation and overall functioning (Wehmeyer, M., Shogren, K., & Brown, 2017). During the implementation of the CRT techniques two core principal has been implemented which are "Structure and repetition" (Miyake, A., & Friedman, 2012). Furthermore, different cultures and in scenarios CRT has been implemented in different ways such as through paper pencil tasks, computer based activities (Bennett, S., Holmes, J., and Buckley, S. , 2013) and therapist guided tasks, which in every form showed significant cognitive impact among children (Sharma and Singh, 2019). Different researches indicated that CRT has significantly improves the cognitive functioning

among children with ID such as attention span, functional independence through repetition and developmentally appropriate tasks (Danielsson, H., Henry, L., and Ronnberg, 2017: Saloviita, 2016: Krik et al., 2015).

Thus, through different studies or literature analysis it has been indicated that there are attention span difficulties among children with ID. Due to lack of empirical studies, CRT has not been implemented in LMICs as well as in Pakistan, and attention span plays a central role to develop and enhancing the severity of other associated problems for day to day functioning. The aim of the current study is to address the critical research gap and check the feasibility and effectiveness of contextually appropriate Cognitive Remedial Therapy (CRT) to enhance and sustain attention span among children aged 6 to 13 years in Lahore, Pakistan. The findings of the study will potentially contribute towards the improvement of overall functioning of the children.

Research Objective

- To find out current status of language development and attention span among children with mild intellectual disability.
- To find out effectiveness of Cognitive Remedial Therapy (CRT) for sustaining attention span among children with Mild Intellectual Disabilities in Lahore Pakistan.

Methodology

The aim of the current study was to investigate the applicability of the intervention (CRT) among children with Mild Intellectual Disability in Lahore, Pakistan. The single subject experimental study design has been employed in the current study. The children for the study were recruited from the Special Education Centers of Lahore, Pakistan, who has been taking different therapeutic interventions (e.g. Behavioral therapy, Speech Therapy, Occupational therapy) and formally diagnosed with Mild Intellectual Disability. The diagnosis of the children was confirmed from the hospital , where they were taking either sessions or doing regular assessments. The study sample size was based on an estimation of how many parents were willing to volunteer involve in the study during the study period. Total (n=20) Parent's having children with mild ID aged 6 to 13 years were volunteer given the consent to participate in the study. The inclusion criteria have been followed to recruit the children in the study;

- Children having Mild Intellectual Disability (IQ 50-70) was included in the study.
- Aged 6 to 13 years were included in the study.
- Children with prominent attention span difficulties (specifically sustaining attention span) *(confirmed from psychologist & parents)* were included in the study.
- Children living in the catchment area of the Lahore were included in the study.
- Those whose parents are willing to give consent to participate in the study.

Exclusion Criteria

- Children having Mild, Severe or Moderate Intellectual Disability were excluded in the study.
- Children having any physical illness or having co existing neurological disorders were excluded in the study.
- Children having significant sensory impairments (vision or hearing) excluded.
- Children having on any medications specifically to improve attention span were excluded from the study.

Instruments

The following instruments has been implemented during the study these are;

- **Diagnostic tool**

The demographic form has been developed to obtain the information from the children's family. The

items included age, gender and grade of the children with Mild ID. The form also includes information about family structure, family history and number of siblings. Furthermore, detailed developmental history has been explored such as first cry of the child, developmental milestones (crawling, babbling and physical). Psychological and medical history has been also explored with detailed treatment sessions plan such as (Physical, OT and speech sessions) has been explored.

- **Clinical Information Form**

Clinical information has been developed in which the information data has been explored about the children. The Responses were consisted on the Likert Scale and based on the four main domains; Sustained attention span, distractibility, Task persistency and Attention Span were explored. Through the psychological record, IQ assessment scores were also explored to confirm the Mild Intellectual Disability of the children.

Thus, both questionnaires were reviewed from the different experts of the field before administration of the data. All necessary amendments has been done while reviewing the cultural sensitive aspects.

- **Cognitive Remedial Therapy (CRT)**

Cognitive Remedial Therapy (CRT) has been delivered using the digital Platform HeadAPP Neurvitals (2021). This is digital software designed for the neuropsychology assessment of the neurodevelopment disorders (e.g. Autism, ADHD) and core cognitive domains (e.g. attention span, memory and processing speed). In the current study this digital application has been used to deliver the Cognitive Remedial Therapy. The therapy has been delivered on the laptop to the children after providing them proper trial of the instrument. Total 40 sessions has been delivered by using the digital platform and all the activities including the HeadAPP based to sustain the attention span. The duration of the session varies from 35 to 45 minutes as per the length of the activities. Sessions has been delivered thrice in a week as per the feasibility of the children. Furthermore, sessions has been delivered in a calm room with minimum distraction. The first session of the session on the application was used as the baseline information or as the Pre Intervention results, and the last session was indicated the post results of the CRT intervention. The session content includes different activities based on sustaining attention span which is mentioned in the below table;

Table 1.1

Activities included to Sustain Attention span among children with Mild Intellectual Disability (ID)

Type of Intervention	Time Management	Goal Management / Activities
Reaction and impulse control tasks	No of stimuli per task(50)mint reaction time (500ms)	React by clicking or tapping card
Attention and focus tasks	Limit training duration to 30 mints	Image word, word image mode
Attention/ versatility tasks	Limit training duration to 20 mints	Scroll/tap images (color, shapes) that match specifications on the edge
Spatial Cognition Tasks	Subtask: build city map Limit training duration to 20 mints	Complete the city map; drag the correct parts into the map.

Divided attention tasks	Stop training after 4 scenes	See short screen, answer questions
Complexity of the task	• Simple • Mild • Moderate • Complex	Color and shape sorting , Counting backward and forward Pattern structure
Level of assistance needed	• None • Mild • Moderate • Maximum	
Measure of achievements & Reinforcements	Time/ speed to complete task Stars while achieving goal Green color highlighted in case of correct answer and red color highlighted in case of incorrect answer	

Procedure

The study was conducted after obtaining approval from the ethical board of the university. After approval from the university the permission letter has been signed from the special education schools while mentioning the study procedure and process. All information has been presented by the researchers to the principal and teachers and questions were tackled. The eligible children who completed the recruitment requirements were identified after confirming from the school and the concern hospitals. The formal permission was signed from the parents and information leaflet were provided to the parents obtaining all the information. The parents were re assured about the study and about their rights if they want to discontinue the study at any point. The Parents of the participants were reassured about the anonymity of the data and all questions were answered. The data were analyzed from the SPSS while evaluation the pre and post evaluation of the assessment.

Data Analysis

The data analysis for this study was conducted using both descriptive and inferential statistical methods, ensuring a comprehensive evaluation of the data collected. To evaluate the magnitude of trends of intervention plan of each child behavioral change for each participant, single case trends of TauU was computed. TauU is a rank based non parametric statistic that measures the magnitude and statistical significance of change between phases while controlling for undesirable baseline trend (Parker, Vannest, & Davis, 2011). Together, these indices offer both descriptive and inferential perspectives on intervention effectiveness and are well suited for single subject experimental designs.

In the attention span domain, all subtests showed marked improvement over time. For example, performance on the “Hit it” task rose from a baseline mean of 73.75 (SD = 13.82) to a post intervention mean of 93.95 (SD = 5.88), with a moderate trends. Similar patterns were observed in “Pick it,” “Vita at,” “Vita city,” and “See it,” with “Vita city” showing particularly strong gains. These results suggest substantial improvement in sustained attention span and improvement in focus as a result of the intervention.

Table 1.2

Descriptive statistics of Demographic information of the sample (N=20)

Variables		Mean	SD
Child age (years)		10.48	1.76
Order of sibling		2.00	1.00
Mental age of child (months)		78.80	30.58
Child speech age (months)		67.80	21.31
Birth weight (lb)		5.01	0.63
		Frequency	**Percentage**
Gender			
	Male	11	55.0%
	Female	09	45.0%
Disability			
	Yes	00	0%
	No	20	100.0%
Other sibling with disability			
	Yes	06	30.0%
	No	14	70.0%
Area of residence			
	Farooq Gunj	07	35.0%
	Habib Gunj	05	25.0%
	Industrial	02	10.0%
	Misri Shah	03	15.0%
	Shalamar Bagh	03	15.0%
History of changing school of child			
	Yes	13	65.0%
	No	07	35.0%
Inherited			
	Yes	06	30.0%
	No	14	70.0%
Availability of speech therapist in school			
	Yes	01	5.0%
	No	19	95.0%
Lack of accessibility of school service			
	Yes	15	75.0%
	No	05	25.0%
Does the child receive any specialized service in school			
	Yes	09	45.0%
	No	11	55.0%

Table 1.2 shows descriptive analysis demographic information of children with mild intellectual disability. The research involved 20 children with an average chronological age of 10.48 years (SD = 1.76). The typical birth order was around the second child in the family (M = 2.00, SD = 1.00). The mean mental age of the children was 78.80 months (SD = 30.58), and the average speech age was 67.80

months (SD = 21.31). In terms of physical growth, the average birth weight was 5.01 lb (SD = 0.63). Regarding gender distribution, 55% of the participants were male (n = 11) and 45% were female (n = 9). None of the children were reported to have a disability themselves; however, 30% (n = 6) indicated having a sibling with a disability, while 70% (n = 14) did not.

With respect to gender distribution, 55% of the participants were male (n = 11) and 45% were female (n = 9). None of the children were identified as having a disability themselves; however, 30% (n = 6) reported having a sibling with a disability, while 70% (n = 14) did not.

Participants were recruited from various regions, with the largest representation from Farooq Gunj (35%, n = 7), followed by Habib Gunj (25%, n = 5), Misri Shah (15%, n = 3), Shalamar Bagh (15%, n = 3), and the Industrial area (10%, n = 2).

A majority of children (65%, n = 13) had a history of changing schools, whereas 35% (n = 7) remained in the same school. Regarding familial inheritance, 30% (n = 6) of the cases were reported as inherited, while 70% (n = 14) were not.

When evaluating educational support services, only 5% (n = 1) of schools had a speech therapist available, while 95% (n = 19) did not have such resources. Furthermore, 75% (n = 15) of families reported a lack of access to school services, while 25% (n = 5) did not perceive this issue. Finally, 45% (n = 9) of children were receiving specialized services in school, while 55% (n = 11) were not.

Table 1.2

Descriptive therapy goal wise analysis of baseline and intervention phases

Activities	**Baseline/ Pre Intervention n=20**		**Post Intervention n=20**
	Mean (SD)		***SD***
	BL n=20	**Dur n=20**	**Post n=20**
Attention			
Hit it	73.75 (13.82)	79.65 (14.82)	93.95 (5.88)
Pick it	83.25 (9.99)	88.75 (8.33)	93.70 (5.66)
Vita at	90.15 (6.70)	94.80 (6.58)	97.05 (4.63)
Vita city	69.60 (18.83)	90.05 (10.39)	93.90 (9.87)
See it	61.60 (12.59)	68.55 (14.09)	77.10 (11.69)

Table 1.2 shows the attention domain, all subtests depicted significant improvement over time. Notably, the “Hit it” task improved from a baseline mean of 73.75 (SD = 13.82) to a post intervention mean of 93.95 (SD = 5.88), with a moderate effect size .Similar upward trends were observed in “Pick it,” “Vita at,” “Vita city,” and “See it,” with “Vita city” showing particularly strong gains (M= 93.70,M= 93.90, M=77.10). These findings suggest that attention capacities, particularly those related to sustained focus and visual spatial attention, improved substantially as a result of the intervention.

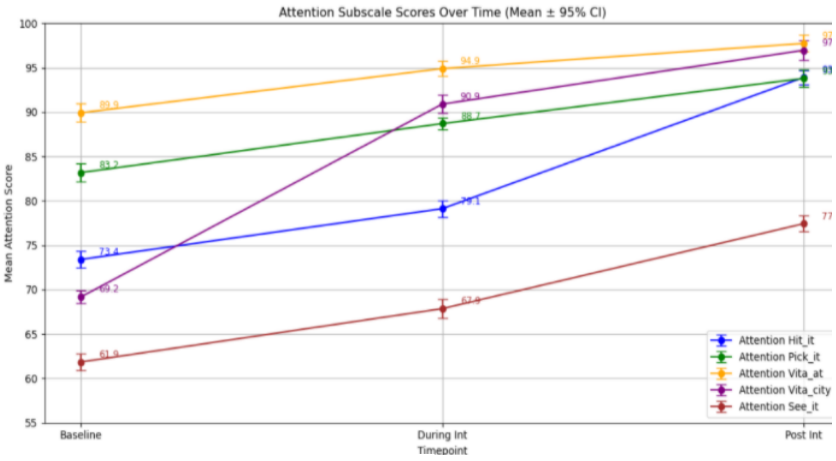
Table 1. 3

Tau U analysis for Magnitude of effect size of attention span intervention

Label	Tau	Var-Tau	Z	p-value	CI 85%	CI 95%
A-B	0.936	0.1421	5.4651	0.000	0.6894<>1	0.6003<>1

Table 1. 3 identifies the Result of Tau-U value of 0.93 (p = 0.00), indicated a marked enhancement in attention span of children with mild intellectual disability. In single subject research design, the Tau-U value presents the effect size of intervention in the context of measuring the non-overlapping data in all intervention phases. This value also confirmed the assumption that the intervention had a strong positive effect on children with mild intellectual disability. These findings support the effectiveness of the intervention in enhancing appropriate attention span among children with mild intellectual disability.

Figure 1.1



Shows trends of Pre and Post Therapy Goals of Attention span (n=20)

Discussion

The current study focused on the evaluation of effectiveness CRT to improving attention span of the children with mild intellectual disability, Pakistan. The intervention was implemented while using the HeadApp focusing on the attention span. The results indicated that the children showed significant improvement in the sustaining attention span as shown through the Tau-U analysis in different pre and post phases of the therapeutic intervention. Thus, the results indicated that technology based CRT plays a significant impact on sustaining attention span among children with Mild ID.

As mentioned in the literature review, the children with Mild ID attention span is the important part of the other malfunctioning such as learning and adaptive functioning (Schalock et al., 2021). The results of the current study also indicated that the as attention span improves and sustain among children also improves the functioning of the children. Previous studies indicated that computer assisted technology enhance the cognitive functioning includes attention span, memory for those children suffered in mild intellectual functioning (Ashman et al., 2020: Aro et al., 2019). The current study results showed compliance from the previous studies and also relevant with the culture of the Pakistan.

The HeadAPP is a tool used for the significant assessment in the neuropsychology with the children with neuro developmental disorder (Aro et al., 2019). The tool is effective to measure the attention span difficulties, memory and executive functioning which were also measured by the complete study and attention span is the one component, all component involves in executive functioning showed improvements as they are also reinforce children while showing different results such as green light, stickers and different indicators (Ashman, A. F., Neal, D., and Banks, 2020). In the current study the structured learning environment helped children to enhance the attention span and remain more focused to achieve the specific goals such as stars. Furthermore, continuous reinforcement enhance the children to pass through the mild to moderate task towards the complex tasks which further enhance

the children cognitive load management and adaptation with the different situations.

Most commonly, CRT has been delivered on inpatients units (Sturm, W., Willmes, K., & Zimmermann, 2021: Bexkens et al., 2014) and only a few studies have explored outpatient delivery but mostly with the severe patients (Abbate Daga, et al., 2012; Pitt, Lewis, Morgan, & Woodward, 2010; Pretorius et al., 2012). In contrast to earlier studies, ours is the first to explore CRT with the children Mild intellectual disability or school settings. Results indicated that CRT appealed to the children group and confirm that the intervention is effective in the mild intellectual functioning while improving the overall learning, adaptive and executive functioning.

The current study also emphasized the importance of digital tools in Low and middle income countries (LMICs) such as Pakistan as a specialized cognitive rehabilitation tool (Schalock,R. L., Luckasson, R., and Tassé, 2021). The CRT therapy indicated that it is cost effective and can be implement in low setting with precautions and a little centralized training as indicated in the current study. In the world of digitalization, the current study indicated that improvement can be achieved with the minimal training and this technology can be integrated in different educational set ups and different therapeutic interventions such as Speech, OT and special education programs. Rattat and Collié (2020) reported that individuals aged 11 - 19 with mild intellectual disability exhibited deficits in duration estimation when compared to their typically developing counterparts. Their sensitivity to duration appeared to increase with age during temporal bisection tasks, indicating a developmental lag in attention span timing abilities. The results also concluded in the current study in the perspective of attention span lag.

Thus, the results concluded about the effectiveness of the RCT to sustain attention span among children with Mild Intellectual Disability to improve their overall functioning. The structured, engaging, and adaptive format of the intervention supports measurable improvements and demonstrates the potential of digital therapy as an essential component of educational and therapeutic programs for children with mild intellectual disabilities.

Limitations

- The sample size of the study (n=20) indicates the lack of generalizability of the study, Furthermore study has been conducted only in one city of the country and become the cause of the lack of reliability of the implications in the broader population.
- The dependability of the digital software for pre and post analysis of the results restrict the causality of the data and also reduce the exploration factors of others external variables.
- The intervention was delivered only for specific time duration with, limited sessions (30-40 sessions) with the lack of long term follow up and measurement of the sustainability of the intervention.

Recommendations

- With increasing digitalization, integrating digital therapy and computer based technology into school programs is essential. Research indicates that these techniques can enhance engagement and consistency for children with developmental disabilities. They provide structured yet adaptable activities that fit well within IEPs and support individualized instruction and therapeutic interventions. So it is requested to Directorate General of Special education that digitalization procedures may be adopted in centers for special education.
- Digital therapy platforms provide real time data on a child's performance and engagement results/ feedbacks, giving parents and teacher's clearer insight into progress.
- Interactive digital therapies stimulate neuroplasticity by targeting skills such as attention span, working memory, and processing speed. Through repetition and multisensory feedback, these

tools help build new neural pathways, improving attention, focus, and academic performance in children with MID.

- Children with MID may pay close attention during these supervised, play based activities and react to certain cues, such as stories, instructions, or sound patterns. Assist children in Enhancing their working memory, focus, and auditory processing, all of which are crucial for communication and learning in the classroom.
- To improve visual scanning, discrimination, and sustained attention, structured exercises and computer based or tabletop tasks are involved. Spot the difference, pattern recognition, matching cards, and visual sequencing tasks are a few examples. It enhances the fundamental executive skills that help children diagnosed with MID in facilitating reading, writing, and problem solving.

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