

# Cumulative Rehearsal and Auditory Verbal Memory of Persons with Down Syndrome

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**Abstract:** One of the characteristics of persons with Down syndrome is poor memory, especially the Auditory-Verbal Memory (AVM). Lack of verbal memory among persons with Down syndrome is one major factor that inhibits learning. This is why the effort towards enhancing AVM of persons with Down syndrome is evolving. This study, therefore, investigated the efficacy of cumulative rehearsal on auditory verbal memory of persons with Down syndrome with speech production and gender as moderator variables.

A 2 x 2 x 2 factorial matrix of pretest-posttest control group experimental design was used in the study. A sample of thirty participants was drawn from a population of 44 persons with Down syndrome and randomly assigned to control and experimental groups in two special schools; National Orthopaedic Special School, Igbobi, and Modupe Cole Memorial Childcare and Treatment Home/School, Akoka. Data was collected using a validated self-developed instrument, Auditory Verbal Memory Assessment Scale (AVMAS) ( $r=0.86$ ). Two hypotheses were tested using ANCOVA.

Findings from the study revealed that: cumulative rehearsal therapy significantly impacted the auditory-verbal memory of persons with Down syndrome, with significant improvement observed. There was no significant interaction effect of speech level and gender with the therapy.

It was thus concluded that cumulative rehearsal therapy is effective in enhancing auditory-verbal memory and so recommended for the improvement of AVM of persons with Down syndrome.

**Keywords:** Persons with Down syndrome, Cumulative Rehearsal, Auditory Verbal Memory, Experimental design.

## INTRODUCTION

Functional memory is a part of a human being without which learning, socialization, and life fulfillment might be difficult. Every person requires good memory, particularly for learning and development. Auditory verbal memory is essential for life-long learning, particularly for growing children and those with disabilities, including individuals with Down syndrome. Down syndrome is a developmental disability that originates from a chromosomal abnormality. This genetic abnormality is associated with intellectual disability, of which auditory-verbal memory is major. Intellectually, persons with Down syndrome have a cognitive impairment, which is characterized by attention deficit, poor language acquisition, poor general learning skills [1], and poor memory span. Professionals in special education and educational psychology have therefore been concerned with

evolving effective interventions to enhance the memory of persons with Down syndrome.

Impaired auditory-verbal memory in persons with Down syndrome greatly limits their learning and other daily functional activities. Impaired memory adversely affects language acquisition and, by extension, the social interaction of the affected persons. Inability to remember past events affects learning generally; it makes the development of language and social relationships, and personal identity difficult. Different studies have investigated the effect of different intervention strategies on the memory of persons with Down syndrome. However, the majority of the studies have been on the visuospatial aspect of memory, while auditory-verbal memory has received less attention in foreign study, with no local study in Nigeria [2, 3] (Dsaco, 2020). Meanwhile, the profound adverse effect of impaired auditory-verbal memory of persons with Down syndrome has persisted. There is a need, therefore, for intervention to improve the auditory-verbal memory of persons with Down syndrome to

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enable them to learn and live a meaningful life and become useful to the best of their abilities.

Down syndrome is a common chromosomal disorder and genetic cause of intellectual disability [2]. Globally, it has an incidence of about 1 in 1000 live births [4]. The estimated incidence of Down syndrome is one in every thousand live births worldwide. Each year, about 6,000 babies are born with Down syndrome in the United States [5]. Persons with Down syndrome tend to have variable physical features that include: characteristic Mongolian face, small chin, slanted eyes, flat nasal bridge, single crease on the palm, flat and wide face, short neck, extra space between the big toe and second toe, short fingers, short toes, abnormal patterns on the fingertips, poor muscle tone, small mouth, relatively large tongue, protruding tongue, excessive flexibility of the joints [6]. The condition is also associated with physical growth retardation and mild to moderate intellectual disability [7]. With regard to intellectual disability associated with Down syndrome, the average IQ of persons with Down syndrome was reportedly low [6]. Intellectual disability is associated with a short memory span and other learning inhibiting characteristics [8]. The memory of persons with Down syndrome is adversely affected also because the higher centers in the human brain, namely, the Amygdala and Pre-frontal cortex, responsible for memory, tend to be under-developed. If appropriate intervention is not put in place early, a vulnerable child might find life meaningless, which may result in serious social, economic, and educational consequences.

There are three types of Down syndrome: trisomy 21 (non-disjunction), translocation, and mosaicism. Trisomy 21, the most common type of Down syndrome, occurs when there are three rather than two number 21st chromosomes present in every cell of the body. Trisomy 21 accounts for 95% of cases of Down syndrome, while translocation accounts for 4%. In translocation, part of chromosome 21 breaks off during cell division and attaches to another chromosome, typically chromosome 14. Mosaicism occurs when the non-disjunction of chromosome 21 takes place in one but not all of the initial cell divisions after fertilization. When this occurs, there is a mixture of two types of cells, some containing the usual 46 chromosomes and others containing 47. Mosaicism accounts for about 1% of all cases of Down syndrome [2].

Most, if not all, persons with Down syndrome tend to have some degree of intellectual impairment, which

may vary in severity and mode of presentation. They tend to develop cognitive dysfunction that commonly manifests as speech and language impairments [9]. Generally, they present with more difficulty in expressive language than with language comprehension (10). Also, their non-verbal skills tend to be less severely impaired than their verbal skills. These shortcomings are believed to be dependent on the aspect of cognition [11], majorly, memory. Meanwhile, normal language acquisition requires adequate cognition and functional memory).

Three types of memory are important to learning: working memory, short-term memory, and long-term memory [12]. Working memory refers to a mental system that functions in the temporary storage of information and its simultaneous processing or manipulation. It is the memory that is needed for everyday life activities such as learning, reading, writing, arithmetic, language-processing, orientation, and imagination. There are three aspects of working memory; namely, central executive, visuospatial memory, and auditory-verbal memory, also referred to as phonological memory. Studies have shown that individuals with Down syndrome tend to have better preservation of visuospatial memory than auditory-verbal memory [4, 11]. Like every condition associated with intellectual disability, this may have serious consequences on their learning and, perhaps, family life in general [13].

Persons with Down syndrome tend to have very poor auditory-verbal memory when compared with children of similar mental age [14]. Owing to the significance of auditory-verbal memory for effective participation in classroom and day-to-day life activities such as language processing and comprehension, imagination, orientation, and so on, it is imperative to provide an intervention for individuals with Down syndrome to achieve their best in learning. There is also evidence to suggest that gender plays a critical role in memory function, with gender differentially influencing memory type [15]. Females tend to outperform males in verbal-based memory tasks [16], whilst males have an advantage for spatial-based memory. Generally, female children access their memories faster than males, date them precisely, and use more emotional terms when describing memories. Basically, Down syndrome occurs in both males and females. A few studies have shown that more males are affected. Memory deficit is also recorded in both genders, yet, the severity of Down syndrome is reported not to depend on gender [16].

It is reported that persons with Down syndrome also experience a delay in language acquisition and vocalization. They may not begin to speak until they are between 24 to 36 months old as opposed to between 10 to 18 months for typically developing children [17]. Their speech difficulties are in part due to anatomical and physiological differences in their mouth. These anatomical differences include - a small oral cavity with a relatively large tongue, narrow high arched palate, small upper jaw, low muscle tone in the tongue, and weak oral muscles, which inhibit speech, language development, and learning [18]. Yet, functional memory is necessary for further language and vocabulary acquisition.

One of the techniques for enhancing memory span is cumulative rehearsal. Cumulative rehearsal is a strategy for retaining information in the short-term memory in which a person repeats the most recently presented item (for example, a word) and then rehearses it with the items that have been presented before it. The therapy can be administered at home (home-based cumulative rehearsal) or in school (school-based cumulative rehearsal). Because auditory-verbal memory is linked developmentally to language acquisition skills, it may represent the basic necessity for language learning and acquisition [4, 15]. Essentially, the improvement of auditory verbal memory is reported to be enhanced by cumulative rehearsal intervention. Other strategies abound, such as the elaborate (rational) rehearsal, which makes use of mnemonics and passive rehearsal [12]. The choice of cumulative rehearsal is because it is the most appropriate intervention procedure that will benefit persons with Down syndrome as they are unable to manipulate the use of mnemonics associated with elaborate rehearsal. On the other hand, passive rehearsal will not give them enough opportunity to rehearse all the previously presented items. Based on this background, this study investigates the effect of school-based cumulative rehearsal on the auditory-verbal memory of persons with Down syndrome in special schools in Lagos State, Nigeria.

### **Hypothesis**

**Ho1.** There is no significant effect of cumulative rehearsal on the auditory-verbal memory of persons with Down syndrome.

**Ho2.** There is no significant interaction effect of cumulative rehearsal, gender, and speech level on the auditory-verbal memory of persons with Down syndrome.

## **METHOD**

### **Design**

In a pretest-posttest control group, the experimental research design was adopted to establish the efficacy of cumulative rehearsal in enhancing the verbal memory of children with Down syndrome in the selected special schools in this study.

### **Participants**

Participants for this study comprised 30 persons with Down syndrome, selected from two special schools in Lagos state; 15 participants were drawn from National Orthopaedic Special School, Igbobi, which served as the experimental group, while 15 participants that represented the control group were drawn from Modupe Cole Memorial Childcare and Treatment Home/School, Akoka. Consent approvals for individual study participants were received from the parents through the two School Principals.

### **Instrument**

A validated self-developed structured Auditory Verbal Memory Assessment Scale (AVMAS,  $r=0.86$ ) was used for data collection. The instrument had two parts: part one was used to collect information on the participants' bio-data and level of speech functioning. Part two contains the test items for the assessment of auditory verbal memory through digit span and word span. Memory Rehearsal Treatment Package (MRTP) was used as the treatment package. AVMAS was used to measure the level of verbal memory among the study participants before the treatment (pretest) and after the treatment (post-test). MRTP was used as a strategy for the experimental group, while the control group was exposed to conventional methods of teaching.

### **Ethical Approval**

Permission for this study was obtained from the management of the two special schools used for the study. Informed consent was obtained from parents of persons with Down syndrome after the explanation of the study objectives, voluntary participation, and confidentiality of participants' responses/performance.

### **Experimental Procedure**

Stage 1: Pre-experimental stage: the pre-experimental stage was carried out by the researchers. It involved the training of the research assistants and

subsequent pretest assessment of the participants in the two groups (experimental and control) with AVMAS. The process of the cumulative rehearsal technique was explained and demonstrated with examples of digit span and word recall to the research assistants.

Stage 2: Experimental procedures: This was carried out by the trained research assistants under the supervision of the researchers. The sessions were short but frequent. Each session lasted for 10 minutes daily, five times a week, and for a period of six weeks. Each training session consisted of 2 phases: the first phase (learning phase) and the second phase (memory phase). The learning phase involved teaching the children the cumulative rehearsal technique.

Thereafter, the actual memory training began. For the control group, a conventional teaching strategy was used for the same period of time. A post-test was then administered using AVMAS to determine the Auditory-Verbal Memory of the participants after treatment.

**RESULTS**

**General Description of Research Participants**

There are 30 participants in the study. There are 15 participants each in the experimental and control groups. The experimental group has 9 males, 5 with good speech ( $\bar{x} = 15.00$ ;  $\sigma^2 = 9.618$ ) and 4 with fair speech ( $\bar{x} = 10.75$ ;  $\sigma^2 = 6.29$ ), 6 females with 4 good

**Table 1: Descriptive Statistics of the Mean and Standard Deviation of Data on the Effect of Cumulative Rehearsal Therapy on the Auditory-Verbal Memory of Persons with Down Syndrome**

Participants	gender	Speech Level	Mean	Std. Dev.	N
Experimental group	Male	Fair	10.75	6.291	4
		Good	15.00	9.618	5
		Total	13.11	8.131	9
	Female	Fair	7.50	0.707	2
		Good	28.50	8.963	4
		Total	21.50	12.880	6
	Total	Fair	9.67	5.164	6
		Good	21.00	11.269	9
		Total	16.47	10.729	15
Control	Male	Fair	0.00	0.000	3
		Good	1.50	2.811	6
		Total	1.00	2.345	9
	Female	Fair	1.00	0.000	2
		Good	6.00	3.163	4
		Total	4.33	3.559	6
	Total	Fair	0.40	0.548	5
		Good	3.30	3.622	10
		Total	2.33	3.244	15
Total	Male	Fair	6.15	7.267	7
		Good	7.64	9.521	11
		Total	7.06	8.516	18
	Female	Fair	4.25	3.775	4
		Good	17.25	13.541	8
		Total	12.92	12.709	12
	Total	Fair	5.45	6.073	11
		Good	11.68	12.060	19
		Total	9.40	10.598	30

**Table 2: ANCOVA of the Main and Interaction Effects of Cumulative Rehearsal Gender and Speech on Auditory Verbal Memory of Persons with Down Syndrome**

Source	Type III Sum of Squares	Df	Mean Square	F-ratio	p-value	Partial Eta Squared ( $\eta^2$ )
Corrected Model	2651.435 <sup>a</sup>	8	331.429	11.490	0.000	0.814 <sup>a</sup>
Intercept	1170.398	1	1170.398	40.574	0.000	0.659
Pretest	193.985	1	193.985	6.725	0.017	0.243
Therapy Group	964.677	1	964.677	33.442	0.000	0.614
gender	14.070	1	14.070	0.488	0.493	0.023
Speech	146.679	1	146.679	5.085	0.035	0.195
Cumulative rehearsal * gender* Speech	25.267	1	25.267	0.876	0.360	0.040
Error	605.765	21	28.846			
Total	5908.000	30				
Corrected Total	3257.200	29				

a. R Squared = 0.814 (Adjusted R Squared = 0.743).

speech ( $\bar{x} = 28.50$ ;  $\sigma^2 = 8.963$ ) and 2 with fair speech ( $\bar{x} = 7.50$ ;  $\sigma^2 = 0.707$ ). The control group has 9 males, 6 with good speech ( $\bar{x} = 1.50$ ;  $\sigma^2 = 2.811$ ) and 3 with fair speech ( $\bar{x} = 0.00$ ;  $\sigma^2 = 0.00$ ), 6 females with 4 good speech ( $\bar{x} = 6.00$ ;  $\sigma^2 = 3.163$ ) and 2 with fair speech ( $\bar{x} = 1.00$ ;  $\sigma^2 = 0.00$ ).

The result of the analysis, as shown in Table 1, shows that  $F_{(1,27)} = 33.44$ ;  $p = 0.000 < 0.05$ , indicating that the cumulative rehearsal has a significant effect on the auditory-verbal memory of persons with Down syndrome. The result also indicates that the cumulative rehearsal as a treatment has a Partial Eta Squared ( $\eta^2$ ) = 0.614 effects on the auditory-verbal memory of the participants. This implies that cumulative rehearsal as a treatment has an 81.4% effect on the observed difference between the pretest and post-test of the auditory-verbal memory of the participants. The percentage contribution of the treatment is significant; hence the null hypothesis that there is no significant effect of cumulative rehearsal on auditory verbal memory of persons with Down syndrome is rejected at a 0.05 alpha level. This result implies that there is a significant effect of cumulative rehearsal on the auditory-verbal memory of persons with Down syndrome. The adjusted R square also gives a value of 0.743, meaning that the cumulative rehearsal accounted for 74.3 % of the variance of the auditory-verbal memory in the population of persons with Down syndrome.

As shown in Table 2, the result shows that  $F_{(1,21)} = 0.876$ ;  $p = 0.360 > 0.05$ , indicating that the interaction of Cumulative rehearsal, gender, and speech has no

significant effect on the auditory-verbal memory of persons with Down syndrome. The result also indicates that the interaction of Cumulative rehearsal, gender, and speech has a Partial Eta Squared ( $\eta^2$ ) = 0.040 effects on the auditory-verbal memory of the participants. This implies that the interaction of Cumulative rehearsal, gender, and speech has a 4% effect on the observed difference between the pretest and post-test scores in the auditory-verbal memory of the participants. The percentage contribution of the effect of the interaction of Cumulative rehearsal, gender, and speech is not significant; hence the null hypothesis that there is no significant effect of the interaction of Cumulative rehearsal, gender, and speech on the auditory-verbal memory of persons with Down syndrome is accepted at 0.05 alpha level. This result implies that there is no significant effect of the interaction of gender and speech on the auditory-verbal memory of persons with Down syndrome. The adjusted R square also gives a value of 0.743, meaning that the interaction of Cumulative rehearsal, gender, and speech accounted for 74.3% of the non-significant variance of the auditory-verbal memory in the population of persons with Down syndrome.

## DISCUSSION

### Cumulative Rehearsal and Auditory Verbal Memory of Persons with Down Syndrome

The result obtained from the analysis of data collected in respect of the first hypothesis indicates that persons with Down syndrome taught via the cumulative rehearsal technique showed significant improvement in

their auditory-verbal memory. In addition, the application of the cumulative rehearsal training was responsible for the observed difference between the pretest and post-test results of the auditory-verbal memory of the study participants. These findings are in line with the findings of Conners *et al.* [19], who reported an improvement in the auditory-verbal memory span of their study participants following the application of home-based cumulative rehearsal training. These findings suggest that the auditory-verbal memory of persons with Down syndrome can be enhanced with cumulative rehearsal therapy using an auditory-verbal-only procedure as was done in this study. Auditory-verbal memory requires an auditory-verbal-only rehearsal strategy to be strengthened. Consequently, language acquisition and general learning capabilities will be improved.

These findings are also similar to the observations made by Conners *et al.* [19], Comblain [20], and Costa *et al.* [12] through their various empirical studies. They all showed the impact of school-based training on the memory skills of individuals with Down syndrome, for which they reported improvements regardless of the somewhat variations in their study techniques. The consistency of their results has been validated by the findings of the current study. It is therefore obvious that the application of the cumulative rehearsal strategy will enhance the auditory-verbal memory and, by extension, the learning and speech abilities of persons with Down syndrome.

### **Interaction of Cumulative Rehearsal, Gender, and Speech on Auditory Verbal Memory of Persons with Down Syndrome**

The findings on the interaction effect of cumulative rehearsal, gender, and speech level on auditory verbal memory of persons with Down syndrome were not significant. Gender singly and as a moderator variable had no significant effect on the observed difference between the pretest and the post-test of the auditory-verbal memory of the study participants. These findings are in line with the findings of Conners *et al.* [14], who observed modest improvement in auditory-verbal memory of their participants exposed to cumulative rehearsal in a home-based study and found no relationship between gender and improvement of auditory-verbal memory of the participants. This result implies that cumulative rehearsal therapy can enhance the auditory-verbal memory of persons with Down syndrome irrespective of gender. Besides, they reported that the improvement in the auditory-verbal

memory following the cumulative rehearsal training was not related to chronological age, non-verbal ability, and behavioral variables but to several training sessions completed by their study participants.

On the aspect of speech effect on the auditory-verbal memory of persons with Down Syndrome, the result of the analysis shows that speech singly had no significant effect on the auditory-verbal memory of persons with Down syndrome, and as a moderator variable, the speech did not affect the observed difference between the pretest and post-test of their auditory-verbal memory. This suggests that the effectiveness of cumulative rehearsal on auditory-verbal memory is not dependent on the speech levels of children with Down syndrome.

These findings are in line with the findings of Conners *et al.* [14], who observed, as earlier mentioned, that the non-verbal ability of their study participants was not related to improvement in the auditory-verbal memory following the cumulative rehearsal training protocol. Further studies with a larger sample size and rigorous cumulative rehearsal training sessions will be required to clear these conflicting observations. On the whole, the result of data analysis reveals that the cumulative rehearsal, gender, and speech concertededly produced only a minimal effect on the observed difference between the pretest and post-test scores in the auditory-verbal memory of the study participants, whereas the effect of treatment on the difference observed on these scores was significant.

The implication of this result is that improvement in the auditory-verbal memory span of persons with Down syndrome does not necessarily depend on the presence or absence of speech and on whether the affected individuals are females or males. Furthermore, it is a clear fact that individuals with Down syndrome, no matter their level of language/speech development or whether they are males or females, tend to have poor auditory-verbal memory. The use of cumulative rehearsal in enhancing the auditory-verbal memory of persons with Down syndrome towards the attainment of a functional memory has been established.

### **STUDY LIMITATION**

The finding of this study is limited in geographical scope to the Lagos state of Nigeria. The participant scope is limited to persons with Down syndrome who ordinarily experience auditory verbal memory loss.

## CONCLUSIONS

Speech, language, and memory play important roles in general learning, especially for persons with intellectual disabilities. For normal speech development, language acquisition, and learning, there is a need for adequate cognition and functional memory. This is especially important for growing children and persons with intellectual disabilities, including those with Down syndrome. Persons with Down syndrome have some levels of intellectual impairment, which vary in severity and mode of presentation and reflects mostly in impairments in speech development, language acquisition, and memory span, especially auditory-verbal memory. Nonetheless, since a functional auditory-verbal memory is required for learning and development, this provided the impetus for intervention.

The administration of the cumulative rehearsal strategy on persons with Down syndrome, as revealed by this study, improved their auditory-verbal memory independent of gender and speech development. These findings, like others before it, thus provide the bases for advocating the use of cumulative rehearsal strategy as a veritable tool for specialized education for improving the auditory-verbal memory of persons with Down syndrome.

## RECOMMENDATION

The therapeutic technique should be administered as a school-based training protocol for special needs and inclusive education teachers. The cumulative rehearsal technique is attested to enhance the memory of children with Down syndrome. Therefore, it should be integrated into the school curriculum for teaching persons with Down syndrome to enhance and develop their auditory-verbal memory.

Teachers should be appropriately trained on the technique (cumulative rehearsal) so that they will be able to use it to teach persons with Down syndrome for the improvement of their auditory-verbal memory. Necessary retraining for teachers who need it should be organized through workshops, and the government and relevant agencies should provide this regularly to give teachers updates and training on the use of cumulative rehearsal.

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