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Chapter 5

SHORT AND LONG TERM MEMORY IN PEDIATRIC IDIOPATHIC EPILEPSY: FUNCTIONS AND EFFECT OF INTERVENTIONS

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ABSTRACT

Multiple diseases affect memory, but only in a few pathological processes, memory systems are discretely affected, allowing to study short and longterm - resilience and susceptibility of memory systems, in the absence of other background cognitive deficits. Idiopathic epilepsies (IE) are considered to have relatively good prognoses and normal or near normal developmental outcomes. Nevertheless, accumulating studies demonstrate memory and executive functions deficits in this population. The aim of this chapter is to describe in details memory systems in children with IE and to present a new structured cognitive group intervention protocol in children with mild memory deficits.

The intervention program is designed to improve auditory verbal short term and long term memory using strategic abilities in a specific manner. The program is composed of 5 weekly sessions in a group format. 33 children with IE, ages 9-14 years participated in the research protocol and were compared to 27 age and education matched healthy control. Initial results demonstrate that auditory verbal short term memory skills which were frequently deficient at baseline were improved as a result of the intervention. Further analysis indicated that executive functions mediated the intervention effect. The effects were such that participants with higher EF functioning gained less from the intervention and improved their auditory memory less than participants with lower baseline EF. Results suggest that group therapy for children with mild memory impairments such as children with IE may benefit from short term intervention which is specifically tailored to limit the degree of the persistent auditory verbal memory deficits.

Based on these results, the chapter presents a theoretical model for memory intervention paths, designed for pediatric populations with mild memory deficits with emphasis on the role of executive functions in short term memory rehabilitation in these patients.

Future studies that will focus on pediatric populations with mild memory deficits and widen the knowledge on executive functions role in memory rehabilitation, utilization of retrieval strategies in memory intervention protocols and methods that help assimilate strategies learned are recommended in addition to examining long term effect and ecology of the model presented.

INTRODUCTION

Epilepsy, a group of disorders that cause disturbances in electrical signaling in the brain, is a fairly common in the general population [1]. An epileptic seizure occurs when an electric pulse surges rapidly due to abnormal, excessive or synchronous neural activity in the brain [2]. This brief electrical surge can transpire in a limited brain region, or it can affect the whole brain. Depending on the affected area, this surge can produce changes in a person's sensations or state of consciousness. It can also instigate uncontrolled movements of certain parts of the body or of the whole body [3]. There are three main types of epilepsy: idiopathic (elicited by an unknown cause), symptomatic (activated by an identifiable etiology), or cryptogenic (with an un-known cause). Idiopathic epilepsy can be partial (seizures involving only part of the brain) or generalized (seizures involving both sides of the brain) [4, 5]. Idiopathic epilepsy tends to appear during childhood or adolescence [6]. People with idiopathic epilepsy (IE) typically display normal intelligence and typical neurological and MRI results [6], yet electroencephalogram (EEG) tests, which measures electrical impulses in the brain, may show epileptic discharges affecting the entire or part of the brain [7-9]. IE was considered for many years to result in a preserved cognitive profile, as well as in preserved memory. Nevertheless, data from the recent decade indicate that memory difficulties represent the most common clinical complaints in patients with epilepsy, including those with IE type [10, 11], suggesting that the cognitive impact of epilepsy has been at times underestimated.

MECHANISMS FOR MEMORY LOSS IN EPILEPSY

Basic neurophysiological work suggests that seizures can modify, slow down, or accelerate a wide range of unique processes that take place during development and that are essential for the correct formation and function of brain circuitry and for memory [12].

According to several studies, three main factors are considered to be involved in IE patients' memory impairments. The first factor is the underlying etiology for epilepsy. For example, memory impairments resulting from childhood absence epilepsy [13] are different from impairments resulting from idiopathic generalized epilepsy or rolandic epilepsy [14-16]. The second factor has to do with the effects of seizures/epileptiform EEG discharges themselves, which insult consolidation during sleep of declarative memories [17]. In addition, memory impairments can result from the effects of chronic repetitive spikes that inhibit or disrupt activity in the same cortical area for many years [7]. The third factor concerns the effects of antiepileptic drugs (AEDs), as several AEDs, such as Topiramate and

Phenobarbital, are associated with memory problems in children [18]. Though most patients with epilepsy are successfully treated with a single antiepileptic drug (monotherapy), this sometimes does not lead to complete seizure control, and thus in at times a combination of antiepileptic medications are prescribed (polytherapy) [18, 19]. Several studies have shown polytherapy results in more pervasive cognitive deficits than monotherapy [18, 20]. With this in mind, it seems important to explore what particular memory deficits are expected in IE.

DISCRETE MEMORY DEFICITS IN IE

Memory is a multi-system construct [21] with different types of memory systems affected to varying degrees in childhood epilepsy [11, 14, 22, 23]. Most cognitive theoreticians address memory as a continuous process that involves different stages, including: encoding, storage and retrieval [21]. One common theoretical framework used to define memory differentiates between three types of time-dependent memory systems: short term memory (STM; 24, 25), long term memory (LTM; 26, 27-30); and working memory (WM; 31, 32-34).

STM in idiopathic epilepsy: Research regarding whether or not STM is affected in children with IE have yielded conflicting results. Several studies have demonstrated that processes of encoding and immediate recall are preserved in children with IE [11, 14, 23, 35, 36], while others have discovered greater risks for STM deficits in this population [15, 16, 37, 38]. Several factors may play into this discrepancy. One reason may be attributed to the fact that some studies were conducted when the participants were in remission as during remission, many patients show improved performance in a general intellectual test [15]. Other reasons may be related to differences in test sensitivity or task impurity [39].

A third explanation for these discrepancies may arise from diverse etiologies that fall under the category of idiopathic. Some idiopathic syndromes are benign, such as benign epilepsy with centrotemporal spikes [4], whereas others involve different brain substrates, such as is often the case in primary generalized epilepsy [5]. These diverse etiologies may form different memory impairments [40]. *LTM in IE*: Unlike in STM, LTM, and especially auditory verbal LTM [16] has been determined as a major area of deficit in children with IE. These deficits usually include delayed recall and recognition [14-16, 23, 35-38, 41, 42].These deficits may indicate the impairment in LTM may possibly result from deficits in storage and retrieval of information. *WM in IE*: While there may be significant individual variations, it was found that there is a high probability of relative deficits in aspects of processing speed and working memory in childhood epilepsy regardless of specific etiology [43], more specifically in children with recently diagnosed epilepsy [44], in particularly in children with idiopathic generalized epilepsy [16, 36, 38, 45, 46] and in children with benign epilepsy with centrotemporal spikes [14-16, 37, 47].

MODALITY DIFFERENCES IN IE

In recent years studies point to the role of modality in memory impairments in epilepsy, highlighting a particular sensitivity in coding and memorizing auditory verbal material as compared with nonverbal or visual stimuli [14-16, 35]. These deficits seem to also extend to

other types of epilepsy, namely with benign epilepsy with centrotemporal spikes [for instance; 37, 47, 48-50] and Panayiotopoulos epilepsy [for instance 51, 52]. More specifically, whereas STM impairments are eminent in both auditory verbal and in nonverbal systems, LTM and WM deficits are mainly noted in response to auditory verbal cues. These deficits have been noted using canonical tools such as the digit span test and Rey auditory verbal test [14, 53].

Overall, it seems that children with IE tend to suffer from a pervasive auditory verbal memory impairments in STM, LTM and WM; as well as a marked susceptibility in STM, evident by deficits in holding in STM both verbal and nonverbal information. There is no consensus, however, whether STM impairments in this population are transient or chronic.

Considering Rehabilitation of Memory Deficits in IE

Deficits in global cognition [54], processing speed and memory [16, 42, 55] are associated with poorer quality of life in children with epilepsy, highlighting the need for early identification and intervention.

For this reason, designing a rehabilitation program suitable for children with IE, focusing mainly on auditory verbal impairments, while taking into account patient's preserved intelligence, seems warranted. Moreover, recent studies on memory rehabilitation among children have highlighted executive functions' role in memory rehabilitation [56] and in cognitive behavioral therapy [57, 58]. For this reason examining EF role in IE seems warranted when designing memory rehabilitation for this population.

EXECUTIVE FUNCTIONS MAY SUPPORT SHORT AND LONG TERM MEMORY IN PEDIATRIC IE

The term "executive function" refers to a set of higher order cognitive skills that allow purposeful, goal-directed activity, such as initiation of behaviors, planning in order to complete a desired activity, and self-regulation of behavior [59-61]. The study of executive dysfunction in pediatric epilepsy is particularly important, as the development of these cognitive skills follows a protracted course paralleling functional maturity of the frontal systems [61]. In addition, executive functions play a central role in memory functions and memory rehabilitation [56, 62-65].

Executive functions deficits are frequently found to affect children with IE [22, 66-70]. Interestingly, there is a strong relation between severity of executive function deficits and epilepsy severity [69].

Considering the integrity of EF, it is important to explore the role of age and development. From school age through adolescents, executive attention and cognitive strategies go through a marked developmental spurt, with some young patients enjoying the advents of fairly mature EF networks and others having to rely on immature ones. A recent review on efficacy of memory interventions with children who suffer from childhood CNS disorders suggests that the use of memory rehabilitation techniques that rely on executive components after 7 years of age yields better outcomes [56]. In that review, we suggested that

there is a possible mediating roles of executive functions and metacognitive abilities in supporting memory during in middle childhood [71, 72]. Hence it seems important to consider the mediating role of EF in understanding memory intervention effects in IE.

MEMORY INTERVENTION PROTOCOL FOR CHILDREN WITH IE

In view of the above information, we designed a group memory intervention procedure for children aged 9-14 who suffer from IE. Our approach to rehabilitation was guided by encouraging memory intervention results in other pediatric populations, such as children with CNS disorders of childhood [73-76], fetal alcohol syndrome [77] and other disorders [78, 79], all pointing to the notion that auditory verbal WM and STM may possibly improve as a result of comprehensive memory interventions [56]. The program presented in the current chapter was specifically designed for children with IE and the specific cognitive challenges children in this population face [11, 16].

The underlying mechanism that explains how intervention improves memory functions is not clear. There is a debate in the literature concerning whether memory itself can be improved as a result of practicing strategies, or whether mediating factors are actually being targeted for intervention [56]. In the current framework, we explored three possible paths (see figure 1):

a) A direct path: improvements in memory are caused directly by learning memory strategies.
b) A mediating path concerning EF: improvements in memory are moderated by improvements in executive skills [16, 65].
c) A mediating path concerning medication: improvements in memory are moderated by medication profile, with children who receive monotherapy improving more so than children who receive polytherapy [18].

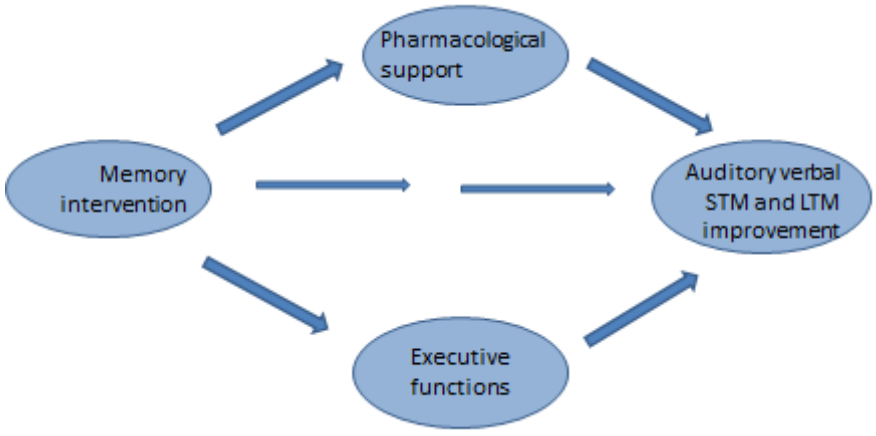


Figure 1. Direct and indirect path s for memory improvement in IE.

MEMORY INTERVENTION PROTOCOL TAILORED FOR CHILDREN WITH IE

The intervention program was developed as a brief, 5 group session training program (approximately 10 child-training hours in total, two hours per group meeting) that teaches strategies designed to improve auditory verbal memory daily functioning with an emphasis on self-monitoring and self-efficacy stances. We opted for specifically targeting auditory verbal memory deficits, given its central role in IE, and hypothesized a domain specific effect, such that a tailored intervention would affect auditory verbal memory more than it would affect less directly targeted domains, namely visual memory.

The focus of the memory training module was on learning a variety of strategies and techniques to improve organizational and memory skills. The first memory training session began with an open discussion of the rehabilitation program goal, including its aims and objectives. This session was followed by interactive memory games that incorporated participant's personal characteristics (e.g., names and hobbies) while presenting auditory verbal STM memory strategies [80]. The game was followed by a discussion about the idea that forgetting can occur at different rates, for different reasons and it can affect successful encoding and retrieval (e.g., attention, fatigue, physical limitations, pain, medication, stress). At the completion of the first session, self-awareness of individual memory slips, such as forgetting to complete homework assignments or to deliver a message, was promoted by encouraging participants to maintain a "slips" log throughout the week. In addition participants were briefly asked to practice the strategy that they learned in the session.

The second training session continued the focus on external strategies. It began with a review and discussion of memory slips that participants logged throughout the week and of practicing memory strategies. The use of strategies such as smartphone© reminders was practiced and encouraged [81, 82]. For example, each child received a note with a specific hour and programed the smartphone reminder. During the session, participants were asked to press a bell placed in the middle of the room on the specific time they received. At the same time, additional auditory verbal elaborative encoding technique and strategies for enhancing remembering were practiced [83], such as connecting knowledge and background story for the information that should be remembered. Diverse objects were placed in the middle of the room and participants were asked to remember the objects by telling a story or connecting the object to past experience. The children were amazed to discover that after connecting the object to past experience they remembered better. At the conclusion of this session, participants were asked as homework to practice the strategy and to send a message to the group counselor on specific date by using a Smartphone reminder.

The primary focus of training sessions 3 to 5 was to practice a variety of internal strategies which help to encode information in a deep and meaningful way and implement using external memory aids in daily life. For these purposes, participants were introduced and practiced the following strategies: visualization, categorization, question asking and association [21] all improving auditory verbal STM. Each strategy was taught using games and materials suitable for children. For example visualization was practiced using drawings of the material learned, and categorization was practiced using daily chores of each child making the memory intervention relevant for the children's life. As for daily memory functioning, learning the importance of routines and habits was one of the memory intervention goals

(placing keys or cellular phone in the same location in the house ensures being able to find them when needed) and participants were introduced to the idea and asked to practice it through the following weeks. In addition training of everyday memory compensatory aids was done by using Smartphone reminders in daily life and during the sessions. As homework between sessions 3 to 5, participants were given assignments for practicing the various strategies and planning the Smartphone reminder in order to perform several tasks during the week in their natural home/school settings. For example participants were asked to send messages for each other, to use categorization in order to plan the afternoon assignments etc. Although participants were encouraged to learn and practice all strategies, it was recognized that different strategies work for different children in different situations and that combinations of strategies are commonly used.

Intervention Efficacy: Promising Pilot Results

Participants and design: We have conducted a study with thirty-three 9-14 year olds (mean age M = 10.88, SD = 1.5; 51% female) who were diagnosed with IE, and 27 healthy control participants, aged 9-14 years (mean age M = 10.18, SD = 1.4; 52% female). All fluent in Hebrew (their native language) were enrolled in the study [84] All participants had an estimated intelligence score within normal limits based on the block design subtest from the WISC-IV [85] (Estimated intelligence quotient, ESIQ >79), and were enrolled in mainstream schooling.

For the IE group, children were enrolled through the neurology department at Sheba hospital and at the neurology department at Schneider Children's hospital at the Rabin Medical Centre, Israel. Medical history, electroencephalography, and imaging data were reviewed by the treating neurologists according to the International League against Epilepsy (ILAE) criteria for IE [4]. Inclusion criteria consisted of at least one unprovoked non-febrile seizure or status epilepticus in the past, but no current seizures (balanced condition). Further all participants were classified with idiopathic etiology: benign Rolandic epilepsy (n = 18), absence epilepsy (n = 4), and generalized epilepsy (n = 11). Exclusion criteria included temporal epilepsy, structural epilepsy, metabolic epilepsy, co-morbid neurological disorders other than ADHD [86], co-morbid chronic illness (e.g., diabetes and asthma), major depression [86], psychosis, and prescribed use of Topiramate and Phenobarbital AEDs.

The control participants were comprised of 27 children (14 females, 13 males) who were matched to the epilepsy group for age and sex. These children showed no evidence of any neurological or other disorder. Children were randomly recruited from mainstream public schools in the (central) district of Israel via word-of-mouth (snowball recruitment) and were exposed to the same educational curriculum as the epilepsy group. Their past medical history, as reported by their parents, was unremarkable. The same inclusion criteria used for the epilepsy group was also used for the control group with regard to age, intelligence, reported head injuries, schooling, psychiatric involvement, and/or medication.

Intervention efficacy was tested using two comparable pre-post intervention testing sessions that employed comparable, yet non-identical assessment items in order to limit item exposure effects (further details in [84]). The pre-assessment conducted one to two weeks before intervention provided baseline measures and the post-assessment assessed participants' performance in the two weeks following completion of the intervention. The training sessions

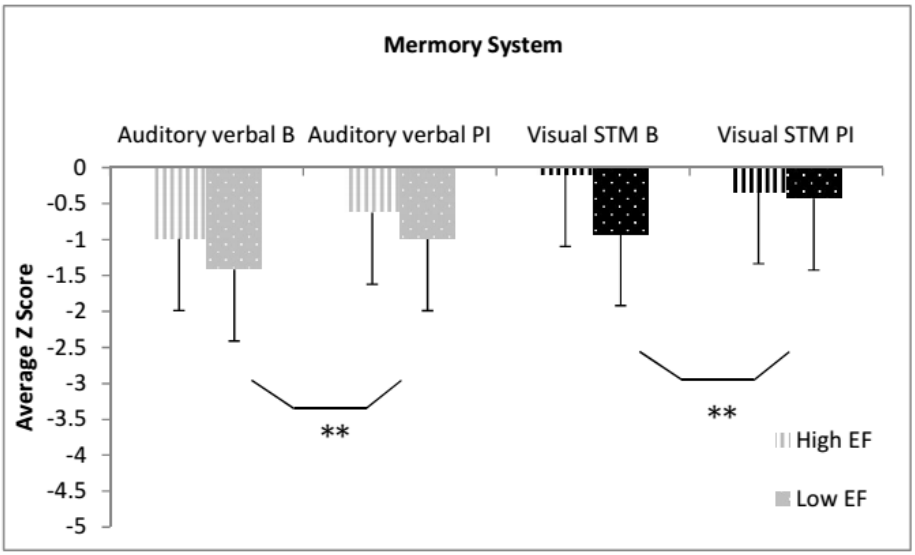
were administered to groups of 4– 6 participants in carefully matched ages and mixed genders. Missed attendance was negligible (3% missing attendance), with make-up sessions provided to ensure that all participants received the same amount of training. Homework task completion was monitored between sessions, using parental mediation via emails, in order to maximize efficacy and to ensure comparability.

RESULTS

Direct Path: Memory Systems Analysis

In the analysis conducted to examine whether intervention will affect auditory verbal memory more than it will affect visual memory, a significant effect for mode was found such that auditory memory was lower relative to visual memory. In addition, a significant main effect for intervention was seen, such that an improvement in memory functions was evident in both modalities (auditory and visual memory) as a result of intervention. There was no interaction between mode and intervention indicating a domain general effect of intervention [84].

In the next step an investigation of the specific memory system (STM, WM and LTM) was conducted. We included verbal STM, LTM and WM scores in a repeated measures analysis, comparing memory systems pre- and post-intervention. Results showed a moderate effect for memory system and a near significant interaction between memory system and intervention effect though post-hoc examination highlighted a post-intervention improvement only in verbal STM [84].



Legend: B, baseline assessment; PI, post intervention assessment.
*p < 0.05; **p < 0.01.

Figure 2. Intervention effect: Auditory memory versus visual memory as a function of executive functions.

Lastly, frequency of normalized performance as a function of intervention was performed. Results demonstrated that at baseline, participants with IE were at a higher risk for auditory verbal memory and for verbal STM more than controls.

In the post treatment analysis, the risk for auditory verbal memory and for verbal STM post intervention was markedly reduced [84].

EF moderation path: Findings showed that the children with IE have lower executive functioning than controls and that post intervention no EF improvement was seen [84]. Then, we examined the role of executive functions (EF) as measured at baseline in memory outcome comparing auditory verbal memory and visual memory before and after intervention as a function of EF (high vs low, defined by a median-split). This analysis resulted in a moderate main effect for mode ($F_{(1,26)} = 28.124$, $p < 0.0001$, $\eta^2 = 0.529$) and intervention ($F_{(1,26)} = 8.888$, $p < 0.01$, $\eta^2 = 0.262$). In addition a significant interaction between mode, intervention and EF was found ($F_{(1,25)} = 6.820$, $P < 0.05$, $\eta^2 = 0.214$), such that participants with lower functioning of EF tended to show improved auditory verbal memory relative to participants with higher EF. This suggests that auditory verbal memory improvement was moderated by EF (see Figure 2).

Moderation of pharmacological support: To explore whether the noted improvement after intervention is related to the intervention protocol alone, or rather is moderated by the participant's routine care prescribed pharmacological intervention, we conducted the same analysis with pharmacological intervention as a between subjects variable (2 levels: monotherapy versus polytherapy) . Analysis indicated that the above results were preserved; indicating that pharmacological intervention does not account for further explained variance [84].

To conclude, these results showed that auditory verbal memory and visual memory improved as a result of our intervention and that baseline EF played a role in auditory verbal improvement. In addition medication profile did not play a role in intervention outcome.

DISCUSSION

The main goal of the current chapter was to present an intervention that is specifically designed to support short- and long term auditory verbal memory deficits in children with IE. Furthermore, this research aimed to deepen the understanding of the mechanisms involved in the intervention process. To do this, we examined the roles of EF and pharmacological profile on memory outcome of this population. Data showed that a susceptible neuropsychological domain (i.e., auditory verbal memory) was improved as a result of this intervention protocol. Further, analysis showed that baseline EF played a role in these effects, such that children with low EFs profited more from the intervention than children with high EF, although both groups demonstrated improvements in memory post intervention. The implications of these findings are briefly discussed below.

The cognitive profile of children with IE is characterized by intelligence within normal range with diverse moderate memory and EF impairments [7, 15, 16, 69, 70]. This specific cognitive profile doesn't characterize children with IE only, but is eminent in other neurological disorders such as post-concussion or after minor traumatic brain injuries that may cause mild memory deficits [87, 88]. For this reason results may underscore a promising

direction for other samples with mild memory deficits as current results seem to indicate efficacy for short term focused intervention programs with children with a comparable neuropsychological profile.

The intervention program results demonstrate auditory verbal memory amenability to intervention that is mediated by EF. Two points emerge from this result; the first concerns the particular sensitivity of auditory verbal memory to intervention; and the second concerns role of executive functions in memory rehabilitation.

Auditory Verbal Short and Long Term Memory in Rehabilitation for Children with IE

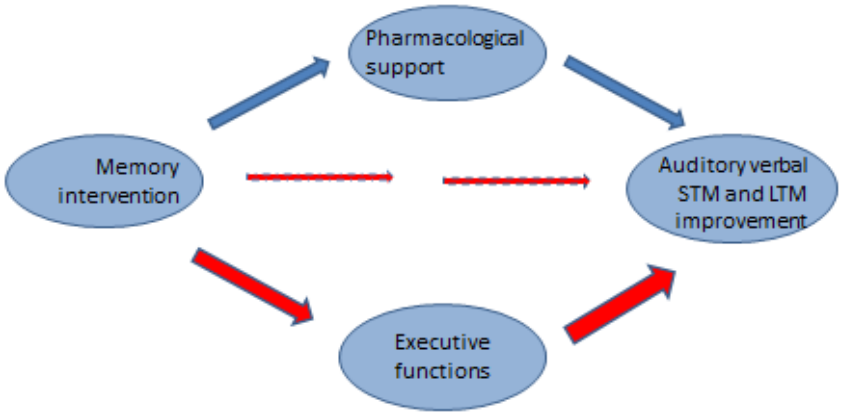
Results seem to demonstrate that children with IE can benefit from specifically tailored memory rehabilitation to improve their most affected memory system, auditory verbal memory [14-16]. This finding may be promising, in that auditory verbal memory is important for all ages, but specifically at school age. Children at school age face multiple challenges in dealing with auditory verbal memory tasks, especially when learning new materials. Auditory verbal memory is also important in social interactions, such as in forming autobiographical memories (i.e., recalling personally experienced events), keeping a conversation going and remembering content [89-92]. This suggests that improving short and long term auditory verbal memory in children with IE, who suffer from a deficit in this specific memory system, may help improve social functioning as well as auditory verbal memory impairments.

However, the investigation made in order to discover which memory system was most amenable to intervention discovered that short term memory improved the most as a result of intervention.

Apparently improving long term memory seems to be a complicated task [56, 93, 94] although children were taught mainly elaborative encoding strategies that theoretically improve LTM as well as STM [21]. In order to delve into this question we went back to results and deepen the examination of different memory systems in LTM. It is well known that LTM can be divided into two parts sub-systems: an explicit system whereby auditory verbal material that is retrieved explicitly using recall questions (the child tells what he or she remembers from a story) and an implicit one, whereby auditory verbal material that is retrieved implicitly using recognition questions (using multi choice questions or yes or no questions) [21]. In this view, when examining our results again we discovered that current results seem to indicate improvement in the implicit LTM network, evident by improvements occurred only when recognition questions were asked and that using an average score of LTM befogged this finding. This pattern possibly points on *retrieval difficulties* rather than un-improvement in LTM memory consolidation of system as a whole information. This notion seems to be strengthened by several studies pointing on retrieval difficulties in children with IE [36, 95] and in other CNS disorders [96, 97].

On a similar vein, anecdotal information indicates that an interesting phenomenon occurred in many participants in our study: often children could not say explicitly what they have gained from intervention and what strategy they used. Nevertheless observation during assessments discovered implicit utilization of strategies with supremacy to rehearsal techniques. What does this observation can teach us about the role of implicit memory in pediatric memory interventions?

It is known that implicit memory develops early in life and reaches to adults' level very soon [98]. Considering this and taking into account intervention outcome, children with mild memory deficits may gain from interventions even if they do not recognize it. Similar mode of intervention is evident in errorless learning method [99] in which clients learns implicitly auditory verbal material [100-103]. In this regard, our results may point to the importance of practicing memory strategies even if explicit retrieval of a learnt method is not accessible. In comparison to our sample, a study with participants with mild-moderate memory impairments showed that implicit memory strategy (using errorless learning), produced greater accuracy in name recall than did trial-and-error learning [104]. These results seem to also strengthen our observation with regard to improvements in implicit LTM and calls for future studies aiming to promote retrieval strategies in this population. Nevertheless the use of diverse memory rehabilitation strategies aiming to improve STM and LTM, seems to be effective in improving auditory verbal memory as a whole, but needs further research in order to investigate what effects explicit LTM as well. The lack of efficient retrieval strategy may be related to compromises in strategy use, deficits in retrieval and/or be related to deficits in systems supporting executive abilities (Figure 3).



Legend: In red: significant path; In blue: nonsignificant path.

Figure 3. Outcome of intervention: direct and indirect path for memory improvement in IE.

EF Role in Memory Rehabilitation

Current results showed that the presented intervention, which highlights specific strategies to improve memory, did not improve executive functions, but rather relied on the child's baseline executive functions to improve memory functions. This finding extends a compatible finding noted with elderly people with subjective complaints of cognitive or memory decline [105] and with adults who show a variety of suspected neurological and psychiatric conditions, including head injury, dementia, vascular disorders and neoplasms [106], underscoring the role of preserved executive functions in memory rehabilitation and calls for further investigation on the mechanisms which cognitive behavioral interventions rely on. Such a notion would merit further studies with other clinical cohorts.

CLINICAL IMPLICATIONS

First, the current results point the role of EF in improving verbal memory in this population. These results call for assessing the neuropsychological profile of children with mild memory deficits, as a careful delineation of the memory deficits may be fruitful in order to plan the efficient rehabilitation intervention.

Moreover, structuring EF interventions for children in order to improve baseline EF may strengthen memory intervention efficacy in children with mild memory impairments.

Combining explicit memory strategies, specific strategies to improve retrieval and implicit memory strategies may be fruitful and enhance children profit from memory intervention.

Finally, interventions with children are recommended to address family issues, as the family often experience stress associated with their child's condition. In this regard, an interesting observation was that the parents created an unintended support group. It was noted that the parents had shared their experiences and gave and received emotional support by waiting together and letting themselves meet each other. For this reason, perhaps a more structured support group, with estimation for parental support may be highly useful.

CONCLUSION

The chapter presents a theoretical model for memory intervention paths, designed for pediatric populations with mild memory deficits with emphasis on the role of executive functions in short term memory rehabilitation in these patients. The model supports using short term group intervention protocol for children with IE who suffer from mild memory impairments. Results highlight that while retrieval of information from LTM is more resistant to intervention in this population. STM is amenable to intervention. Moreover, baseline EF seems to play a significant role in rehabilitation of this population pointing on the mediating roles of executive functions and metacognitive abilities in supporting memory.

This study points to the importance of intervention specifically designed to improve short and long term memory deficits in pediatric IE in particular and perhaps other neurological population with mild verbal auditory memory impairments.

REFERENCES

[1] Palencia R: Prevalence and incidence of epilepsy in childhood. *Revista De Neurologia.* 2000, *30(s):*1-4.

[2] Fisher R, van Emde Boas W, Blume W, et al.: Epileptic seizures and epilepsy: definitions proposed by the International League Against Epilepsy (ILAE) and the International Bureau for Epilepsy (IBE). *Epilepsia.* 2005, *46:*470-472.

[3] Aldenkamp A, Dreifuss F, Reiner W, Suurmeijer T: *Epilpesy in children and adolescents*. Boca Raton: CRC press, 1995.

[4] Scheffer IE, Berkovic SF, Capovilla G, et al.: The organization of the epilepsies: Report of the ILAE Commission on Classification and Terminology. 2014.

[5] Panayiotopoulos C: *Idiopathic Generalised Epilepsies*: Springer, 2010.
[6] Camfield P, Camfield C: Epileptic syndromes in childhood: clinical features, outcomes, and treatment. *Epilepsia.* 2002, *43:*27-32.
[7] Nicolai J, Van Der Linden I, Arends JB, et al.: EEG characteristics related to educational impairments in children with benign childhood epilepsy with centrotemporal spikes. *Epilepsia.* 2007, *48:*2093-2100.
[8] Aldenkamp A, Weber B, Overweg-Plandsoen W, Reijs R, van Mil S: Educational underachievement in children with epilepsy: a model to predict the effects of epilepsy on educational achievement. *Journal of Child Neurology.* 2005, *20:*175-180.
[9] Kellaway P: The electroencephalographic features of benign centrotemporal (rolandic) epilepsy of childhood. *Epilepsia.* 2000, *41:*1053-1056.
[10] Kadis D, Stollstorff M, Elliott I, Lach L, Smith M: Cognitive and psychological predictors of everyday memory in children with intractable epilepsy. *Epilpesy and Behavior.* 2004, *5:*37-43.
[11] Gascoigne MB, Barton B, Webster R, et al.: Accelerated long-term forgetting in children with idiopathic generalized epilepsy. *Epilepsia.* 2012, *53:*2135-2140.
[12] Holmes G: Pathogenesis of learning disabilities in epilepsy. *Epilepsia.* 2001, *42:*13-15.
[13] Nolan M, Redoblado M, Lah S, et al.: Memory function in childhood epilepsy syndromes. *Journal of Paediatric and Child Health.* 2004, *40:*20-27.
[14] Goldberg-Stern H, Gonen O, Sadeh M, et al.: Neuropsychological aspects of benign childhood epilepsy with centrotemporal spikes. *Seizure.* 2010, *19:*12-16.
[15] Bhise VV, Burack GD, Mandelbaum DE: Baseline cognition, behavior, and motor skills in children with new-onset, idiopathic epilepsy. *Developmental Medicine and Child Neurology.* 2010, *52:*22-26.
[16] Schaffer Y, Ben Zeev B, Cohen R, Shufer A, Geva G: Auditory verbal memory and psychosocial symptoms are related in children with idiopathic epilepsy *Epilepsy & Behavior.* 2015, *ahead-of-print*.
[17] Galer S, Urbain C, De Tiège X, et al.: Impaired sleep-related consolidation of declarative memories in idiopathic focal epilepsies of childhood. *Epilpesy and Behavior.* 2015, *43:*16-23.
[18] Ijff D, Aldenkamp A: Cognitive side-effects of antiepileptic drugs in children. *Handbook of clinical neurology.* 2012, *111:*707-718.
[19] Schmidt D, L G: Monotherapy versus Polytherapy in epilepsy. *CNS Dtugs.* 1995, *3:*194-208.
[20] Andrew T, Milinis K, Baker G, Wieshmann U: Self reported adverse effects of mono and polytherapy for epilepsy. *Seizure.* 2012, *21:*610-613.
[21] Sohlberg MM, Mateer CA: *Cognitive rehabilitation: An integrative neuropsychological approach*. New York: Guilford Press, 2001.
[22] Nicolai J, Aldenkamp AP, Arends J, Weber JW, Vles JS: Cognitive and behavioral effects of nocturnal epileptiform discharges in children with benign childhood epilepsy with centrotemporal spikes. *Epilepsy & Behavior.* 2006, *8:*56-70.
[23] Giordani B, Caveney A, Laughrin D, et al.: Cognition and behavior in children with benign epilepsy with centrotemporal spikes (BECTS). *Epilepsy Research.* 2006, *70:*89-94.
[24] Geva R: Short term memory. In S. Norbert (ed), *Encyclopedia of the sciences of learning*. New York: Springer, 2012, 3058-3061.

[25] Baddeley A, Thomson N, Buchanan M: Word length and the structure of short-term memory. *Journal of Verbal Learning and Verbal Behavior.* 1975, *14:*575-589.
[26] Jonides J: Working memory and the brain. *Paper presented at the International Neuropsychology Society*. Denver, CO, 2000.
[27] Squire L: Declarative and nondeclarative memory: Multiple brain systems supporting learning and memory. *Journal of Cognitive Neuroscience.* 1992, *4:*232-243.
[28] Baddeley A, Warrington E: Amnesia and the distinction between long-and short-term memory. *J Verbal Learning Verbal Behav.* 1970, *9:*176-189.
[29] Baddeley A: The influence of acoustic and semantic similarity on long-term memory for word sequences. *Quarterly Journal of Experimental Psychology.* 1966, *18:*302-309.
[30] Wood R, Baxter P, Belpaeme T: A review of long-term memory in natural and synthetic systems. *Adaptive Behavior.* 2012, *20:*81-103.
[31] Baddeley AD, Hitch G: Working memory. *Psychology of learning and motivation.* 1974, *8:*47-89.
[32] Engle RW, Kane MJ: Executive attention, working memory capacity, and a two-factor theory of cognitive control. *Psychology of learning and motivation.* 2004, *44:*145-200.
[33] Miyake A, Friedman NP, Emerson MJ, et al.: The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: A latent variable analysis. *Cognitive psychology.* 2000, *41:*49-100.
[34] Baddeley A: Working memory. *Science.* 1992, *255:*556-559.
[35] Croona C, Kihlgren M, Lundberg S, Eeg-Olofsson O, Eeg-Olofsson K: Neuropsychologicalfindings in childrenwith benign childhoodepilepsy with centrotemporal spikes. *Developmental Medicine & Child Neurology.* 1999, *41:*813-818.
[36] Davidson M, Dorris L, O'Regan M, Zuberi SM: Memory consolidation and accelerated forgetting in children with idiopathic generalized epilepsy. *Epilepsy & Behavior.* 2007, *11:*394-400.
[37] Baglietto MG, Battaglia FM, Nobili L, et al.: Neuropsychological disorders related to interictal epileptic discharges during sleep in benign epilepsy of childhood with centrotemporal or Rolandic spikes. *Developmental Medicine & Child Neurology.* 2001, *43:*407-412.
[38] Henkin Y, Sadeh M, Kivity S, et al.: Cognitive function in idiopathic generalized epilepsy of childhood. *Developmental Medicine and Child Neurology.* 2005, *47:*126-132.
[39] Miyake A, Friedman NP: The Nature and Organization of Individual Differences in Executive Functions: Four General Conclusions. *Current Directions in Psychological Science.* 2012, *21:*8-14.
[40] You S: Cognitive function of idiopathic childhood epilepsy. *Korean Journal of Pediatrics.* 2012, *55:*159-163.
[41] Jambaqué I, Dellatolas G, Dulac O, Ponsot G, Signoret J-L: Verbal and visual memory impairment in childrem with epilepsy. *Neuropsychologia.* 1993, *31:*1321-1337.
[42] Schouten A, Oostrom KJ, Pestman WR, et al.: Learning and memory of school children with epilepsy: a prospective controlled longitudinal study. *Developmental Medicine and Child Neurology.* 2002, *44:*803-811.
[43] Reilly C, Atkinson P, Das K, et al.: Cognition in school-aged children with "active" epilepsy: A population-based study. *Journal of Clinical and Experimental Neuropsychology.* 2015, *37:*429-438.

[44] Hermann B, Jones J, Sheth R, et al.: Children with new-onset epilepsy: Neuropsychological status and brain structure. *Brain.* 2006, *129:*2609-2619.
[45] Aldenkamp A, Arends J: Effects of epileptiform EEG discharges on cognitive function: is the concept of "transient cognitive impairment" still valid? *Epilpesy and Behavior.* 2004, *5:*S25-S34.
[46] Sonmez F, Atakli D, Sari H, Atay T, Arpaci B: Cognitive function in juvenile myoclonic epilepsy. *Epilpesy and Behavior.* 2004, *5:*329–336.
[47] Metz-Lutz MN, Kleitz C, de Saint Martin A, et al.: Cognitive development in benign focal epilepsies of childhood. *Developmental neuroscience.* 1999, *21:*182-190.
[48] Massa R, de Saint–Martin A, Carcangiu R, et al.: EEG criteria predictive of complicated evolution in idiopathic rolandic epilepsy. *Neurology.* 2001, *57:*1071-1079.
[49] Pinton F, Ducot B, Motte J, et al.: Cognitive functions in children with benign childhood epilepsy with centrotemporal spikes (BECTS). *Epileptic Disorders.* 2006, *8:*11-23.
[50] Völkl-Kernstock S, Willinger U, Feucht M: Spacial perception and spatial memory in children with benign childhood epilepsy with centro-temporal spikes (BCECTS). *Epilepsy research.* 2006, *72:*39-48.
[51] Germanò E, Gagliano A, Magazù A, et al.: Benign childhood epilepsy with occipital paroxysms: neuropsychological findings. *Epilepsy research.* 2005, *64:*137-150.
[52] Gülgönen S, Demirbilek V, Korkmaz B, Dervent A, Townes BD: Neuropsychological functions in idiopathic occipital lobe epilepsy. *Epilepsia.* 2000, *41:*405-411.
[53] Gathercole S, Hitch G, Service E, Martin A: Phonological short-term memory and new word learning in children. *Developmental Psychology.* 1997, *33:*966-979.
[54] Ferro M, Camfield C, Levin S, et al.: Trajectories of health related quality of life in children with epilepsy: A cohort study. *Epilepsia.* 2013, *54:*1889–1897.
[55] Hrabok M, Sherman E, Bello-Espinosa L, Hader W: Memory and health-related quality of life in severe paediatric epilepsy. *Pediatrics.* 2013, *131:*525–532.
[56] Schaffer Y, Geva R: Memory outcomes following cognitive interventions in children with neurological deficits: A review with a focus on under-studied populations. *Neuropsychological Rehabilitation.* 2015*:*1-32.
[57] Mischel W: Towerd an integrative model for CBT: encompassing behavior, cognition, affect and process. *Behavior and Therapy.* 2004, *35:*185-203.
[58] Grave J, Blissett J: Is cognitive behavior therapy developmentally appropriate for young children? A critical review of the evidence. *Clinical Psychological Review.* 2004, *24:*399-420.
[59] Elliott R: Executive functions and their disorders. *British Medical Bulletin.* 2003, *65:*49-59.
[60] Lezak M: *Neuropsychological assessment (4th ed.)* New York Oxford University Press, 2004.
[61] Samango-Sprouse C: *Frontal lobe development in childhood*. New York: The Guilford Press, 2007.
[62] Isaacs E, Vargha-Khadem F: Differential course of development of spatial and verbal memory span: A normative study. *British Journal of Developmental Psychology.* 2011, *7:*377-380.
[63] Gathercole S: Cognitive approaches to the development of short-term memory. *Trends in Cognitive Sciences.* 1999, *3:*410-419.

[64] Bryck R, Fisher P: Training the brain: practical applications of neural plasticity from the intersection of cognitive neuroscience, developmental psychology, and prevention science. *The American Psychologist.* 2012, *67:*87-100.
[65] Rabipour S, Raz A: Training the brain: fact and fad in cognitive and behavioral remediation. *Brain and Cognition.* 2012, *79:*159-179.
[66] Vuilleumier P, Assal F, Blanke O, Jallon P: Distinct behavioral and EEG topographic correlates of loss of consciousness in absences. *Epilepsia.* 2000, *41:*687-693.
[67] Caplan R, Levitt J, Siddarth P, et al.: Frontal and temporal volumes in childhood absence epilepsy. *Epilepsia.* 2009, *50:*2466-2472.
[68] Parrish J, Geary E, Jones J, et al.: Executive functioning in childhood epilepsy: Parent-report and cognitive assessment. *Developmental Medicine and Child Neurology.* 2007, *49:*412-416.
[69] MacAllister W, Bender H, Whitman L, et al.: Assessment of executive functioning in childhood epilepsy: the Tower of London and BRIEF. *Child Neuropsychology.* 2012, *18:*404-415.
[70] Kellermann T, Bonilha L, Lin J, Hermann B: Mapping the landscape of cognitive development in children with epilepsy. *Cortex.* 2015, *66.*
[71] Brocki K, Bohlin G: Executive functions in children aged 6 to 13: A dimensional and developmental study. *Developmental Neuropsychology.* 2004, *26:*571-593.
[72] Anderson V, Anderson P, Northam E, Jacobs R, Catroppa C: Development of executive functions through late childhood and adolescence in an Australian sample. *Developmental Neuropsychology.* 2001, *20:*385-406.
[73] van't Hooft I, Andersson K, Sejersen T, Bartfai A, von Wendt L: Attention and memory training in children with acquired brain injuries. *Acta pediatrica.* 2003, *92:*935-940.
[74] van't Hooft I, Andersson K, Bergman B, et al.: Beneficial effect from a cognitive training programme on children with acquired brain injuries demonstrated in a controlled study. *Brain injury.* 2005, *19:*511-518.
[75] van't Hooft I, Andersson K, Bergman B, et al.: Sustained favorable effects of cognitive training in children with acquired brain injuries. *Neurorehabilitation.* 2007, *22:*109-116.
[76] Patel SK, Katz ER, Richardson R, Rimmer M, Kilian S: Cognitive and Problem Solving Training in Children with Cancer: A Pilot Project. *Journal of pediatric hematology and oncology.* 2009, *9:*670-677.
[77] Loomes C, Rasmussen C, Pei J, Manji S, Andrew G: The effect of rehearsal training on working memory span of children with fetal alcohol spectrum disorder. *Research In Developmental Disabilities.* 2008, *29:*113-124.
[78] Conners FA, Rosenquist CJ, Arnett L, Moore MS, Hume LE: Improving memory span in children with Down syndrome. *Journal of Intellectual Disability Research.* 2008, *52:*244-255.
[79] King AA, White DA, McKinstry M, Noetzel M, DeBaun MR: A pilot randomized education rehabilitation trial is feasible in sickle cell and strokes. *Neurology.* 2007, *68:*2008-2011.
[80] Wilson B, Moffat N: *Clinical managment of memory problems*. London: Chapman and Hall, 1992.

[81] DePompei R, Gillette Y, Goetz E, et al.: Practical applications for use of PDAs and smartphones with children and adolescents who have traumatic brain injury. *Neurorehabilitation.* 2008, *23:*487-499.
[82] Wilson B, Emslie H, Evans J, et al.: The NeuroPage system for children and adolescents with neurological deficits. *Developmental Neurorehabilitation.* 2009, *12:*421-426.
[83] Brown S, Craik F: Encoding and retrieval of information. In E. Tulving and F. Craik (eds), *The Oxford handbook of memory*. New York: Oxford University Press, 2000, 93-107.
[84] Schaffer Y, Geva R: Cognitive rehabilitation intervention in children with idiopathic epilepsy: uncovering factors supporting intervention efficacy on memory and psychosocial characteristics. *European Archives of Psychiatry and Clinical Neurosciene.* submitted.
[85] Wechsler D: *Wechsler Intelligence Scale for Children—4th Edition (WISCIV)*. San Antonio, TX: Harcourt Assessment, 2003.
[86] American Psychiatric Association: *The diagnostic and statistical manual of mental disorders: DSM 5*: bookpointUS, 2013.
[87] Dean P, Sterr A: Long-term effects of mild traumatic brain injury on cognitive performance. *Fronties in Human Neuroscience.* 2013, *12:*30.
[88] Smits M, Dippel D, Houston G, et al.: Postconcussion syndrome after minor head injury: brain activation of working memory and attention. *Human Brain Mapping.* 2009, *30:*2789-2803.
[89] Buckner RL, Carroll DC: Self-projection and the brain. *Trends Cogn Sci.* 2007, *11:*49-57.
[90] Spreng RN, Grady CL: Patterns of brain activity supporting autobiographical memory, prospection, and theory of mind, and their relationship to the default mode network. *Journal of Cognitive Neuroscience.* 2010, *22:*1112-1123.
[91] Spreng RN, Mar RA: I remember you: a role for memory in social cognition and the functional neuroanatomy of their interaction. *Brain research.* 2012, *1428:*43-50.
[92] Rabin JS, Rosenbaum RS: Familiarity modulates the functional relationship between theory of mind and autobiographical memory. *Neuroimage.* 2012, *62:*520-529.
[93] Limond J, Leeke R: Practitioner Review: Cognitive rehabilitation for children with acquired brain injury. *Journal of Child Psychology and Psychiatry.* 2005, *46:*339-352.
[94] Oberg L, Turkstra L: Use of elaborative encoding to facilitate verbal learning after adolescent traumatic brain injury. *Journal of Head Trauma Rehabilitation.* 1998, *13:*44-62.
[95] Vago C, Bulgheroni S, Franceschetti S, Usilla A, Riva D: Memory performance on the California Verbal Learning Test of children with benign childhood epilepsy with centrotemporal spikes. *Epilepsy and Behavior.* 2008, *13:*600-606.
[96] Bassett S, Slater E: Neuropsychological function in adolescents sustainig mild closed brain injury. *Journal of Pediatric Psychology.* 1990, *15:*225-236.
[97] Kizony R, Tau S, Bar O, Engel Yeger B: Comparing memory and meta-memory abilities between children with acquired brain injury and healthy peers. *Research In Developmental Disabilities.* 2014, *35:*1666-1673.
[98] de Hann M, Johnson M: *The cognitive neuroscience of development*. New York: Psychology Press, 2003.

[99] Wilson B, Baddeley A, Evans J, Shiel A: Errorless learning in the rehabilitation of memory impaired people. *Neuropsychological Rehabilitation.* 1994, *4:*307-326.
[100] Haslam C, Bazen-Peters C, Wright I: Errorless learning improves memory performance in children with acquired brain injury: a controlled comparison of standard and self-generation techniques. *Neuropsychological Rehabiltation.* 2012, *22:*697-715.
[101] Guillery-Girard B, Martins S, Parisot-Carbuccia D, Eustache F: Semantic acquisition in childhood amnesic syndrome: a prospective study. *Neuroreport.* 2004, *15:*377-381.
[102] Martins S, Guillery-Girard B, Jambaqué I, Dulac O, Eustache F: How children suffering severe amnesic syndrome acquire new concepts? *Neuropsychologia.* 2006, *44:*2792-2805.
[103] Kessels R, De Haan E: Implicit learning in memory rehabilitation: a meta-analysis on errorless learning and vanishing cues methods. *Journal of Clinical and Experimental Neuropsychology.* 2003, *23*.
[104] Haslam C, Hodder K, Yates P: Errorless learning and spaced retrieval: how do these methods fare in healthy and clinical populations? *Journal of Clinical and Experimental Neuropsychology.* 2011, *33:*432-447.
[105] Craik F, Winocur G, Palmer H, et al.: Cognitive rehabilitation in the elderly: effects on memory. *Journal of International Neuropsychological Society.* 2007, *13:*132-142.
[106] Duff K, Schoenberg M, Scott J, Adams R: The relationship between executive functioning and verbal and visual learning and memory. *Archives of Clinical Neuropsychology.* 2005, *20:*111-122.