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IMPROVING COGNITIVE ABILITY AMONGST SCHOOL AGED CHILDREN BORN PRE-TERM POTENTIAL ADVICE WHEN SOFTWARE INTERVENTIONS ARE UNAVAILABLE

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ABSTRACT

Objective: To understand software tasks aimed at improving cognitive abilities in school-aged children born pre-term to determine if paediatric clinic advice on manual exercises can be given if the software is inaccessible. **Method:** Exploration of software tasks and linking these to results of seminal experiments on cognitive ability. **Outcome:** It may be possible to performing some of these software tasks manually to improve working memory, however some further research on the efficacy of these techniques with school-aged children born pre-term are required.

Keywords: Pre-Term, School age, Cognitive, Learning

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Introduction

Developmental and learning concerns amongst children born pre-term are common referrals to Australian paediatric out-patient clinics. Clinicians are often in a dilemma as to what types of "learning" interventions are available to these children, especially when the children are of school going age. Potential interventions may be expensive, or otherwise still the subject of university research projects, hence simple advice to needy parents, may often be beyond the realm of the clinician in their daily practice. This paper provides a brief overview on kinds of developmental and cognitive problems faced by pre-term children followed by an examination of the types of available interventions for those who are of school-going age, and the advice that may be offered based on how the interventions relate to existing theories of human cognition.

8.7% of babies were born pre-term (<37 weeks), where gestational age was between 32 and 36 weeks (mean=33.4 weeks). As birthweight is another important indicator of long-term development, it is also relevant to note that approximately 6.5% of infants were born with low birthweight (<2500 gms).

Short-Term Effects

Cognitive difficulties are more common amongst children born pre-term, when compared with their same-aged peers in the first years of life [2-4]. The differences in cognitive ability scores are noticeable, where pre-term children have been observed to perform 0.5 standard deviations lower than full-term children [5-9]. For example,

General Prevalence

Approximately 1 in 10 Australian babies are born pre-term [1]. According to this source, in 2014,

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this would mean that if the average child's Wechsler Intelligence Scale for Children (WISC-IV) General IQ Index age-scaled score was 100 (1 SD=15), the pre-term child's General IQ score would be around 93. Cognitive delay has flow-on effects to learning in other areas such as speech, language, and adaptive behaviour. Very young children have also been observed to be 3-5 times more likely to experience speech articulation and pre-reading skill deficits which has been observed to continue into adolescence [8, 10].

Long Term Effects

Given that very young children born pre-term have a variety of language and cognitive deficits, the developmental problems that they face are of concern when it comes to learning at school. Whilst weaker language abilities have been observed, there have been indications that above the age of 4 years, the language deficits are less pronounced [11, 12]. However, there remain cognitive difficulties such as selective attention, verbal memory, and visuospatial memory, processing speed, working memory and perceptual organisation [13-16]. By 8 years of age, they have slightly weaker abilities in linguistics, but greater difficulties in cognitive processes such as accuracy and speed of writing, suggesting that trainable language abilities may be catching up, but the more natural cognitive abilities are still somewhat delayed [17]. There is also some evidence using functional MRI findings that suggest that pre-term children may develop compensating alternative language neural pathways [18]. Untrainable aspects of executive dysfunction may therefore persist while verbal skills are more amenable to interventions. Subtle cognitive deficits may affect school work and affect the child's ability to cope with increasing daily demands [19]. Difficulties in spatial, memory and attention continue to be observed up to 13 years old [18, 20-24]. However, the weaknesses in cognitive ability, when compared with their full-term peers, whilst significant, are small [13]. By 17 years, impaired executive function is more evident when the cognitive assessments are more complex and demanding [25].

Interventions

Most interventions that target cognitive and behavioural issues for pre-term children tend to focus on infants and toddlers, and focus on early intervention or mother-child bonding [26-29]. Systematic reviews suggest that whilst early intervention programmes may initially improve cognitive outcomes, these benefits are not always observed at school-age [30, 31].

Interventions that target school-aged pre-term children with cognitive difficulties tend to be computer-based and focus on improving working memory. Working memory is required to comprehend information, reason, and learn [32]. A literature search which included CINAHL, Embase, Medline, PsycInfo, Psychology and Behavioural Sciences (EbscoHost) and SocIndex identified only two studies that involved cognitive interventions for school-aged children (i.e., 5-15 years) born pre-term, which were the "Memory Strategy Training Group" [33] and "Cogmed RM" [34]. The "Memory Strategy Training Group" involves teaching children five different memory strategies over 4 weekly sessions, accompanied by 16 practice sessions. The memory strategies included chaining, rehearsal, similarities, imagination or visualization and symbolic coding (see Table 1). "Cogmed RM" program focusses on visual-spatial and auditory verbal working memory through video game activities [35, 36]. It consists of 25 forty-five minute sessions over a 5-week period. The video-games are graded in complexity with names such as "Data room, Decoder, Sorter, 3D Cube, Asteroids, Rotating Data Link, Rotating dots, Space Whack, Input Module, Visual Data Link, and Input Module with Lid" (see Table 1). In both studies, participating children were born very preterm (<32 weeks of gestational age) and had very low birth weight (<1500 g), and at the time of the study had IQ scores of more than 80. Both studies reported that at 6 months post-intervention, there were improvements in verbal and executive function aspects of memory based on standardised cognitive test batteries.

Closer inspection of the computer-based tasks suggest that the software program tasks may be based on intervention results of seminal experiments which have resulted in the following conclusions. Retrieval cues, such as grouping into categories, helps with remembering [37], and imagery of locations can help with retrieving

memories [38]. Repeating the information to oneself and repeated exposure aids recall [39]. Pairing or associating information with images

helps promote recall [40]. Finally, it helps to associate new information with something you already know [41].

Table 1: Task within Memory Improvement Software

Memory Strategy Training Group [33]	CogMed RM [34]
<ul style="list-style-type: none"> comprehending parts of an oral story remembering parts of an oral story verbally repeating, and recalling, words or short sentences quietly repeating to yourself, and recalling, words or short sentences remembering pairs of words that are related using imagination or visualisation to practice recalling information creating codes, symbols or short cuts to remember information 	<ul style="list-style-type: none"> remembering if an image was previously shown in a string of images remembering the position of objects remembering lists of words remembering lists of letters remembering lists of digits forwards and backwards remembering oral stories comprehending oral stories remembering information after a period of time (i.e., 1 hour)

Table 2: Memory Recall Advice and Memory Enhancement Activities

Memory Recall Advice	Examples of Children's Memory Enhancement Activities
Try to understand oral stories to assist recall	<p><i>How:</i> Develop a problem solving game, or hands-on real life activity, out of the task the child is required to learn. For example: "Mathematics" might require learning to bake bread in order to learn weights and measurement. Alternatively, one could go outdoors and measure the height of trees, cars and fun things. "Science" might require developing an experiment using by putting a "mentos" sweet into a fizzy drink to observe a chemical reactions</p> <p><i>Frequency:</i> Whenever there is a new concept to be learnt</p>
Verbally repeat, and recall, words or short sentences	<p><i>How:</i> Teach the child words through playing games. For example: With new words, play word games by telling a story using the new "word". They could also use commercially available games such as "Story cubes", or create their own "Pictionary" using the new "words".</p> <p><i>Frequency:</i> Twice a week, or when there are several new words that need to be learnt</p>
Repeat, and remember pairs of words that are related	<p><i>How:</i> Write the names of matching words on cards (i.e., 1 word per card), and play a game where the child is encouraged to find the matching pair of cards, and explain the relationship between the "words".</p> <p><i>Frequency:</i> Twice a week, or when there are several new concepts that need to be learnt</p>
Practice remembering if an image was previously shown in a string of images	<p><i>How:</i> Play the "Chinese whispers" in picture form. Start by preparing of string of pictures that tell a story. Show this to the child, who has to remember the pictures in sequence. The child draws these pictures in sequence for the parent.</p>

	<i>Frequency:</i> Twice a week, or when there is an important concept to be remembered
Practice remembering the position of objects shown in a previous picture	<p><i>How:</i> Take the child for a short walk, and along the way, hide/place various objects, with the child watching and assisting. Go back to class/home and get the child to draw a map which shows where all the objects are hidden. Then, using the map, go and retrieve all the hidden objects.</p> <p><i>Frequency:</i> Twice a week</p>
Remember lists of digits forwards and backwards	<p><i>How:</i> Give the child a string of numbers, and get the child to pass it to another child, in reverse as a relay game, and see if the other child can remember.</p> <p>Dance can also be used to practice this game. Draw the numbers 1-9 on the floor. Then give the child a string of numbers and ask them to step on the numbers in sequence like a "dance". Alternatively, give the same numbers, and ask them to step on the numbers in reverse sequence.</p> <p><i>Frequency:</i> Twice a week</p>
Imagine or visualise the information to help recall it	<p><i>How:</i> Get the child to draw a funny picture containing all the things they are to remember. For example, if you need to buy things from a grocery store (i.e., 6 eggs, 1 bottle of oil, 1 toothpaste and 1 bag of pasta). Draw a funny picture that has all the grocery items, and correct number, in it and remember the picture (i.e., a person juggling 6 eggs, has a bottle of oil in the pocket, balancing a bag of pasta on the head, and gripping a tube of toothpaste with his mouth/teeth)</p> <p><i>Frequency:</i> Twice a week, or when there is an important concept to be remembered</p>
Create codes, symbols or short-cuts to help remember information	<p><i>How:</i> Get the child to create acronyms out of sentences or information to be remembered. Examples of acronyms are below:</p> <ul style="list-style-type: none"> • Colours of the rainbow (i.e., Violet, Indigo, Blue, Green, Yellow, Orange, Red) = "Richard Of York Gave Battle In Vain" • North Atlantic Treaty Organisation = NATO • Joint Photographic Experts Group = JPEG • Radio Detection and Ranging = Radar • To be honest = TBH • Have a nice day = HAND <p><i>Frequency:</i> Twice a week, or when there is an important concept to be remembered</p>

Limitations and Further Research

While the summary describes memory enhancement strategies that are derived from computer programs, usage of computer-based programs have some advantages over non-computerised tasks. Computer based programmes often have improved presentation

such as appealing visuals, and sound effects, which are likely to hold a child's attention for longer, and each task presentation would have an identical format which removes inconsistency in presentation style. Thus, further research would need to be carried out on the efficacy of these manual techniques with school-aged children born pre-term.

Conclusion

School-aged children born pre-term continue to experience more cognitive executive functioning problems when compared with their full-term peers. Computer programs aimed at improving working memory, whose tasks are based on seminal experiments, report positive improvements in working memory. Perhaps performing some of these computerised tasks manually may help to improve working memory. However, inconsistent and less attractive presentation may be less engaging and may limit the effects of the manual tasks. Despite this, there may be some merit in encouraging parents with children born pre-term, who lack access to sophisticated programs, to try these tasks in an effort to improve working memory and thus enhance learning.

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