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"Investigating the relationship between working memory and behaviour difficulties between children attending a SEN primary school and children attending a mainstream school."

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"Investigating the relationship between working memory and behaviour difficulties between children attending a SEN primary school and children attending a mainstream school."

Abstract

This study investigates working memory deficits in children attending either an SEN primary school or a mainstream primary school. The sample consisted of 28 participants, aged between 7 and 11yrs old, attending either a SEN or mainstream primary school in Greater Manchester. Students completed the Automated Working Memory Assessment (AWMA) and teachers completed the Working Memory Rating Scale (WMRS) and the Strengths and Difficulties Questionnaire (SDQ) for each participant. Responses were recorded and analysed using SPSS via an independent t-test and a pearson's correlation coefficient.

An independent t-test established no significant difference in working memory between the two schools. Pearson's correlation coefficient indicated negative significant correlation between hyperactivity and verbal working memory; *r(26)=-.515, p=.005;* and visuospatial working memory; *r(26)=-.458, p=.014.* Finally, no significant correlation was found between the AWMA and the WMRS. These findings were consistent with previous research. The present study provided further evidence establishing a significant relationship between hyperactivity and working memory. This study has particularly enhanced the knowledge surrounding identification of working memory deficits and teachers failure to recognise these difficulties. Ideas for future research have been suggested in order to provide a more in-depth and detailed study into working memory in children attending primary school.

Key Words: Working Memory, Behaviour Difficulties, SEN, Mainstream, Teachers

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Introduction

Working Memory
Working memory is defined as “the ability to hold and manipulate information in the mind over short periods of time” (Gathercole & Alloway, 2008) and is related to short-term memory. Baddeley and Hitch (1974) formed a working memory model composed of a central executive system. This system is responsible for a range of functions such as: the retrieval of information from long-term memory; the regulation of information in working memory; attentional control of encoding and retrieval strategies; and task shifting (Baddelely, 1986, 1996; Baddeley & Hitch, 1974).

An important feature of working memory is that it has limited capacity. If more demands are made on the central executive system, there is less cognitive energy and processing space available for the subsidiary systems (Siegel & Ryan, 1989). The phonological loop retains materials susceptible to time-based decay and the visuospatial sketchpad has limited capacities to represent information in terms of its’ visual-spatial characteristics (Gathercole et al, 2006). Proponents of the model suggest the storage demands of complex memory tasks depend on appropriate subsystems, with processing demands, and are supported by the central executive (Baddeley & Logie, 1999).

Classroom Learning
Over the last two decades, research has established close links between learning difficulties and working memory in children. Relatively poor abilities to store materials over brief periods of time have been found to characterise children’s failing progress in areas such as language comprehension (Nation, Adams, Bowyer-Crain, & Snowling, 1999; Seigneuric, Ehrlich, Oakhill & Quill, 2000), mathematics (Bull & Scerif, 2001; Jarvis & Gathercole, 2003; Mayringer & Wimmer, 2000; Siegel & Ryan, 1989), literacy (de Jong, 1998; Gathercole & Pickering, 2000; Gathercole, Pickering, Knight, & Stegmann, 2004; Swanson, 1994).

Working memory can be a highly influential factor of classroom learning therefore working memory assessments, such as the Automated Working Memory Assessment (AWMA), have been developed to predict children’s educational achievement in school. St Clair-Thompson and Sykes (2010) conducted a study using the AWMA where 100 school children aged 7-8 years were tested on five measures of working memory. The results revealed the scores on the assessment were excellent predictors of what a child’s achievement would be throughout the academic school years (St-Clair-Thompson & Sykes, 2010).

Classroom Behaviour
In 2007, researcher’s Dr Tracy Packiam Alloway and Susan Gathercole described the typical profile of a child with a low working memory capacity. Typically the child is: reserved during group activities in the classroom and sometimes fails to answer direct questions; has normal social relationships with peers; has difficulty following instructions; loses track during complicated tasks; skips or repeats steps; abandons the task; shows incomplete recall; appears inattentive or ‘zoned out’ and easily distracted; and finally, has difficulty with activities which require both storage and processing of information (Gathercole & Alloway, 2007).

For example, children with low working memory capacity can struggle with day to day classroom activities in comparison to those children who have higher working memory capacity. Gathercole et al (2008) compared performance on the AWMA with laboratory analogues of classroom activities and found that working memory is strongly associated with the accuracy of performing instructions. The researchers concluded that working memory plays a significant role in typical classroom activities which involve both the

storage and mental manipulation of information (Gathercole et al, 2008).

Performing instructions, particularly during periods of learning, is crucial for effective functioning in every day life. Considerable evidence suggests children with poor working memory skills perform very poorly when following instructions such as, “pick up the blue pencil and put it in the green folder” (Gathercole, Durling, Evans, Jeffcock & Stone, 2008). The same difficulties are evident in classroom observations of children with working memory deficits due to these children being unable to meet the demands of many structured learning activities (Gathercole & Alloway, 2008). Consequently, a child’s working memory becomes overloaded and the crucial information needed to guide the ongoing activity, is lost (Gathercole, Durling, Evans, Jeffcock & Stone, 2008).

Attention Difficulties

Academic performance and learning difficulties have been closely linked to particular behaviours e.g. poor attention skills (Gathercole, Alloway, Kirkwood & Elliot, 2008), anxiety (Visu-Petra, Cheie, Bena & Alloway, 2011), mind-wandering (Kane et al, 2004) and group membership (Scope, Epson & Mchale, 2010). Research in recent years has revealed the link between attention difficulties and working memory, in particular among children who are diagnosed with Attention Deficit and Hyperactivity Disorder (ADHD). Children with ADHD usually appear very distractible and have difficulties in sustaining attention (Barkley, 2003). Research has concentrated on working memory abilities in clinical groups of children who demonstrate hyperactive behaviours (Gathercole & Alloway, 2006). A meta-analysis of studies investigating ADHD and working memory problems concluded the findings supported theoretical models which implicate working memory processes in ADHD (Martinussen et al., 2005); however, the nature of the link between ADHD and working memory problems continues to lack clarity.

Gathercole et al (2008) conducted further research to investigate the possible link between inattention in pupils who did not have a diagnosis of ADHD attending mainstream schools and working memory. It was revealed that results were consistent with the hypothesis that inattentive behaviour and poor working memory functions are closely associated in non-clinical samples of children (Gathercole et al, 2008, p. 221). These findings provide evidence to suggest that there is a relationship between working memory and behavioural inattention (Scope, Epson & McHale, 2010).

Teacher Observations

It is important to discover whether teachers are noticing these common behaviours related to poor working memory early on in education. Teachers fail to address working memory impairments underlying the behaviour as it is proposed that teachers focus on the behaviour as the problem rather than the behaviour as a symptom. As noted by Gathercole et al. (2006), ‘working memory deficits are not easy to detect on the basis of informal contact alone and may easily be misclassified either as attentional problems or more pervasive cognitive impairments’. (p. 234).

Children with low working memory capacity are frequently described by their teachers as being easily distracted, inattentive and fail to listen to instructions. Researchers estimate that around 10-15% of school children have working memory problems but are often misidentified as deficits of attention or intelligence (Holmes et al, 2009). While these behaviours do not appear to be initially serious, research concluded that teachers perceive frequent disruptions to be the most troublesome (Beaman, Wheldall & Kemp, 2007). Ho and Leung (2002) discovered the top three troublesome behaviours out of 15 behaviour categories were non-attentiveness, forgetfulness and talking out of turn (Ho & Leung,

2002). It is notable that these behaviours are particularly similar to those used to describe children who are identified as having working memory deficits.

Improving Working Memory

Willingham (2009) proposed that people like to learn and are naturally curious, however thinking requires much concentration and is effortful. When problems are solved successfully, learning is pleasurable and therefore it is unsurprising that pupils with working memory problems soon become unmotivated when repeatedly experiencing task failure (Willingham, 2009). Frequent task failures indicate recurrent missed learning opportunities which are likely to be reflected in poor learning outcomes (Gathercole & Alloway, 2009). Strategies enforced by teachers can be used to help reduce task failure and are an important way of reducing distracted behaviour and supporting working memory.

Gathercole and Alloway (2009) have suggested 7 core principles of working memory. The researchers propose that teachers should utilise these to reduce the risk of task failures due to an overload in working memory. Some of the core principles include; identifying warning signs of poor working memory such as inattentive behaviour and failure to follow instructions; reflect on working memory capacity of planned activities; and reduce the amount of information the child would be required to remember and manipulate. They also strongly advise that teachers should prepare to repeat information for those with poor working memory and have agreed methods where the children can find the information they need if the information it is forgotten, such as having prompt sheets or identifying adults who they can ask (Gathercole & Alloway, 2009). Furthermore, it has been found that working memory can be affected by background noise and in particular, unrelated speech (Gathercole & Alloway, 2009). For teachers, it is important to consider these factors when organising and planning classroom activities.

Justification for new research

Given the impact of having a working memory deficit on an individual's ability to acquire knowledge, develop crucial behavioural skills and benefit from formal education, the identification of working memory impairments is a priority for many adults working with children. Working memory assessments can be used to provide valuable prospective indicators for working memory impairments (Gathercole et al, 2003). The current research will use a comparison study to investigate any significant differences in working memory between children who attend a mainstream primary school and children who attend a special educational needs primary school. The research will also measure six common behaviours, including hyperactivity, to reveal any significant relationships between the behaviours and working memory. Finally, children's working memory assessment scores will be compared to the teachers rating of their working memory to reveal whether teacher's can accurately identify working memory difficulties.

Research Aim

Investigate working memory deficits and behaviour difficulties in children attending either an SEN primary school or a mainstream primary school.

Research Questions

1. Is there a difference in working memory scores between children attending either a mainstream primary school or a special educational needs primary school?
2. To what extent does working memory contribute towards common behaviours outlined on the SDQ?

3. Do teachers observations of a child's working memory differ from the child's working memory scores on the AWMA?

Research Hypothesis

1. Working memory scores will be lower for those children attending the SEN primary school and higher for those children attending a mainstream primary school.

2. There will be a relationship between working memory and behaviour difficulties; as working memory scores decrease, behaviour difficulties scores will increase.

3. There will be a relationship between teachers observations of a child's working memory on the WMRS and a child's working memory score on the AWMA.

Methodology

Method and Design

The two independent variables (IV) in this study is the type of school the participants were attending; either a SEN primary school or a mainstream primary school. There were three dependent variables (DV) in the study which were the Automated Working Memory Assessment (AWMA); the Working Memory Rating Scale (WMRS); and finally, the Strength and Difficulties Questionnaire (SDQ). In order for numerical data to be provided for the results, quantitative data was used for all of the dependant variables in the study.

As participants naturally fell into one of the two IV groups based on which school they were attending, the study used an experimental quasi experiment. Participants were as closely matched as possible between the two schools based on their gender, year group and age in months.

Sample and Participants

This study consisted a total of 28 participants (26 male and 2 female), aged between 7 and 11yrs old, from two primary schools in the Greater Manchester area. To begin with, an opportunity sample of 14 participants took part in the study who attended the SEN primary school which is a specialist school for pupil's with social and emotional needs and behaviour issues. This half of the sample was selected using pupils from years 3, 4, 5 and 6. The other 14 participants attending the mainstream school were then matched to the SEN group as closely as possible based on their gender, year group and age in months.

Materials

Strength and Difficulties Questionnaire (SDQ)

The 25 item 'Strengths and Difficulties Questionnaire' (designed by Goodman, 2005) was completed by each of the participants' teachers on the basis of the participants' behaviour over the last six months/last school year. The questionnaire is printed on one side of A4 paper and includes 5 scales with 5 items in each which looked at participants; Conduct Problems, Emotional Issues, Hyperactivity, Peer Problems, Prosocial Behaviour and additionally an overall Total Difficulties. An example of one item measuring 'Hyperactivity' states, "Restless, overactive, cannot stay still for long". Each item was measured on a 3 point scale, where teachers were asked to mark each item either 'Not True', 'Somewhat True' or 'Certainly True'. Using the data provided by the completed SDQ, a total difficulties

score was calculated by adding the scores from the total scores from the following scales, 'Emotional Problems', 'Conduct Problems', 'Hyperactivity' and 'Peer Problems'. This gave raw scores for each of the 5 scales and also a total difficulties score.

Working Memory Rating Scale (WMRS)

The teacher's were then asked to complete a 20 item 'Working Memory Rating Scale' (published by Gathercole, Alloway & Kirkwood in 2008). This scale is suitable for children aged 5yrs to 11yrs and was originally developed for teachers to simply facilitate easy identification of children with working memory deficits. The WMRSis printed on one side of A4 paper and contains short descriptions of common problem behaviours that differentiate those children with low and average working memory abilities. Two examples of the short descriptions on the scale are, "frequently asks for help" and "not able to focus during activities" . The teacher had to rate how typical each behaviour is of the participant on a 4 point scale, circling each of the 20 descriptions either 'not typical at all (0)', 'occasionally (1)', 'fairly typical (2)' or 'very typical (3)'. Once the WMRS was completed, the total score was calculated by adding all 20 items together. Higher scores indicated greater working memory impairments. The raw scores were then converted to T scores using the graph provided in the appendix of the WMRS manual. These scores describe the participants performance with respect to the performance of others within the same age band.

Automated Working Memory Assessment (AWMA)

The 'Automated Working Memory Assessment' (developed by Dr Tracy Packiam Alloway in 2007) has been co-normed with the WMRS. The AWMA is a PC-based assessment which is used to assess working memory skills with a friendly user interface and is suitable for ages 4yrs to 22yrs. This study used the 'AWMA Short Form' (AWMA-S) which took on average around 15-20 minutes to complete which each participant. The AMWA-S consists of four tests: Digit Recall. Listening Recall, Dot Matrix, Spatial Recall with each measuring either Verbal Short-Term Memory, Verbal Working Memory, Visuospatial Short-Term Memory or Visuospatial Working Memory.

To begin with, the 'Digit Recall' test required the participant to listen to a sequence of numbers and then recall the sequence in the correct order. A standardised score for digit recall was provided for verbal short-term memory.

Secondly, the 'Listening Recall' test required the participant to listen to a series of sentences, judging whether each sentence was true or false. At the end of each trial, the participant had to recall the final word of each sentence in the correct order. A standardised score for listening recall and listening recall processing were combined calculating an average score for verbal working memory.

Thirdly, in the 'Dot Matrix' test, the participant was shown the position of a red dot in a series of four by four matrices and had to recall the position of the red dot by tapping the squares on the computer screen. A standardised score for dot matrix was provided for visuo-spatial short-term memory.

Finally, in the 'Spatial Recall' test, the participant viewed a picture of two shapes where the shape on the right has a dot above it. The participant identified whether the shape on the right is the same or opposite of the shape on the left. The shape with the red dot may also be rotated. At the end of each trial, the participant had to recall the location of each red dot on the shape in the correct order by pointing to a picture with three possible positions. A standardised score for spatial recall and spatial recall processing were combined calculating an average score for visuo-spatial working memory.

Once the assessment was complete, the standardised scores for each test were automatically produced and formed into a report.

Permissions to use any of the tests or scales wasn't necessary as they are all standardised and published tests which were available through the Department of Psychology at Manchester Metropolitan University.

Procedure, Setting and Ethical Considerations

Before conducting this study, ethical approval was granted from the Psychology Ethics Committee at Manchester Metropolitan University in line with the British Psychological Society guidelines.

Headteachers from both schools were provided with an invitation letter and a consent form which described the standardised, published materials which were used in the study to assess working memory appropriately. Both headteachers decided that further parental consent would not be necessary as the study was anonymous and non-invasive as no inducements, drugs, placebo or other substances were used.

Verbal progress consent was given throughout the duration of the study by the participants as they were at a vulnerable primary school age. Before the first test began, each participant was presented with five different emotion faces using the five face activity. They were asked before and after each of the four tests which emotion face they were feeling at that time to ensure participants left the study in the same emotional state as when they began the assessment. If I found any participant becoming agitated or upset, I was required to stop the study immediately - withdrawing them from the study.

The assessment was conducted using a PC-laptop in a spare classroom in a quiet environment. Children were taken out of class one at at time to complete the four tasks on the AWMA-S. The researcher sat next to the participant on their right-hand side for easy access to the arrow keys located on the keyboard which are used for scoring. The scorebook was held in such a way that the participant were unable to see the correct responses. All scoring instructions were detailed in the AWMA manual which the researcher had read thoroughly prior to conducting the assessment. Before beginning the tests, it was necessary for the researcher to complete the details of the participant on the program under ‘Report Details’ using the participants name, school, year group, birth date, the current date and finally the researchers name. Once completed, the ‘Start’ button began the assessment.

Due to half of the sample consisting of participants attending an SEN school, they may have been more vulnerable to stress/anxiety caused by the four tests than those attending the mainstream school. This was an unlikely matter, however, school rules and regulations were complied with as the researcher was supervised by a teacher who was trained to manage participants behaviour if it was necessary for their own safety.

Finally, the researcher asked the teacher of each participant taking part in the study to complete the SDQ and the WMRS. Both scales took no longer than 5 minutes each to complete and were completed in a quiet area within one sitting at a time which was most convenient for them. Finally, the headteachers were given a debrief following their participation in the study.

All data collected was kept on a password protected laptop and a hard copy of each report and questionnaire was stored in a locked cabinet in my home office. Data was also anonymised using an anonymous identity code so results could be identified if participants

had wished to withdraw from the study. Once all data was collected, it was input and analysed by SPSS Statistical Analysis programme.

Results

Research Question 1

Is there a difference in working memory scores between children attending either a mainstream primary school or a special educational needs primary school?

Overall scores were recorded for both school types in all four areas of working memory and the WMRS. The means and standard deviations are shown below in table 1.

Table 1. Means and SD's of the four areas of working memory for both school types.

	Type of School			
	SEN (N=14)		Mainstream (N=14)	
	M	SD	M	SD
Areas of Working Memory				
Verbal Short-Term Memory	95.86	16.93	105.07	17.21
Verbal Working Memory	109.03	27.16	198.17	17.82
Visuo-Spatial Short-Term Memory	90.74	13.98	99.88	13.25
Visuo-Spatial Working Memory	190.96	32.41	195.52	25.19
WMRS Score	57.50	6.38	53.29	11.03

The descriptive statistics in table 1 shows that the mainstream school consistently performed better on the four areas of working memory tested on the AWMA. Higher the scores on the AWMA indicate fewer working memory impairments. The mean averages for the mainstream school are higher for each of the four areas of working memory in comparison to the mean averages for the SEN school. In regards to the scoring of the WMRS, the higher the score on the rating scale, the greater the working memory impairments. Therefore, table 1 shows that the mainstream school have a lower mean average for the WMRS Score than the SEN school, revealing that the mainstream school have been found to have fewer working memory impairments.

An independent t-test which was conducted to compare participants (*N=14*) from each of the school types in the four tested areas of working memory (Appendix 9, 10). There was no significant difference found between SEN (*M=95.86, SD=16.93*) and mainstream (*M=105.07, SD=17.21*) in the scores for verbal short-term memory; *t(26)=-1.427, p=.165*. There was no significant difference found between SEN (*M=109.03, SD=27.16*) and mainstream (*M=198.17, SD=17.82*) in the scores for verbal working memory; *t(26)=-.938, p=.357*. There was no significant difference found between SEN (*M=90.74, SD=13.98*) and mainstream (*M=99.88, SD=13.25*) in the scores for visuo-spatial short-term memory; *t(26)=-1.776, p=.087*. There was no significant difference found between SEN (*M=190.96, SD=32.41*) and mainstream (*M=195.52, SD=25.19*) in the scores for visuo-spatial working memory; *t(26)=-.415, p=.681*. The was no significant difference found between SEN (*M=57.50, SD= 6.38*) and mainstream (*M=53.29, SD=11.03*) for the scores on the WMRS; *t(26)=1.238, p=.227*. This shows that all results were non-significant.

Research Question 2

To what extent does working memory contribute towards common behaviours outlined on the SDQ?

A Pearson's Correlation Matrix was conducted to see the relationship between the six measures of common behaviours from the SDQ, the four areas of working memory from the AWMA and the scores from the WMRS. This is shown below in table 2.

Table 2. Correlation showing the relationship between the behaviours on the SDQ, the four areas of working memory from the AWMA and the scores from the WMRS.

	Strength and Difficulties Questionnaire (SDQ) (N=28)					
	Total Difficulties	Emotional Problems	Conduct Problems	Hyper -activity	Peer Problems	Prosocial Score
Areas of Working Memory						
Verbal Short-Term Memory	-.282	-.199	-0.220	-.144	-.361	.148
Verbal Working Memory	-.404*	-.132	-0.361	-.515**	-.236	.007
Visuo-Spatial Short-Term Memory	-.454*	-.153	-.437*	-.285	-.616**	.109
Visuo-Spatial Working Memory	-.360	-.012	-.324	-.458*	-.312	.540
WMRS Score	.612**	.427*	.395*	.671**	.350	-.272

*Note: ** Correlation is significant at the 0.01 level, * Correlation is significant at the 0.05 level*

Correlations were used to examine the relationship between six areas of behaviour on the SDQ and the four tested areas of working memory on the AWMA for all 28 participants from both school types. In regards to the scoring of the AWMA, lower scores indicate greater working memory impairments. As shown in table 2, a significant negative correlation was found between participants total difficulties score and verbal working memory, *r(26)=-.404, p=.033*. This reveals that when scores on the verbal working memory test decrease, the score on the total difficulties scale increases. A significant negative correlation was found between participants total difficulties score and visuo-spatial short-term memory, *r(26)=-.454, p=.015*. This reveals that when scores on the visuo-spatial short-term memory test decrease, the score on the total difficulties scale increases. A significant negative correlation was found between participants conduct problems and visuo-spatial short-term memory, *r(26)=-.437, p=.020*. This reveals that when scores on the visuospatial short-term memory test decrease, the score on the conduct problem scale increases. A significant negative correlation was found between participants hyperactivity and verbal working memory, *r(26)=-.515, p=.005*. This reveals that when scores on the verbal working memory test decrease, the score on the hyperactivity scale increases. A significant negative correlation was found between participants hyperactivity and visuo-spatial working memory, *r(26)=-.458, p=.014*. This reveals that when scores on the visuo-spatial working memory test decrease, the score on the hyperactivity scale increases. A significant negative correlation was found between

participants peer problems and visuo-spatial short-term memory, *r(26)=-.616, p=.000.* This reveals that when scores on the visuo-spatial short-term memory test decrease, the score on the peer problem scale increases.

Furthermore, in regards to the scoring of the WMRS, higher scores on the rating scale indicate greater working memory impairments. A significant positive correlation was found between participants WMRS Score and their total difficulties score, *r(26)=.612, p=.001* This reveals that when scores from the WMRS increase, the scores on the total difficulties scale increase. A significant positive correlation was found between participants WMRS Score and their emotional problems score, *r(26)=.427, p=.023.* This reveals that when scores from the WMRS increase, the scores on the emotional problems scale increase. A significant positive correlation was found between participants WMRS Score and their conduct problems score, *r(26)=.395, p=.038.* This reveals that when scores from the WMRS increase, the scores on the conduct problems scale increase. A significant positive correlation was found between participants WMRS Score and their hyperactivity score, *r(26)=.671, p=.000.* This reveals that when scores from the WMRS increase, the scores on the hyperactivity scale increase.

Research Question 3

Do teachers observations of a child's working memory differ from the child's working memory scores on the AWMA?

A Pearson's Correlation Matrix was conducted to see the relationship between the four areas of working memory from the AWMA and the score on the WMRS. This is shown below in table 3.

Table 3. Correlation showing the relationship between the four tested areas of working memory and the scores from the WMRS.

	Automated Working Memory Assessment (AWMA) (N=28)			
	Verbal Short-Term Memory	Verbal Working Memory	Visuo-Spatial Short-Term Memory	Visuo-Spatial Working Memory
Working Memory Rating Scale				
WMRS Score	-0.265	-0.298	-0.210	-0.341

In regards to the scoring of the WMRS, higher scores on the rating scale indicate greater working memory impairments. Results indicate that there is no significant relationship found between the the WMRS and the four areas of working memory from the AWMA. Despite this, a relationship between the two variables has been discovered even though the correlation for each is fairly week.

Correlations were used to examine the relationship between the four tested areas of working memory on the AWMA and the scores on the WMRS for all 28 participants from both school types. Table 3 shows that there was no significant correlation found between verbal short-term memory and the WMRS score; *r(26)=-.265, p=.173*. There was no significant correlation found between verbal working memory and the WMRS score;

r(26)=-.298, p=.123. There was no significant correlation found between visuospatial short-term memory and the WMRS score; *r(26)=-.210, p=.283*. There was no significant correlation found between visuo-spatial working memory and the WMRS score; *r(26)=-.341, p=0.76.*

Discussion

Summary of Results

This research set out to investigate working memory deficits and behaviour difficulties in children attending either an SEN primary school or a mainstream school. This study discovered no significant difference in working memory between the SEN primary school and the mainstream primary school. Furthermore, the findings also revealed hyperactivity had a negative significant relationship with visuo-spatial and verbal working memory. Finally the results indicated that the WMRS and the AWMA do not have a significant relationship suggesting that teachers are not recognising working memory deficits.

Findings and Implications

Differences in Working Memory

After analysing the data collected, the results clearly show that there was no significant difference found between the scores on the AWMA, the WMRS and the type of school the children where attending. These findings indicate that working memory scores do not significantly differ between a SEN primary school or mainstream primary school and therefore, the results did not support the research hypothesis.

In terms of Baddeley and Hitch's working memory model (1974), the current research indicates that the children from both schools have a similar ability to retrieve information from long term memory; regulate information within working memory and have attentional control of both encoding, retrieval strategies and task shifting (Baddeley & Hitch, 1974; Baddeley, 1986, 1996). The children's ability to retain materials, which are susceptible to time-based decay, are evidently not significantly different between the SEN and mainstream school. However, following an independent t-test, the means in table 1 appeared to be consistently higher for the mainstream school in comparison to the mean averages for the SEN school for each of the four tested areas of working memory. This suggests that with a larger sample, a significant difference could be found and would therefore be a recommendation for future research.

Working memory and behaviour

A Pearson's correlation coefficient revealed that hyperactivity had a negative significant relationship with verbal working memory. A negative significant relationship was also found between hyperactivity and visuo-spatial working memory. This shows that those children who display hyperactive behaviours also have poor visual-spatial and verbal working memory. This is consistent with previous research which suggests that children with poor working memory tend to appear 'easily distracted', 'inattentive' (Barkley, 2003; Gathercole & Alloway, 2007).

In recent years, research has revealed links between working memory and attention difficulties, particularly among children who are diagnosed with ADHD. This has previously been found among both clinical groups and non clinical groups of children attending school (Gathercole & Alloway, 2006). The current research continues to support evidence which

suggests there is a relationship between working memory and behavioural inattention (Scope, Epson & McHale, 2010). Therefore it seems logical to implement strategies across all both school types to target children who display hyperactive behaviour and those children who are diagnosed with ADHD. One example of this would be that researchers have previously found that working memory and hyperactive behaviour can be affected by background noise and in particular, unrelated speech (Gathercole & Alloway, 2009). This would therefore have implications for the ways these children should be taught in school. For teachers, it would be important to consider these factors when organising the classroom and planning classroom activities so that these children do not miss learning opportunities. This would help increase motivation among children, reduce the risk of task failure and will help support working memory and reduce distracted behaviours.

Furthermore, peer problems were also revealed to have a negative significant relationship with verbal working memory. This contradicts Susan Gathercole and Dr Tracy Packiam Alloway's recent description of a typical child who has working memory difficulties where they believe the child to have 'normal social relationships with peers' (Gathercole & Alloway, 2007). Therefore, further research would be required to investigate the link between working memory and peer problems. However, schools should also consider peer problems to be a possible predictor of poor working memory.

Teacher Observations

The current research discovered no significant relationship between the scores from the AWMA and the scores from the WMRS, therefore, the hypothesis for this research was not supported. The results support previous research by Gathercole et al (2006) who discovered across multiple studies that children who had been identified to have working memory impairments via routine screening, are rarely described by their teachers as having memory problems (Gathercole et al, 2006). Researchers also previously estimated that 10-15% of school children with working memory impairments were misidentified by teachers as having impairments of attention or intelligence (Holmes et al, 2009). To follow on from this, a relationship between the two variables in the current research has emerged in the same direction and although the correlation is fairly weak, this suggests that teachers do notice the common behaviours from children in class but perhaps do not recognise these behaviours to be linked to working memory deficits.

In order to reduce the number of misidentified children, necessary steps should be taken in schools which involve training teachers to be aware of working memory impairments and the effects it can have on classroom learning and behaviour. Willingham (2009) previously proposed that humans like to learn and are naturally curious, however thinking requires much concentration and can be effortful. When problems are solved successfully, learning is pleasurable and therefore it is unsurprising that pupils with poor working memory who repeatedly experience task failure soon become unmotivated (Willingham, 2009). As recurrent task failures indicate frequent missed learning opportunities which are likely to be reflected in poor learning outcomes (Gathercole & Alloway, 2009), it is important that necessary strategies are enforced by teachers which can be used to help reduce task failure. Teachers should utilise the 7 core principles suggested by Gathercole and Alloway (2009) as a way of supporting those children with working memory difficulties and to reduce distracted and inattentive behaviour (Gathercole & Alloway, 2009).

Limitations and Future Research

The use of standardised, published materials in this research meant that reliable data was collected during this study. However, limitations are evident in this current research but this provides useful avenues for future research. Part of this study explored common behaviours on the Strength and Difficulties questionnaire and working memory on the

Working Memory Rating Scale. Although both are standardised and published, the structure of each statement used in the questionnaire may be open to subjectivity of how the teachers view each of the behaviours and working memory problems listed on both questionnaires. It cannot be assumed that all teachers completing this will hold similar meanings of each variable as each teachers may have different interpretations, leading to confirmation bias (Owad, 2006). Therefore, the questionnaires may not establish a true measurement for each sub scale of behaviour or working memory problem. This could be improved in future research by using a more rigid explanation for example providing a definition of each variable which will enable teachers to have a cohesive understanding and interpretation of each concept.

A further limitation with the current study is the sample size used. The study used a relatively small sample of 28 participants comprised of 14 participants from each of the two schools. However, due to the availability of children and the time constraints given for data collection, a larger sample was not facilitated for this study. For future improvements, if time permits ideally a larger sample should be used in order to look at a wider population of children attending mainstream primary schools and SEN primary schools. This could effect the significance of results obtained and may produce a better general understanding of working memory, behaviour and teachers observations among the two school types.

To follow on from this, although this study did not set out to investigate the differences between gender, the sample was gender bias as it included 26 males and only 2 females. As the current research set out to look at working memory differences between the two schools and was not gender specific, it could be suggested for future research to use a comparison study investigating working memory and its relationship with behaviours between males and females. This could provide further evidence which could develop teachers understanding if working memory is found to be more prevalent among males or females.

Conclusion

The present study has provided further evidence establishing a significant relationship between hyperactivity and working memory. This study has particularly enhanced the knowledge surrounding identification of working memory deficits and teachers failure to recognise these difficulties. Suggested ideas for future research have been suggested in order to provide a more in-depth and detailed study into working memory in children attending primary school. Working memory is complex and so a wider perspective among teachers is required. This will help teachers to understand how having a poor working memory can contribute to failing academic performance, learning difficulties and also associated behaviours. Improving teachers knowledge explaining the key features of working memory deficits will benefit those children who are identified sooner as interventions can be put in place to target their working memory.

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References

Alloway, T.P. (2007) Automated qWorking Memory Assessment. London: Harcourt.

Alloway, T.P., Gathercole, S. E., & Kirkwood, H. J. (2008) A working memory rating scale for children. Manuscript submitted for publication.

Alloway, T.P., Gathercole, S.E., & Pickering, S.J. (2006). Verbal and visuo-spatial short-term and working memory in children: Are they separable? *Child Development*, 77, 1698-1716.

Baddeley, A. D. (1986). *Working memory.* Oxford: Oxford University Press.

Baddeley, A. D. (1996). Exploring the central executive. *Quarterly Journal of Experimental Psychology, 49,* 5-28.

Baddeley, A. D., & Hitch, G. (1974). Working memory. In G. Bower (Ed.), *The Psychology of Learning and Motivation* (pp.47-90). New York: Academic Press.

Baddeley, A. D., Logie, R. H. (1999). Working memory: The multiple-component model. in A. Miyake & P.Shah (Eds) *Models of working memory: Mechanisms of active maintenance and executive control* (pp. 28-61). New York: Cambridge University Press.

Barkley, R.A. (2003) Issues in the diagnosis of attention-deficit/hyperactivity disorder in children. *Brain and Development,* 25, 77-83.

Beaman, R., Wheldall, K. & Kemp, C (2007) Recent research on troublesome classroom behaviour: A review. *Australasian Journal of Special Education*, 31, (1), 45-60.

Bull, R., & Scerif, G. (2001). Executive functioning as a predictor of children's mathematics ability: Inhibition, task switching, and working memory. *Developmental Neuropsychology*, 19, 273–293.

de Jong, P. F. (1998). Working memory deficits of reading disabled children. *Journal of Experimental Child Psychology*, 70, 75–96.

Engel, P. M. J., Santos, F. H., & Gathercole, S. E. (2008). Are working memory measures free of socio-economic influence? *Journal of Speech Language and Hearing Research.* 51, 1580-1587.

Gathercole, S.E., and Alloway, T.P. (2007). Understanding working memory. *London: Harcourt*.

Gathercole, S.E. & Alloway, T.P. (2008). Working memory and learning: A practical guide for teachers. *London: Sage*.

Gathercole, S.E, Alloway, T.P., Kirkwood, H.J., & Elliott, J.E. (2008). Attentional and executive function behaviors in children with poor working memory. *Learning and Individual Differences*, 18, 214-223.

Gathercole, S.E., Alloway, T.P., Kirkwood, H.J., Elliott, J.G., Holmes, J. & Hilton, K.A. (2008). Attentional and executive function behaviours in children with poor working memory. *Learning and Individual Differences,* 18, 214-223.

Gathercole, S.E., Brown, L. & Pickering, S.J. (2003). Working memory assessments at school entry as longitudinal predictors of National Curriculum attainment levels. *Educational and Child Psychology,* 20, 109–122.

Gathercole, S.E., Durling, M., Evans, S. et al. (2008). Working memory abilities and children's performance in laboratory analogues of classroom activities. *Applied Cognitive Psychology*.

Gathercole, S. E., Lamont, E. & Alloway, T. P. (2006). Working memory in the classroom. *In S. Pickering (Ed.) Working memory and education.* London: Academic Press.

Gathercole, S. E., & Pickering, S. J. (2000). Working memory deficits in children with low achievements in the national curriculum at seven years of age. *British Journal of* Educational Psychology, 70, 177–194.

Gathercole, S. E., Pickering, S. J., Knight, C., & Stegmann, Z. (2004). Working memory skills and educational attainment: Evidence from national curriculum assessments at 7 and 14 years of age. *Applied Cognitive Psychology,* 18, 1–16.

Ho, C. & Leung, J. (2002) Disruptive classroom behaviours of secondary and primary school students. *Educational Research Journal*, 17, 219-233.

Holmes, J., Gathercole, S.E., and Dunning, D.L., (2009). Adaptive training leads to sustained enhancement of poor working memory in children. *Dev Sci*. 12(4):F9-15.

Jarvis, H. L., & Gathercole, S. E. (2003). Verbal and non- verbal working memory and achievements on national curriculum tests at 11 and 14 years of age. *Educational and Child Psychology*, 20, 123–140.

Kane, M. J., Hambrick, D. Z., Tuholski, S. W. et al. (2007) The generality of working-memory capacity: A latent - variable approach to verbal and visuo-spatial memory span and reasoning. *Journal of Experimental Psychology: General*, 133, 189-217.

Martinussen, R., Hayden, J., Hogg-Johnson, S. & Tannock, R. (2005) A Meta-analysis of working memory impairments in children with attention-deficit/hyperactivity disorder. *Journal of the American Academy of Child and Adolescent Psychiatry,* 44, (4), 377-384.

Owad, T. (2006). 'Confirmation bias: A ubiquitous phenomenon in many guises.' *Review of General Psychology.* 2(2) pp. 175-220.

Owens et al (2008). Processing efficiency theory in children: working memory as a mediator between trait anxiety and academic performance. *Anxiety, Stress, and Coping*, 21, 417-430.

Mayringer, H., & Wimmer, H. (2000). Pseudoname learning by German-speaking children with dyslexia: Evidence for a phonological learning deficit. *Journal of Experimental Child Psychology*, 75, 116–133.

Nation, K., Adams, J. W., Bowyer-Crane, C. A., & Snowling, M. J. (1999). Working memory deficits in poor comprehenders reflect underlying language impairments. *Journal of Experimental Child Psychology*, 73, 139–158.

Scope, Empson, & McHale (2010). Executive function in children with high and low attentional skills: Correspondences between behavioural and cognitive profiles. *British Journal of Developmental Psychology*, 28, 293-305.

Seigneuric, A., Ehrlich, M. F., Oakhill, J. V., & Yuill, N. M. (2000). Working memory resources and children's reading comprehension. *Reading and Writing*, *13*, 81–103.

Siegel, L. S., & Ryan, E. B. (1989). The development of working memory in normally achieving and subtypes of learning disabled children. *Child Development*, *60*, 973–980.

St Clair-Thompson & Sykes (2010). Scoring methods and the predictive ability of working memory tasks. *Behav Res Methods*, 4, 969-75.

Swanson, H. L. (1994). Short-term memory and working memory—Do both contribute to our understanding of academic achievement in children and adults with learning disabilities? *Journal of Learning Disabilities*, 27, 34–50.

Visu-Petra, L, Cheie, L, Benga, O, & Alloway, T.P. (2011). Effects of anxiety on simple retention and memory updating in young children. *International Journal of Behavioral Development*, 35, 38-47.

Willingham, D. (2009) *Why Don't Students like School?* Jossey-Bass. San Francisco.