'Why does he never listen? It drives me nuts!'

Working memory and inattentive behaviour: The implications for children's learning

opportunities in the classroom.

By Plum Hutton (5833 words)

<u>**Abstrac**</u>t

Working memory skills are strongly associated with scholastic achievement in schools. It

is proposed that although poor working memory is known to be a cognitive difficulty,

pupils with low working memory scores may be characterised by teachers as being

inattentive and distractible. This paper links together research into working memory and

inattentive behaviour with studies indicating that inattentiveness is rated by teachers as

being one of the most troublesome pupil behaviours and a cause of teacher stress. It is

suggested that some pupils with working memory difficulties may be identified by school

staff as having behaviour difficulties, which may in turn lead to a negative pattern of

interaction between the teacher and pupil. It is proposed that appropriate support of

working memory may improve the academic outcomes for pupils with poor working

memory skills and reduce the amount of inattentive behaviour experienced within the

classroom.

<u>**Introduction**</u>

Most teachers would be able to cite several children who rarely seem to listen and are

constantly in the wrong place and the wrong time with the wrong equipment.

Understandably, such pupils cause substantial frustration for teachers. However, consider

pupils with poor working memory skills. Imagine their frustration and despondency at

often being unable to remember what they have been told to do and being constantly in trouble for being in the wrong place at the wrong time with the wrong equipment. Children often tell adults that they are unable to remember what they should be doing. Such statements may be met with a supportive response or with snappy comments such as: 'Well everyone else knows what they should be doing'. If asked, could children think of several adults who rarely seem to listen to them? Some pupils are inattentive, but it is proposed that adults do not always properly attend to pupils' explanations of their difficulties and work with them to find strategies to help. It is possible that our frustrations with inattentive pupils and a perception that we are failing these children may colour how we interact with them.

This paper examines whether teachers accurately identify pupils with poor working memory skills or whether they are often characterised as being inattentive and easily distracted. The consequences of inattentive behaviour are discussed and strategies suggested for how working memory difficulties could be acknowledged and supported.

Frequent reference is made to studies conducted by Gathercole, Alloway and colleagues, who have carried out extensive research into working memory in the classroom. In contrast, other research on working memory has often focused on clinical settings or on pupils with a clinical diagnosis. Gathercole and Alloway's findings are particularly relevant to the issues raised in this paper.

<u>Overview and Educational Relevance of Working Memory.</u>

The concept of working memory has been extensively researched over several decades. It is recognised that working memory is a vital component in children's ability to learn (Gathercole et al., 2008). Working memory is the ability to store and manipulate information over short periods of time. Although a number of theories of working memory have been explored, one of the most prominent was put forward by Baddeley and Hitch in 1974. This model presents working memory as having three main components, as follows. The central executive controls attention and enables memory skills to be focused on particular tasks. This ability to focus on important stimuli is essential, as all aspects of working memory have limited capacity (Baddeley, 2006). Hence to be an effective learner, it is vital that attention is maintained on the task in hand and other distracting information is filtered out.

The central executive is supported by two subsystems. First, the phonological loop enables the storage and manipulation of verbal information and second, the visuo-spatial sketchpad provides the same facility for visual information (Gathercole & Alloway, 2009). Visual information is often converted into verbal information by verbalising or naming items (Baddeley, 2006), which could lead to the assumption that adequate verbal memory skills are of particular importance.

A number of assessments have been devised to assess working memory; for example *Reading Span* (Daneman & Carpenter, 1980) and, *Automated Working Memory Assessment* (Alloway, 2007). Assessments aimed at measuring verbal short-term memory capacity measure the ability to temporarily store information, such as a list of numbers.

There has been found to be a close and specific link between verbal short-term memory capacity and the ability to learn sound patterns in new words (Gathercole & Alloway, 2006). Hence poor verbal short-term memory skills will impact on children's ability to learn new spoken vocabulary and on their reading and spelling skills. This evidence is reflected in the recent independent report on dyslexia commissioned by the Secretary of State for Children, Schools and Families (Rose, 2009) which clearly states that poor verbal memory is one of three markers of dyslexia.

In order to assess verbal working memory rather than short-term verbal memory, pupils would be expected to complete tasks that involve both storing and manipulating information (Gathercole & Alloway, 2009), for example by presenting children with a list of digits and asking them to repeat the digits in the reverse order. Many classroom activities require pupils to store and manipulate information, an obvious example being mental arithmetic tasks.

Working memory assessments mean that it is possible to formally identify pupils with poor working memory skills. Evidence shows that working memory skills are closely linked to performance on scholastic tests and are highly predictive of measures of literacy, mathematics and language comprehension (Gathercole & Alloway, 2006). However, on one investigation Gathercole et al. (2008) screened over 1800 children for working memory difficulties. Of the 52 that were identified with having very low composite scores for working memory, only 33% were '*identified by their schools as having difficulties relating to learning*' (2008, p. 216). This implies that 67% of the children with working memory difficulties were not considered to have problems with learning, which might indicate that working memory is not as strongly linked to

classroom success as is implied. However, approximately half the children were only 4-5 years old, and the impact of poor working memory skills on their learning may not yet have become apparent. It is also possible that school staff had focused on the behaviour exhibited by some of these children rather than their learning problems.

Although good working memory skills are strongly associated with academic success, Gathercole and Alloway report that Intelligence Quotient (IQ) scores are only '…*moderately associated with children's learning achievements*' (2009, p. 30). This assertion was supported by research conducted by Alloway (2009) where 37 pupils with moderate learning difficulties were assessed for working memory, IQ, literacy and numeracy attainments. The pupils' attainments were retested two years later and it was found that working memory was a better predictor of academic progress than IQ. These observations raise important issues about the value of IQ tests and what assessments should be used by psychologists when trying to establish a child's academic potential. However it should be noted that Alloway's study only included pupils with moderate learning difficulties and so the results may not hold true to for more able pupils. In addition the study used the Wechsler Intelligence Scale for Children 3rd Edition (WISC III) to assess IQ. This assessment has since been updated (WISC IV) to include a working memory index as part of the assessment and may now be a better predictor of potential than was shown in Alloway's research.

During detailed observations of lessons Gathercole, Lamont & Alloway (2006) noted that children faced high demands on working memory throughout the school day. Pupils that had been assessed as having poor working memory skills, frequently failed at tasks set in class, particularly in numeracy and literacy lessons. As Gathercole et al. (2006) stated:

'...activities that place heavy burdens on either processing or storage are likely to place excessive demands on limited resources and therefore will overload the system and result in task failure' (p. 220). An obvious example is the frequent, lengthy instructions given by adults, such as "Before you finish your art work, find your science books and do questions 1-10 on p4". This instruction is difficult because it does not give the information in the order in which the pupil has to carry out the task. The pupil has to reorder the information, remember it and act on it. This may cause working memory overload in some pupils, which would result in the instruction not being carried out.

Evidence suggests that working memory is strongly linked to academic attainment and observations have shown children with poor working memory scores experience frequent task failures and, as a result, missed learning opportunities at school. The impact of these failures on motivation and behaviour should be considered next.

Working Memory and Inattentive Behaviour

Teachers often comment that pupils with poor working memory do not listen, are inattentive, very distractible, always day dreaming, display frustration and have low motivation (Gathercole and Alloway, 2009). If a child has been assessed and found to possess poor working memory skills, these behaviours are understandable. However, the behaviours listed above are consistent with those associated with many children with behavioural, emotional and social difficulties. Hence, it is proposed that school staff may focus on the behaviour as the problem, not the symptom and therefore fail to understand and address the working memory deficit that underlies the behaviour. 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).

In recent years, research has shown links between working memory and attention difficulties, particularly with children diagnosed as having Attention Deficit and Hyperactive Disorder (ADHD). Most research has focused on working memory abilities of clinical groups demonstrating hyperactive behaviour (Gathercole & Alloway, 2006). While the exact nature of the link between ADHD and memory problems still lacks clarity, a meta-analysis of studies into working memory impairments with children who have a diagnosis of ADHD concluded that the evidence supports theoretical models which implicate working memory processes in ADHD (Martinussen et al., 2005). In particular, associations have been proposed between working memory deficits and pupils with inattentive types of ADHD. Such children usually have difficulties in sustaining attention and are very distractible (Barkley, 2003).

Unlike most research that was conducted with clinical groups, Gathercole et al. (2008) investigated whether there was a link between working memory and inattention in pupils attending mainstream schools who did not have a diagnosis of ADHD. It was concluded that: '…*These results are consistent with the hypothesis that poor working memory function and inattentive behaviour are closely associated in non-clinical samples of children.'* (p. 221).

This conclusion is supported by Aronen et al., (2005) who reported in a study of non clinical school children that there was an association between children's working memory scores and teachers' rating of both school performance and attentional and

behavioural difficulties. Links between inattentive behaviour and working memory skills were most evident on auditory working memory tasks which led to the conclusion that children who are good at retaining auditory information succeed at school. As suggested by Baddeley (2006) it appears that adequate functioning of the phonological loop, which enables the retention of verbal information, is particularly important. This finding may also be a reflection on the fact that a large amount of information in classrooms is presented verbally; leaving pupils with poor verbal memory skills at a distinct disadvantage. It should be noted that Aronen et al.'s study took place in Finland and there may be cultural differences both in how classrooms are managed and related to perceptions of inappropriate behaviour.

Difficulties with accessing information verbally may affect a range of pupils beyond those identified as having specific difficulties with working memory. As has been noted, poor verbal memory skills are considered to be one of the main markers of dyslexia (Rose, 2009). Pupils with literacy difficulties have the added disadvantage of finding reading difficult and hence not being able to support their poor verbal memory skills with written prompts. Other children who may have difficulties attending to verbal information include those experiencing intermittent hearing impairment as a result of glue ear for example. Likewise children with English as an additional language (EAL) and those with general learning difficulties may benefit from verbal information being supported by visual prompts. As a consequence of their research Aronen at al. (2005) state, '*Our results suggest that for children with learning difficulties teaching methods other than those based on the auditory modality could be helpful.*' (p. 39).

Aronen et al. (2005) also found links between poor visual working memory skills and children who showed signs of anxiety and depression. This finding is consistent with previous studies that show that even mild levels of anxiety and depression are associated with poorer working memory skills (Aronen et al., 2005). It was suggested that working memory function and the ability to concentrate is impaired in children experiencing anxiety or depression, which in turn leads to poor academic achievement (Aronen et al., 2005). Similar results were identified by Hadwin, Brogan & Stevenson (2005) who found that children with increased anxiety took longer to complete working memory tasks and reported that the task required more effort than was seen in pupils with lower levels of anxiety. This research indicated that although anxious children can achieve the same accuracy on working memory tasks they required more time and effort to achieve accurate scores. It is suggested that worry leaves less capacity in working memory to cope with the current task (Hadwin et al., 2005).

Decline in academic performance is also evident in pupils who have experienced trauma or loss. Difficulties at school are reported to be most severe in subject areas that require a high level of concentration such as mathematics (Dyregrov 2004). Dyregov goes on to comment that, '…*There are clear indications that memory and concentration, so necessary in learning situations, are negatively affected by traumatic situations.*' (p. 78). The effects of trauma and loss may persist for months or even years after a tragic event, by which time school staff may expect children to have come to terms with the tragedy (Dyregrov, 2004). These long-term memory and attention difficulties combined with possible periods school absence will lead to many missed learning opportunities and therefore impact on academic performance.

In summary, it is clear that a range of children experience working memory difficulties and these difficulties may be characterised by inattentive and distractible behaviour. Links have been found between poor working memory and inattentive types of ADHD. It is suggested that a number of children may temporarily benefit from having their working memory supported in school such as those who have experienced trauma or loss and pupils with EAL who have to use much of their cognitive capacity to learn in a foreign language.

Teachers' Perceptions of Troublesome Behaviour

It has been noted that pupils with poor working memory skills are frequently described by teachers as failing to listen to instructions, being inattentive and easily distracted. While these behaviours do not initially appear to be serious, research shows that teachers perceive frequent disruptions as being the most troublesome, even if the behaviour is relatively trivial (Beaman, Wheldall & Kemp 2007). Research conducted by Wheldall & Merrett in the UK (1988) found that teachers perceived *talking out of turn* and *hindering other children* as the most frequent and troublesome behaviours in primary schools. Similar research conducted by McDonald and Wilks (1994, cited in Little, 2005, p. 370) in Australia, found that being *easily distracted* and *not listening to directions* were two of the behaviour problems most reported by teachers. Ho and Leung (2002) found similar results: the top three troublesome behaviours (out of 15 behaviour categories) were rated as *talking out of turn*, *non-attentiveness* and *forgetfulness*. It is notable that these behaviours are very similar to those used to describe pupils with poor working memory skills. Beaman et al. (2007) conducted a review of recent research into teachers' perceptions of troublesome behaviour. Several of the studies reviewed took pace in

Australia with others in the USA, Greece, Hong Kong, Jordan and Malta. The review supported the findings listed above. Although cultural differences must be acknowledged, Beaman et al.'s review indicates that Wheldall and Merrett's research findings in the UK have been supported by a number of other international studies.

Several studies have reported that teachers feel they spend too much time dealing with classroom behaviour issues (e.g. Wheldall & Merrett, 1988) which would indicate that strategies to reduce low level classroom disruptions would be valuable. As stated by Little (2005):

> *'Given that teachers perceive that they are spending too much time on issues of order and control, and that these behaviours are minor in nature, it is clear that interventions that deal specifically with these behaviours are needed'.* (p. 370).

Although it is accepted that good behaviour is encouraged through effective behaviour management techniques, it is possible that some pupils are not able to control their distracted and inattentive behaviour, which is a consequence of working memory deficits. Such pupils may be perceived as being disobedient when they do not follow teacher instructions. However, pupils who are unable to remember the instructions are unable to comply. It is acknowledged that incidents such as verbal or physical abuse within the classroom are more serious than inattentive behaviour, but these tend to be infrequent. Children with working memory problems experience high levels of task failure and are easily distracted (Gathercole & Alloway, 2009). Pupils who are distractible and unable to

complete a task may disturb their peers either through boredom and frustration caused by task failure or through seeking support so that they are able to complete the task in hand.

Willingham (2009) proposes that humans are naturally curious and like to learn, but that thinking is effortful and requires concentration. Pleasure in learning is derived when moderately challenging problems are successfully solved. So it is unsurprising that pupils who repeatedly experience task failure soon become unmotivated (Willingham, 2009). Hence strategies to reduce task failure are important in supporting working memory and in reducing distracted behaviour.

Misperception of working memory difficulties as behaviour problems can lead to serious and negative outcomes for children. As noted by Kokkinos, Panayiotou & Davazoglou (2004) '…*undesirable pupil behaviours are more likely to evoke unfavourable impressions of the pupil, and yield negative attitudes on the teachers' part.'* (p. 110). Negative teacher attitudes may have a significant impact on learning because, as noted by Willingham (2009), one of the key factors which enables children to learn is a good emotional bond between the teacher and the pupil. Evidence shows that when teachers display positive emotional support, pupils report that their behaviour improves: '…*as teachers' display of emotional support toward students increased, students reported that they engaged in less off-task behaviour and less teacher-directed antagonistic behaviour.'* (Geving, 2008, p. 627). It should be noted that students in this research are commenting on their subjective perception of their behaviour rather than data from an objective observation of what actually took place in the classrooms.

As stated above, pupils with working memory difficulties are likely to have difficulties achieving academic success at school; in addition evidence shows that their behaviour is also likely to frustrate their teachers and lead to negative teacher attitudes towards them. This negative teacher attitude in itself may impact on how a pupil learns and may lead to a downward spiral of failure and frustration for both parties.

The importance of effective strategies to manage pupil misbehaviour is highlighted by research into the causes of teacher stress which is reported to be prevalent (Geving, 2007). Pupil misbehaviour has been repeatedly identified as a cause for teacher stress with *student apathy* or *lack of effort* being strongly associated with teacher stress. It could be argued that teachers experiencing high levels of stress will be less tolerant of disruptive classroom behaviour and less able to think of creative ways in which to support pupils with inattentive behaviour in class. Less experienced teachers appear to be more susceptible to stress caused by poor pupil behaviour (Kokkinos et al., 2004) which highlights the need for behaviour management techniques and underlying causes of poor pupil behaviour to be emphasised on teacher training courses.

The recent shift to include children with a diverse range of special educational needs in mainstream schools has created additional challenges for teachers. It is now expected that children with a range of physical, cognitive, sensory and behavioural needs will be managed within mainstream classrooms. In order for this to be successful, teachers are required to provide highly differentiated work to suit children with a wide range of abilities. Additional equipment and support staff may also be present within classrooms and need to be effectively managed. Although the policy of inclusion is laudable, it is possible that an unintended outcome has been an increase in distractions and challenges

within mainstream classrooms. This may impact both on teacher stress levels and on the ability of pupils with poor working memory skills to attend to important information in class. As stated by Beaman et al. (2007):

> *'...the inclusion of students with disabilities within regular classrooms*
> *requires teachers to have high-level classroom management skills, as well*
> *as the necessary skills to program effectively for all students in the class.*
> *Teachers engaged in such a complex instructional mission need highly*
> *effective behaviour management techniques in order to meet with needs of*
> *all the students in their classrooms'.* (p. 45).

It is suggested that supporting pupils' working memory skills could be an important component of an overall strategy to support classroom behaviour difficulties.

In summary it has been established that working memory skills are closely linked with academic success at school. Pupils with poor working memory skills tend to be described by teachers as being inattentive and distractible and it is proposed that such behaviour may be perceived as disruptive per se rather than a consequence of a cognitive difficulty. It is concerning to find that inattentive behaviours are rated as among the most troublesome by teachers and a significant cause of teacher stress. This means that the behaviour exhibited by pupils with working memory difficulties may lead to the development of a negative relationship between teachers and the pupil, which in itself can create a negative impact on pupils' learning opportunities.

Strategies to Support Working Memory and Reduce Inattentive Behaviours

The close association between working memory and scholastic achievement is reason enough to highlight the consequences of poor working memory skills for school-aged children. A first step towards supporting children with poor memory skills is to ensure that teachers are trained in understanding the importance of working memory for success at school. Awareness should also be raised about the way in which children with emotional and behaviour difficulties (for example those who have suffered trauma or neglect) may have reduced attention skills and working memory capacity.

It would be helpful if schools were familiar with techniques for assessing memory so that it is possible for teachers to clearly identify pupils with poor working memory skills. Identification would serve two purposes: firstly a clear picture of a child's strengths and weaknesses provides valuable information about how a child's strengths could be used to support their weaknesses; and secondly if a child is identified as having poor working memory skills it may serve as an explanation for inattentive behaviour in class. Most people who have experienced serious transport delays will recognise how much easier it is to tolerate a problem when the cause is known. While a child may still need instructions to be repeated several times, understanding and supporting the need should make it less stressful for teachers to manage and prevent such children from being perceived so negatively.

Once a pupil has been found to have a working memory deficit an obvious solution would be to directly boost their working memory skills through a memory training programme. However, there is currently little evidence that children are able to generalise

skills from memory training to classroom learning tasks (Gathercole & Alloway, 2006). Alloway (2009) has conducted research on a small number of pupils assessed to have moderate learning difficulties. These pupils were found to have made improvement in memory skills and classroom activities following a 12 week intervention with a programme called 'Jungle Memory'. If further research finds that improvements are replicated with a wider range of pupils and are sustained over time, then this would present an exciting development.

An alternative approach is to provide support for children to help compensate for poor memory skills; the main aim being to prevent memory-based failures in classroom activities. Recurrent task failures indicate frequent missed learning opportunities which are likely to be reflected in poor learning outcomes (Gathercole & Alloway, 2009). Failure leads to frustration and poor motivation, both of which may be reflected in disruptive behaviour. Careful differentiation of work to ensure that tasks present a moderate learning challenge for all pupils in a class is therefore an important aspect of classroom management.

Gathercole and Alloway (2009) have suggested seven core principles of working memory which they propose teachers should utilise to prevent task failures as a result of working memory overload. The main points include identifying the warning signs of working memory difficulties such as failure to follow instructions and inattentive behaviour. Teachers should reflect on the working memory loads of learning activities and, where children's working memory is becoming overloaded, reduce the amount of information that they are required to remember and manipulate. Gathercole and Alloway (2009) also suggest that teachers should also be prepared to repeat important information and have

agreed ways that children can access information if it is forgotten, such as by asking an adult or another pupil or having a written prompt sheet (Gathercole and Alloway, 2009).

Memory aids are commonplace in classrooms. Items such as multiplication grids, number lines, personalised dictionaries and wall charts or posters can be useful resources (Gathercole and Alloway, 2009). However, it has been observed that pupils with memory difficulties rarely use such aids instinctively. This is particularly so if the aids are not immediately to hand; if an aid has to be accessed from across the room it requires the child to shift their attention away from the task in hand, which may lead to information being forgotten (Gathercole & Alloway, 2009). Memory aids may also be ineffective if children have not had sufficient practice in using them, so that their use becomes automatic. If children have to spend considerable attention on how to use a memory aid then it negates the beneficial effects of supporting memory. Use of a memory aid needs to be automatic, as automated skills can be processed without using conscious effort (Mousavi, Low, Sweller, 1995; Willingham, 2009). However, it is possible that many teachers assume that they are a supporting pupils with poor memory skills by providing items such as number lines and multiplication squares in class without carefully evaluating whether children are spontaneously using the aids to good effect, or whether they resort to strategies such as counting on their fingers, a resource which is inevitably close to hand.

Gathercole and Alloway's final principle suggests that pupils should be supported in developing their own memory strategies. As all pupils have different patterns of strengths and weaknesses, different pupils will benefit from different strategies. Like memory aids, successful use of a strategy will depend on the training and practice in applying the

strategy in everyday learning situations. While Gathercole and Alloway's principles are supported by extensive research into working memory and observation of classroom situations, a literature search[1] has not found any studies into whether systematic use of these principles has proved to be effective in reducing memory-based task failures and leading to improved learning outcomes for pupils.

While recent research has indicated that there is little benefit in assessing a child's perceived learning preferences (e.g. receiving information visually or verbally) and adjusting teaching to suit (Pashler et al., 2008), there is considerable research into the benefits of representing information in more than one modality, often termed as multisensory teaching. Dr Samuel Orton first proposed the benefits of using two or more sensory modalities (auditory, visual, kinaesthetic and tactile) in the 1930s. His work was later developed into the Orton-Gillingham principles which have formed the basis of several multisensory learning programmes designed to support literacy skills (Joshi, Dahlgren & Boulware-Gooden, 2002). Hyatt (2007) comments that multisensory teaching approaches are still popular despite a lack of empirical support for the methods. However, Mousavi et al. (1995) conducted a number of experiments into whether the use of more than one modality could increase working memory capacity. They concluded that presenting information both visually and verbally improved working memory capacity because information is likely to be held in both auditory and visual memory rather than just one store. These results support Baddeley and Hitch's model of working memory which contains both a verbal and visual store and also support the findings of Frick, (1984, as cited in Mousavi et al, 1995, p. 321) and Mayer and Anderson (1992) who also found that presentations through more than one modality improved memory

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[1] Search was conducted using PsycINFO and ERIC (Educational Resources Information Centre) data bases. The following key words were used in different combinations: support, principle, strategies, efficacy, effective, working memory, memory, Gathercole, Alloway.

recall. Kratzig & Arbuthnott (2006) conclude, '*…presenting material to students in multiple sensory modalities is undoubtedly beneficial to learning and interest*' (p. 245).

It has been found that working memory capacity is affected by background noise and particularly by unrelated speech (Gathercole and Alloway, 2009). It is important to consider this factor when planning classroom organisation. For example when children are working in groups, one group may struggle to concentrate if the teacher is introducing a different activity to another group. Likewise the importance of appropriate soundproofing to ensure that noise does not carry from one classroom to the next should be raised when new educational buildings are being planned. It is also suggested that teachers should not play the radio or background music with lyrics when children are completing tasks with a high working memory load.

Willingham (2009) suggests that memory is '*a residue of thought*' (p. 41) and it is therefore not possible for us to learn if we are not paying attention, creating a major challenge for teachers in ensuring that pupils attend to important information in class. In order to maintain attention, lessons need to be well structured and interesting. A focus on multisensory teaching may steer some teachers away from delivering lengthy verbal monologues and encourage a range of interactive activities. If this has the consequence of enhancing working memory skills and making lessons fun, then it is surely a laudable aim.

<u>Further Research</u>

This paper makes several suggestions which would benefit from further research. A link has been made between pupils with poor working memory skills and inattentive behaviour. Further studies to validate the findings of Aronen et al. (2005) and Gathercole et al. (2008) who found links between working memory skills and inattentive behaviour in school children without clinical diagnosis would be beneficial. Research could also focus on the identification of inattentive and disruptive pupils and assessing their working memory skills to see whether poor working memory is a common feature of pupils who are classed as having behavioural and emotional difficulties. Further studies into the impact of inclusion on mainstream classrooms would be of interest, with a focus on whether teaching staff feel equipped to meet the challenges presented by including pupils with a wide range of needs in mainstream schools.

Alloway's study into the efficacy of 'Jungle Memory' provides exciting new data suggesting that children's working memory skills can be trained and enhanced. However, the number of participants in this study is too small to enable conclusions to be applied to school children in general without further research. Additional studies establishing the effectiveness of programmes designed to enhance working memory with mainstream pupils would be valuable. Likewise an evaluation of the efficacy of systematically applying Gathercole and Alloway's (2009) seven core principles for supporting working memory in classrooms would be helpful. Firstly it is important to establish whether children can generalise their learning and make long term improvements following a working memory intervention. Secondly, teachers need to identify whether they feel it is possible to adopt such strategies in busy classrooms when there are already so many

demands on teacher time. It is suggested here that teachers may feel that they are already supporting pupils with poor working memory, but that research indicates that pupils are often not benefiting from supports such as memory aids that are currently in place. A study into what support teachers are currently providing and how effective those strategies are would help inform future classroom practice.

Finally the benefits of multisensory teaching have been discussed. Multisensory teaching is considered to be 'traditional wisdom' (Saunders & White, 2002, p. 24) for children experiencing difficulties with learning. However, a literature search[2] found no studies that examined whether the multisensory methods promoted in many literacy programmes are crucial to the effectiveness of the programme.

Conclusion

Increasingly links are being drawn between pupils with poor working memory skills and a pattern of inattentive behaviour. These links have been related to research into behaviours that are considered by teachers to be most troublesome and a source of teacher stress; frequent inattentive behaviour was found to be a considerable concern to teachers. The importance of incorporating sound behavioural management skills in teacher training as suggested by Beaman et al. (2007) and Little (2005) is acknowledged as being essential in enabling teachers to support low level disruptive behaviours in the classroom. However, it is proposed that it may be equally important to provide training on how to support cognitive difficulties, such as working memory, that might underlie many minor but frequent behaviours in mainstream classrooms. This is particularly

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[2] Search was conducted using PsycINFO and ERIC (Educational Resources Information Centre) data bases. The following key words were used in different combinations: multisensory, multi-sensory, multi-modal, literacy, reading, efficacy, effective$, support.

pertinent in the current climate where there is an assumption that most children with special educational needs will attend mainstream schools. The consequences of failing to support working memory are reflected in poor academic outcomes for pupils, frustration and failure. It may be maddening for teachers when pupils appear not to listen, but the irritation felt by teachers is likely to be minor compared to that felt by pupils who face failure daily at school. It is important that we listen to their comments and access their ideas about how they could be best supported. Simple methods such as repeating verbal instructions, multisensory teaching and careful differentiation may benefit pupils' learning and lead to reduced classroom disruptions. In addition there may be a perception of reduced stress and frustration for teaching staff. However further research is required to establish whether such strategies do actually make a significant difference and whether teachers are able to focus on targeting working memory skills when there are so many demands on their time.

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