Exploring the relationship between aspects of metacognitive and cognitive function and the workplace success of dyslexic people

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Thesis submitted for the degree of Doctor of Psychology

March 2018

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Abstract

Objective: To explore how cognitive and metacognitive function influences workplace success in dyslexic adults.

Background: Prior research suggests that dyslexic adults experience difficulties with executive functioning and developing metacognitive skill, in addition to continuing problems with literacy. This thesis proposes that these difficulties may affect their performance at work. This research therefore aims to investigate these aspects of cognitive and metacognitive function to discover how they relate to workplace success. These findings will provide evidence to inform interventions for dyslexic adults in the workplace.

Method: Three studies were conducted. The first study (n=180 dyslexics) established the workplace success criteria: job satisfaction, self-efficacy, academic qualifications and financial success; and explored the relationship with cognitive function in terms of planning and executive attention (the Cognitive failures questionnaire, Broadbent et al., 1982)). The second study (n=116 dyslexics) assessed the participants’ metacognitive skills, confidence and problem solving and investigated the relationships with workplace success criteria. The third study (n=60 dyslexics) assessed executive functioning skills of updating, inhibition and shifting (Miyake et al., 2000) and explored the relationships with workplace success criteria. The data from all three studies were compared with a non-dyslexic control group (n= 30). Variations between the dyslexic and control groups on metacognitive and executive skill were anticipated, and the relationships between these differences and workplace success were investigated.

Results: Study 1 found that cognitive failures were related to aspects of workplace success in dyslexics, and that dyslexics experienced more cognitive failures than the control group. But there were no differences between dyslexic and controls in planning or overall workplace
success. Study 2 found that metacognitive skill was related to aspects of workplace success in both dyslexics and controls. Dyslexics had less metacognitive self-understanding than controls, but other aspects of metacognition were similar. Study 3 found no clear relationship between executive function and workplace success, but dyslexics performed less well than controls in aspects of working memory.

Conclusion: Dyslexic participants attained comparable levels of workplace success despite deficits in working memory processes and self-understanding, and weaker literacy skills. However similar workplace success could not be attributed to compensatory use of metacognitive skills by dyslexics because dyslexics did not have greater metacognitive skill. Possible explanations and recommendations for further research are discussed.
Statement of originality

This thesis and the work to which it refers are the results of my own efforts. Any ideas, data, images or text resulting from the work of others (whether published or unpublished) are fully identified as such within the work and attributed to their originator in the text, bibliography or in footnotes. This thesis has not been submitted in whole or in part for any other academic degree or professional qualification. I agree that the University has the right to submit my work to the plagiarism detection service TurnitinUK for originality checks. Whether or not drafts have been so-assessed, the University reserves the right to require an electronic version of the final document (as submitted) for assessment as above.

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Acknowledgements

There are many people I should thank for their encouragement over the years.

In particular, I would like to thank Dr Henriette Hogh and Dr Ellen Seiss for their support, and patience and for sharing their knowledge and making statistics fun.

A very big thank you Dr Adrian Banks for his consistent encouragement and sage advice, particularly when he was on sabbatical.

I cannot thank Professor John Everatt enough for his instigation of, and ongoing presence in this process. His wisdom, as always, has been invaluable.

I will be forever grateful to Professor David McLoughlin, and especially Kellie Bolger, Vivian Hunot and Penny Carter without whom this thesis would never have been completed.

A very special thank you to all the dyslexic participants and the controls, and also to the many dyslexic people I have worked with over the years who have given me insight and the motivation to do this research.

And finally, thank you to my family for their understanding and continued confidence in me, and especially to Thea Rose Redford whose determination to learn against all odds was inspirational.
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Chapter 1: Thesis Overview

1.1 Introduction

The work reported in this Thesis aims to enhance our understanding of how dyslexia might affect the performance of adults in a working environment. The primary aim was to explore aspects of cognitive functioning, metacognitive skill and executive function that might impact on the workplace success of dyslexic adults. A secondary aim was to determine if differences exist between dyslexic and non-dyslexic adults in metacognitive skill and/or executive function and to establish whether such differences show specific influences on workplace success. The findings may contribute to better practice in supporting adult dyslexics in the workplace.

Research exploring the impact of dyslexia among adults remains limited, especially relating to the impact of dyslexia in a working environment. Research has mainly focused upon dyslexia in children. Interventions developed to support dyslexic adults, but influenced by research on children, have sometimes proved themselves to be inappropriate, since the difficulties and their impact in adulthood are different from childhood (Patton & Polloway, 1992). Literacy-based solutions and interventions may prove insufficient (Gerber, 2012) as literacy may be less of a challenge in adulthood. This is particularly true in some workplace contexts, as problems faced by dyslexics in the workplace may be broader than those caused by reading and spelling weaknesses. This Thesis, therefore, explores the cognitive functioning of adult dyslexics and how it might influence performance in the workplace.

Dyslexia is generally regarded as a reading and spelling disability, but many dyslexic adults develop their literacy skills to a competent level, albeit with residual difficulties with reading speed, which may impact on comprehension, as well as continued weaknesses in spelling (Miles, 2007). The frequently-reported difficulties with planning, organisation and aspects of memory, which together suggest deficits in executive functioning, may be viewed by managers in the workplace as inability or incompetence. Despite these areas of difficulty, some dyslexic people can be highly successful in their chosen field of work (Gerber & Raskind, 2013; Logan, 2009; West, 2010); others are less so (De Beer, Engels, Heerkens &
van der Klink, 2014). Reasons for varying degrees of workplace success experienced by dyslexic people are unclear, although some research conducted in the framework of resilience has identified metacognitive skill, and a self-understanding of cognitive processes, as factors that may influence occupational achievement (Gerber, Ginsberg & Reiff, 1992; Raskind, Goldberg, Higgins & Herman, 1999).

This Thesis sought to explore if, and to what extent, adult dyslexics experience difficulties with metacognitive and executive functions, and if these skills are important for workplace performance; i.e., to what extent workplace success is influenced by metacognitive and executive function in adult dyslexics. Specifically, the research focused on the following questions:

1. Is there evidence that dyslexic people differ from non-dyslexic people in metacognitive skill and executive functioning?
2. Is metacognitive processing (greater self-understanding and increased use of planning skills) related to workplace success? Is there any evidence for any relationships to vary across dyslexic and non-dyslexic people?
3. Do executive function processes influence workplace success? Is there evidence for any such influences to vary across dyslexic and non-dyslexic people?

1.2 Rationale

1.2.1 Dyslexia

Dyslexia is considered by many researchers to be a phonological processing difficulty that impacts on reading and spelling in children and adults (Ramus & Szenkovitz, 2008; Snowling, 2014). Many definitions reflect this, for example “Dyslexia is ... characterized by difficulties with accurate and /or fluent word recognition and by poor spelling and decoding abilities. These difficulties typically result from a deficit in the phonological component of language ....” The International Dyslexia Association (IDA, 2002). There is too much evidence to minimise the role of phonological processing in dyslexia; however, such definitions do not account for the other cognitive difficulties reported. In acknowledgement of this the British Dyslexia Association definition includes these difficulties: “Dyslexia is a
specific learning difficulty that mainly affects the development of literacy and language related skills. It is likely to be present at birth and to be life-long in its effects. It is characterised by difficulties with phonological processing, rapid naming, working memory, processing speed, and the automatic development of skills that may not match up to an individual's other cognitive abilities” (BDA, 2007). This definition includes components of executive functioning skill.

1.2.2 Executive Function and Working Memory

Executive functions have been defined as processing mechanisms related to goal-directed behaviour and the control of complex cognition, especially in non-routine situations (Banich, 2009). They are essential to learning and human development and they play a central role in thinking, problem-solving, and oral language, as well as reading and writing (Reid Lyon, 1996). They are also critical for cognitive development, as well as success in school and adult life (Diamond, 2013). They include top-down attentional processes required especially in novel situations (Suchy, 2009), and involve processes of shifting, up-dating, and inhibition (Miyake, Emerson & Friedman, 2000). Clearly, these are skills necessary for successful employment in many roles; particularly those where focus on the task in hand is essential (Diamond, 2013), where problem-solving is required to make effective decisions (Bailey, 2007), where an individual must respond to rapidly-changing circumstances, or to plan, prioritise, organise and juggle demands of the job (Garner, 2009). Any deficit in these functions could potentially affect performance at work and subsequent success. There is an increasing body of research identifying executive functioning deficits in children (Berninger et al, 2008; Booth, Boyle & Kelly, 2010; Brosnan, Demetre, Hamill, Robson, Shepherd & Cody, 2002; Jefferies & Everatt, 2004; Meltzer, 2007; Menghini, Finzi, Carlisimo, Vicari, 2011; Smith-Spark & Fisk, 2007; Smith-Spark, Zięcik, & Sterling, 2016). Research by Smith-Spark and colleagues have remarked on the implications of executive functioning deficits for the workplace.

One component of executive functioning of relevance for dyslexia, and its impact on performance, is that of working memory (discussed further in Chapter 2). There are many definitions of working memory, but most include the concepts of limited capacity, attention and the manipulation of information: it is defined as ‘a processing resource of limited capacity, involved in the preservation of information while simultaneously processing the
same or other information, Swanson (2015) p:176. In support of the role of working memory in dyslexia, it is notable that measures of memory span (such as in the Wechsler Scales, 2009) are recommended to be used as part of the battery of tests in the diagnostic assessment for dyslexia (Mather & Wendling, 2012). There is also research confirming verbal working memory deficits in adults (Berninger et al., 2006). Therefore, working memory may be relevant to understanding dyslexia and how any deficits could impact on performance and success in the workplace.

1.2.3 Metacognition

Another construct closely associated to executive function is that of metacognition, long defined as “the conscious awareness and control over one’s own cognition and thinking and learning processes” (Flavell, 1979). For some researchers it is considered inherent in executive functioning (Borkowski & Burke, 1996); for others it is related to executive control (Fernandez-Duque, Baird & Posner, 2000); and to working memory (Shimamura, 2000). Others consider it to be the deliberate use of executive functions (Garner, 2009).

Metacognition refers to processes that provide individuals with an understanding of their skills/abilities, and the strategies necessary to complete a task successfully. The term also incorporates self-regulation skills that include planning, monitoring and reflection. There is substantial research documenting metacognition’s importance in successful learning (Isaacson & Fujita, 2006; Swanson, 2012; Wong, 1998). It has been argued that metacognitive skills are inherent in continual improvement of performance (Sternberg, 2005; Zimmerman, 2006), and contribute to successful outcomes in the workplace (Schmidt & Ford, 2003).

Indications that dyslexic children do not develop metacognitive skills automatically has been posited by several researchers (Butler & Schnellert 2015; Wong, 1998). A growing body of research on student populations suggests this continues into adulthood (Bergey, Deacon & Parrila, 2017; Chevalier, Parrila, Ritchie & Deacon, 2017). Trainin & Swanson (2005) hypothesised that metacognitive processing can mitigate dyslexic students’ working memory deficits by decreasing the load on the limited resources of working memory through the utilisation of previous knowledge and experience.
Metacognitive skill is also related to confidence: it has been argued that increased levels of metacognition improve self-confidence (Kleitman & Stankov, 2007), and that increased levels of self-confidence are also related to improved performance (Stankov & Crawford, 2006). A lack of confidence and low self-esteem have been reported in the dyslexia literature (Burden, 2008; De Beer et al., 2014). This research suggests that dyslexics demonstrate lower levels of confidence in their own skills than non-dyslexics, and that this can be found in a range of tasks, not only those involving literacy. Therefore, confidence in memory and reasoning competence was another area of interest in the present research.

1.3 Chapter Overviews

To determine what aspects of cognitive functioning were impacting either positively or negatively on dyslexic adults, it was important to establish measures of success in the workplace, as well as measures of cognitive functioning specifically related to the focus of the current research (i.e., executive functioning, metacognition and related processes). These were developed based on the relevant literature. Once these measures, and those required to confirm evidence of dyslexia, had been determined, three studies were designed.

The first study was an initial exploration into the role of cognitive processing and workplace success. It provided the basis on which to consider measures of workplace success and influences on these measures that might be specific to those with dyslexia. Studies 2 and 3 focused on each of the main areas of cognitive functioning that the present research intended to investigate: Study 2 on the role of metacognition and Study 3 on different aspects of executive function. The three studies combined, therefore, provided an assessment of the variability in metacognition and executive functioning demonstrated by a relatively large group of dyslexic people drawn from a range of occupations, as well as providing a basis on which to assess their potential influence on workplace success. A control group matched for age and occupation (but with no evidence of dyslexia) was included to contrast findings across both cohorts. Differences between these groups allowed the research to determine if the effects shown within the dyslexic cohort were specific or not.

The following provides a brief overview of the contents of subsequent Chapters in this Thesis.
Chapter Two: The Theoretical Framework

This Chapter reviews the relevant literature to provide a theoretical framework for the research and briefly overviews controversies in defining dyslexia, including in adulthood. Frith’s (1999) framework is used to outline the relevant theories of dyslexia. The major theories of working memory, executive functioning and metacognition are outlined, and conceptual overlaps discussed. Literature relating to career success, the roles of job satisfaction and self-efficacy are reviewed, and a model of workplace success proposed. Finally, the extant research into dyslexia and success is outlined.

Chapter Three: Study 1. An initial exploration of the potential relationships between cognitive measures and workplace success

This study comprised an investigation into the relationships between cognitive measures and workplace success that have been associated with metacognition and executive functioning. Through factor analysis, two personal success criteria - job satisfaction and self-efficacy - as well as a planning scale (a measure of metacognition), were validated. Two societal success measures of academic qualifications and financial status were also included. The Cognitive Failures Questionnaire (Broadbent, Cooper, Fitzgerald, & Parkes, 1982) was chosen as a measure of executive functioning. It was anticipated that: (i) the dyslexic group would report more cognitive failures than the control group; (ii) better planning (or metacognitive processing) would be related to fewer cognitive failures across both dyslexics and non-dyslexics; (iii) higher scores on the planning scale and fewer reported cognitive failures would be related to workplace success for both groups.

Overall the results showed that the two groups (n=180 dyslexics, n=30 controls) achieved similar levels across all four of the success criteria. The findings also indicated that planning (as a measure of metacognitive skill) was related to two of the workplace success criteria: i.e., measures of job satisfaction and self-efficacy. These relationships were found in both groups, suggesting similar associations between planning/metacognitive skills and personal aspects of success. The results also confirmed that dyslexic people reported experiencing more cognitive failures than reported by the control group. For the dyslexic group, these cognitive failures were related to levels of job satisfaction and self-efficacy: increased
cognitive failure resulted in diminished job satisfaction and self-efficacy. In addition, superior planning skill was related to fewer cognitive failures for the dyslexic group; however, such a relationship was not evident with the control group. Finally, differences between dyslexics and non-dyslexic groups were found in the size of relationships between the self-efficacy workplace success factor and self-reported cognitive failures.

These results suggest that dyslexics differ from non-dyslexics in their self-reported experience of cognitive failures. Given that such cognitive failures are an indication of executive functioning deficits, then these data support the argument for such deficits to be a specific problem for dyslexics. There was no evidence that the planning skills of the dyslexic and non-dyslexic groups varied, both groups had similar levels. Planning/metacognitive skill may be a learned strategy particularly relevant for the dyslexic group to assist them in overcoming executive functioning difficulties which were assessed in the cognitive failures questionnaire; those dyslexics with good levels of self-reported planning also reported fewer cognitive failures. Finally, although all the participants experienced similar levels of workplace success, the specific larger relationship between self-efficacy and cognitive failures found for the dyslexic group suggests that executive functioning weakness may influence aspects of self-perceived workplace success.

Chapter Four: Study 2. The effect of metacognition and confidence on workplace success

The results of the first study indicated that planning (a component of metacognition) was related to workplace success. The aim of study 2 (n=116 dyslexics, a subset from study 1, n=30 controls, the same as in study 1) was to investigate this in more detail. Previous research argues that the development of metacognition differs between dyslexics and non-dyslexics, so some variability between the dyslexic and non-dyslexic adults was anticipated. However, metacognition is related to improved performance, so overall it was predicted better metacognitive skill would be related to greater workplace success, and that this would be expected to be the case across both dyslexic and non-dyslexic adults. Confidence is also a key component in success and low confidence, particularly in memory ability, is commonly reported by dyslexic adults (McLoughlin & Leather, 2013); therefore, differences between the groups in terms of their self-reported confidence were predicted.
Data were gathered in two ways: self-report scales and reasoning tasks. The self-report measures of metacognitive skill comprised the knowledge of cognition and regulation of cognition scales from the Metacognitive Awareness Inventory (Schraw & Dennison, 1994), and the confidence in memory and reasoning scales from the Memory and Reasoning Competence Inventory (Kleitman & Stankov, 2007). The reasoning tasks included pre-task planning. Dyslexic people may have specific problems with retaining verbal material, therefore, the reasoning tasks involved either verbal or non-verbal material to ensure that the level of reasoning ability and underlying metacognitive aspects of such skills were assessed, rather than difficulties with words. Scores on these measures of metacognition were compared across the dyslexic and non-dyslexic participants and correlated with the measures of work success developed in Study 1, and with the measure of cognitive failures, as an indication of executive functioning, used in Study 1.

Overall the results showed a significant difference between the two groups in aspects of metacognition. These were found for the knowledge of cognition scale, but not regulation of cognition; for confidence in memory but not in reasoning; and for strategies such as pre-task planning used with the verbal reasoning task, though not the non-verbal reasoning task. These results suggest that dyslexics may differ from non-dyslexics in metacognitive skill, but this seems to focus on their self-understanding of their cognition, not the self-regulation of their cognition. Furthermore, this may be focused more on aspects of memory and verbal processing than reasoning and non-verbal cognitions. In this instance, the similarity between dyslexics and non-dyslexics in regulation of cognition may be consistent with the findings of Study 1, where both groups had similar levels of planning. The regulation of cognition scale comprised of planning, monitoring and reflection. It may well be that these dyslexic adults developed this skill as a specific area of compensation.

In relation to executive functioning, on the verbal reasoning task the performance of the dyslexic group was significantly poorer at pre-task planning, and less accurate than the control group, but there was no significant difference between the groups on the non-verbal task. This is consistent with the findings above, suggesting a possible verbal processing deficit in the dyslexic group. As reasoning and planning are both components of executive functioning (Diamond, 2013; Smith-Spark & Fisk, 2007), these findings further indicate the potential for executive functioning deficits in dyslexic adults. The findings also suggest that these deficits are likely to be specific to certain processes or tasks, since differences were
identified for verbal but not non-verbal reasoning, and self-reported planning in a problem-solving task (this study) but not in the self-reported planning measure used in Study 1.

In relation to the workplace success measures, both groups’ scores on the metacognitive measures (knowledge and regulation of cognition, and confidence in memory and reasoning) were associated with greater personal success (job satisfaction and self-efficacy). However, they were not generally related to the societal criteria of academic qualifications, financial status and promotion. As in Study 1, metacognitive skills seem to be more associated with personal feelings about employment rather than more socially recognised aspects of work success.

Overall, the findings of Studies 1 and 2 provide some indications of executive functioning deficits among the dyslexic adults, but any evidence of anticipated differences between the groups on metacognitive skills was inconsistent.

**Chapter Five: Study 3. Executive functioning, dyslexia and workplace success**

While questionnaires elicit a large amount of data, they are self-report measures and therefore clearly subjective. Study 3 aimed to provide clearer answers to the three research questions above, so was designed to explore aspects of executive functioning, particularly the three widely-accepted components; i.e., up-dating, inhibition and changing set (Miyake et al., 2000). These executive skills are recognised as being fundamental to performance in all areas of living, including in the workplace (Diamond, 2013; Reid Lyon & Krasnegor, 1996). Levels of literacy and literacy-related skills were also assessed in this study to assess their influence on any relationships found across dyslexic and non-dyslexic groups. This study involved a subset of dyslexic adults who participated in the first and second studies so that comparisons could be drawn across all three. One-to-one psycho-educational assessments of between 2 to 3 hours duration were conducted.

There were four main aims: firstly, to investigate executive functioning skills between dyslexics (n=60, a subset of study 2) and the control group (n=30, the same as in the previous two studies); secondly, to explore the relationships between executive functions and metacognitive skills in both groups; thirdly, to investigate the relationships between executive functions and workplace success; and finally, to determine if the literacy
difficulties experienced by the dyslexic group had any impact on success at work. Based on the two previous studies and extant research, it was hypothesised that there would be differences between the groups on the executive measures. It was also hypothesised that scores on measures of metacognition would relate to scores on the executive functioning measures. It was anticipated that scores on the executive functioning measures and those for literacy would be related to the workplace success criteria.

The results showed that the two groups had similar levels of fluid intelligence: any differences between the groups on other cognitive measures could not be attributed to general intellectual ability. In relation to executive functions, there were some differences between the groups in each of the investigated areas. However, this was particularly evident in measures of up-dating/working memory, in which the control group generally out-performed the dyslexics. On the measures of shifting and inhibition, the findings were inconclusive. The dyslexic group performed less well on verbal fluency and had slower processing speeds than the controls. Contrary to expectations, few relationships emerged from the analyses involving the executive and metacognitive data. On workplace success, consistent with Studies 1 and 2, the two groups also achieved comparable levels; however, the relationships with the executive measures did vary. In both groups, but on different measures, better performance on a memory task was related to self-efficacy. Furthermore, the ability to cope with distractions and change set was related to better academic qualifications in the control group, but this was not evident in the dyslexic group. Finally, the ability to change set was related to self-efficacy and financial status in the dyslexic group. There were the anticipated differences between the groups on the literacy measures: i.e., significantly lower literacy scores for the dyslexic group compared to controls. Literacy levels were associated with academic qualifications; however, variation in literacy skill was not related to the other success measures.

To conclude, the findings indicated evidence for executive processing differences between the groups, but the differences seemed related to specific areas of functioning rather than a general executive functioning deficit. The dyslexics experienced significantly more difficulty than the control group with tasks that placed specific demands on processes hypothesised to be related to working memory. Furthermore, the differences between groups in verbal fluency and speed of processing confirm that these are areas of deficit for dyslexic adults. In contrast, the levels of metacognitive control were similar across both groups and they were
not significantly related to workplace success in this final study. Unexpectedly, there was no relationship between executive functions and metacognition.

There was some evidence for varying influences of executive function processes on workplace success across the two groups, but as with the first two studies, these did not produce a consistent pattern of findings.

*Chapter Six: Discussion*

The findings from the three studies demonstrated that dyslexics’ and non-dyslexics’ performance in the metacognitive skill and executive functioning tests differed. However, inconsistency across tests was the most obvious finding, with some measures showing differences; other measures showed similarities in performance between the two groups. The results indicated poorer performance among dyslexics compared to controls in two measures of metacognitive skill (knowledge of cognition and self-confidence about memory) but not in other measures associated with metacognition, arguing against a general metacognitive deficit among the dyslexic participants. In the executive functioning tests, the dyslexic participants showed evidence of deficits compared to the controls in terms of self-reported Cognitive Failures, measures of Plus-Minus, Random Number Generation-Inhibition, Listening and Spatial Span. However, again other measures indicated similarity in performance, arguing against a general deficit. The number of executive processing differences provides the opportunity to consider which aspects of executive functions may be related to dyslexia and whether these might influence workplace success.

**1.4 Summary**

Based on the data, the argument is proposed in the General Discussion Chapter 6 that the deficits are most likely associated with up-dating executive processes, which are linked to the functions of working memory. However, these executive deficits appear not to affect the workplace success of the dyslexic participants. These data suggest that dyslexic people can be successful despite experiencing specific executive functioning deficits and weaker literacy skills. The findings also argue against metacognitive mitigating strategies. However, it is
also possible that the dyslexic participants developed their planning/metacognitive skills to a competent level in the workplace or that they have acquired skills, knowledge and experience, thereby placing fewer demands on executive function. In this, dyslexics may have found a way to circumvent or mitigate any deficits: they have developed job specific expertise. Further research in this area, therefore, would be worthwhile, focusing particularly on a wider range of employment backgrounds, and variations in success criteria, among dyslexic adults.
Chapter Two:

2 The Theoretical Framework

2.1 Introduction

The aim of this Study is to investigate the role of executive functioning and metacognitive skills in contributing to the success of dyslexic adults in the workplace. The dearth of research into dyslexia in the adult years has contributed to a lack of clarity about its impact (Gerber, 2012). Interventions for adults are based upon research conducted with children. Dyslexic adults are frequently recommended general solutions such as assistive software, speed reading courses and spelling programmes, with scant regard for the specific difficulties an individual may experience in the workplace. Such interventions are often inappropriate (McLoughlin, 2012). Furthermore, achievement in the workplace requires a range of skill sets with different cognitive demands to those required for success in education. Different job roles require a variety of skill sets: some place heavy demands on literacy, others less so: some are office-based, some operational. Good literacy skills are increasingly essential in most workplaces, and often so are effective communication skills, planning, prioritisation, organisation skills, the ability to multi-task, to work under time pressure, to learn new skills and adapt to continual changes. These are commonly reported areas of difficulty for dyslexic adults (Gerber, 2012), but there is little research to substantiate them as characteristics of dyslexia. In medicine, psychology and education there is a demand for evidence-based practice. At present, there is insufficient evidence from academic research in the field of dyslexia to make this viable. A greater understanding of the impact of dyslexia in adulthood should potentially lead to individualised solutions. This is important, as individuals bring their own range of cognitive skills and experience to their job, so one size clearly does not fit all.

This current research builds on studies suggesting that dyslexia may impact more broadly on performance than literacy alone. It seems, for example, that dyslexic people experience processing difficulties related to working memory and executive functions (Brosnan et al., 2002; Démonet et al., 2004; Gerber, 2012; Menghini et al., 2011; Swanson, 2012). If so, these might explain the reported problems outlined above. Such deficits might result in
challenges in the workplace, as well as life in general (McLoughlin, 2012; Smith-Spark, Ziecik & Sterling, 2016). Impairments in executive functions, memory and language have been linked to employment success or failure (Kalechstein, Newton, & Van Gorp, 2003).

The wide variation in the success levels of dyslexic people confuses understanding further, leading to the question, what is it that enables some people to succeed while others do not? Gerber, Ginsberg and Reiff, (1992) investigated the behaviour patterns of successful dyslexic adults and concluded that internal control and self-understanding (potentially aspects of metacognitive skill) contributed to their success. Findings from diverse studies in dyslexia have not been well integrated but in a review of research on children and adults who have reading disabilities, Swanson and Zeng (2013) identified a range of deficits and suggested that, rather than focusing on developing literacy skills alone, a broader approach should be adopted. The implication for interventions, as these difficulties extend beyond literacy instruction, is that they should include strategies such as the development of metacognitive skill (Swanson 2012).

2.2 Defining dyslexia

Currently, there is no universal definition of dyslexia. Grigorenko (2001, p.93) wrote that “the quilt of definitions covering the body of developmental dyslexia is a subject for research on its own”. It continues to be a controversial issue, as evidenced in the debate surrounding the inclusion of dyslexia in the American Psychiatric Association’s Diagnostic and Statistical Manual DSM -V. (see Tannock, 2013; Snowling, 2012). Unlike in previous versions, dyslexia is now incorporated under the umbrella of neurobiological learning disorders. The criteria for diagnosis now are:
A. Key characteristics: Requirement for persistent learning difficulties despite the provision of intervention that targets those difficulties that are manifest by one of more of the specified clinical/behavioural symptoms
B. Measurement: Requirement for academic skills to be substantially and quantifiably below those expected for the individual’s chronological age, plus impairment arising from low academic achievement

C. Age at onset: The onset of symptoms of SLD during the early school years (but may not become fully manifest until the learning demands exceed the individual’s limited capacities)

D. Exclusion/inclusion: Specification of exclusionary disorders (intellectual developmental disorder, global developmental delay, uncorrected visual or auditory acuity, other mental or neurologic disorders), psychosocial adversity, or lack of educational opportunity (Tannock, 2013 p: 19)

Despite the increasing understanding of the cognitive correlates of reading, accuracy and fluency of reading have remained central to definitions. Most refer to difficulty with acquiring literacy skills and remain narrow in their scope. Some definitions have included reference to possible causal factors. The International Dyslexia Association (2003), for example, refers to both behavioural and cognitive characteristics, describing dyslexia as:

“... a specific learning disability that is neurological in origin. It is characterised by difficulties with accurate or fluent word recognition and by poor spelling and decoding abilities. These difficulties typically result from a deficit in the phonological component of language, that is often unexpected in relation to other cognitive abilities”. (Reid Lyon et al, 2003, p.12).

There are two main consequences of literacy-based definitions. Firstly, they fail to distinguish between those who are dyslexic and those people who have problems with literacy skills because of other factors such as poor educational experience, or different language background (see discussion in Everatt et al., 2010), leading to the questioning of its utility as a concept (Elliot & Grigorenko, 2014). Secondly, the diagnosis of dyslexia in adulthood is at least different from and can become more complicated than childhood diagnosis as, because of their life experience, adults tend to exhibit heterogeneous profiles (Beaton et al., 1997; Gerber, 2012). There is the possibility of misdiagnosis and misunderstanding, particularly of those adults who have been described as “literate”
dyslexics (Miles et al., 2004), but who experience broader difficulties in domains such as reading comprehension, written expression, note-taking, clarity of communication, time management, memory and organisation (Fawcett & Nicolson, 2001; Gregg, 2009; McLoughlin et al., 2002; Smith-Spark et al., 2004).

Increasingly, therefore, researchers, professionals and organisations working with dyslexic adults are adopting broader definitions that include the role of processes such as executive functioning and working memory. McLoughlin and Leather (2013) proposed an active definition based on research as well as professional experience:

“Developmental dyslexia is a genetically inherited and neurologically determined inefficiency in working memory, the information processing system fundamental to learning and performance in conventional educational and work settings. It has a particular impact on verbal and written communication as well as organisation, time management, planning and adaptation to change.” (McLoughlin & Leather, 2013, p.28).

This definition provides an operational model that might explain many of the difficulties experienced by dyslexic adults and promotes self-understanding. Narrower, literacy-based definitions can contribute to misunderstanding amongst dyslexic adults who have overcome many of their literacy difficulties, as well as confusion for educators and employers as to how best they can support dyslexic adults, instruction in reading and spelling often being the least of their needs.

The lack of consensus over a definition reflects the multiplicity of dyslexic characteristics described in the scientific and professional literature (Giraud & Ramus, 2013). This may be a result of its developmental nature, there being a complex interaction amongst individual and environmental factors. In a seminal paper, Frith (1999) considered the danger of cognitive theories becoming circular, i.e., “deficits being merely restatements of behavioural phenomena” (p.195). She also suggested the utilization of a framework to gain a better understanding of dyslexia across the lifespan: at biological, cognitive and behavioural levels. Frith wrote:

“Defining dyslexia at a single level of explanation - biological, cognitive or behavioural - will always lead to the paradoxes. For a full understanding of dyslexia, we need to link
together the three levels and consider the impact of cultural factors which can aggravate or ameliorate the condition. Consensus is emerging that dyslexia is a neurodevelopmental disorder with a biological origin, which impacts on speech processing with a wide range of clinical manifestations.” (Frith, 1999, p.211).

The biological level includes genetics and neurology; the cognitive level, information processing; and the behavioural level, the more observable characteristics such as weak literacy skills, see Figure 1.1.

Until recently, the levels described by Frith have belonged to separate research fields. Increasingly, however, dyslexia is being understood in the context of such a framework and the process-orientated view of cognition. Gregg (2008) argued that the latter provides insight into understanding about how specific abilities influence learning, and to acknowledge the influence of the interaction between brain, behaviour and environment, echoing Frith (1999). She advocated that “behavioural measures should not solely be used to determine causation” (Gregg, 2009, p.61). The process view is particularly relevant for dyslexic adults who have achieved reading competency and achieved success, despite their dyslexia. Environment is likely to have an influence on their performance (Snowling, 2014); this includes protective factors such as family and culture, plus individual personality characteristics like determination and perseverance, as well as developing expertise with language (Fink, 2003; Gerber et al 1992; Gregg, 2013). Nevertheless, they may still experience cognitive deficits which can influence their effectiveness in education and the workplace.
Frith suggested that each of these levels interacts within the individual and their environment, which explains the heterogeneity amongst the population of dyslexic adults.

**Evaluative summary**

In summary, there are several themes within the definitions: those that historically focus on the behavioural characteristics; that is, dyslexia is a difficulty with learning to read and spell which is likely to be a result of a phonological deficit (Duff et al., 2016); those that reflect a more cognitive approach, it is a problem with information-processing in working memory (McLoughlin et al., 2002); and finally, it is increasingly being understood as a language learning impairment (Snowling, 2014), which potentially sits between the two. These perspectives do not necessarily contradict each other, but they reflect the lack of clarity defining dyslexia, particularly in adulthood. Much of the research has focused around the literacy-based definitions, in the development of literacy skills and subsequent interventions around the educational success of children. While this is commendable, it has not addressed the reported difficulties of many dyslexic adults, with planning, organisation, and some memory tasks. The broader cognitive definitions often describe these characteristics that might affect performance at work and, while they do give credence to the difficulties experienced by adults and provide a rationale for interventions, they are not evidenced-based. Hence there is a need for research that may provide evidence as to why many adults report the problems above, which should inform intervention and contribute to greater understanding of dyslexia in the workplace.
2.3. The behavioural characteristics of dyslexia in adulthood

The behavioural characteristics of dyslexia fall into three groups: measurable; observable and self-reported. This also applies to the affective and psychosocial characteristics that arise because of an individual’s experiences in education, employment and daily living. Poor literacy skills are the primary behavioural characteristics of dyslexia: actual literacy attainment, poor decoding skills and lower levels of single word recognition. Slower reading speed and weak reading comprehension skills are also reported. Writing and spelling are also affected, the latter often persisting into adulthood. Writing fluency can also be weak, problems with sentence structure and clarity of expression being common (Snowling, 2012). Problems with numeracy, not a conceptual difficulty but with the procedural aspects, such as the instant recall of symbols, calculations and the language of mathematics have also been reported (Chinn, 2009).

Observable characteristics described have also included: spoken language, having difficulty with word finding, the pronunciation of polysyllabic words, (McLoughlin et al., 2002), and correctly labelling things (Brunswick, 2012; Everatt & Smythe, 2001; Miles, 1992). Problems with time management, organisation and sequencing are frequently reported by dyslexic adults (Bartlett & Moody, 2010), as well as skills such as taking notes (Riddick, Farmer & Sterling, 1997). Difficulties with memory, including recalling instructions, remembering people’s names and retention of times tables have also been reported (Brunswick, 2012; Everatt & Smythe, 2001; Kirk & Reid, 2003; Smith-Spark et al., 2004).

Many of the behavioural self-reported characteristics described above provide the basis for checklists and screening tests that are used to determine if further evaluation is necessary (Everatt & Smythe, 2001). There have also been several systematic studies outlining how some of the behavioural characteristics described above are evident in adulthood (Gerber et al., 2004; Gerber 2012; Maughan et al., 2009). These include problems with all aspects of literacy and numeracy, as well as academic achievement generally, and occupational outcomes.
Affective and psychosocial characteristics

In general, in Western society where literacy is highly valued, the inability of an individual to acquire literacy skills is likely to have a negative long-term effect on them (Gregg, 2013). There is an increasing amount of research devoted to the psychosocial aspects of dyslexia, particularly in childhood. Dyslexia is a life-long condition: the effects of stress, lack of confidence, low self-esteem, anxiety, anger and frustration, as well as problems with social interaction, can persist into adulthood (Burden 2008; Hales, 2004; McNulty, 2003; Miles, 2004; Nalavany et al., 2011). The contribution of constructs such as self-concept, self-esteem and motivation to academic achievement is well documented (Burden, 2008; Elliott & Dweck, 2005; Parajes 1996; Pintrich et al 1994). Individuals who have struggled throughout their education are likely to have lower self-esteem (Terras et al., 2009; Tumner & Chapman, 1996) and perceive themselves as less competent (Alexander Passe, 2015; Burden, 2008; Humphrey & Mullins, 2002).

There is a wealth of research exploring affective factors: humiliation at school, childhood depression and gaining lower than expected achievements, leading to lack of confidence (Alexander-Passe, 2006, 2008; Miles, 2004). Lack of confidence and dyslexic students rating themselves as less competent than their peers in their academic achievements have been well documented (Carroll & Ilies, 2006; Riddick et al 1999). Humphrey and Mullins (2002) and Glazzard (2010) found that dyslexic students attributed their success to external, rather than internal factors, because of their own perceived inadequacies: they considered themselves not in control of their own success in relation to learning.

These feelings of inferiority persist into adulthood: lack of confidence and failure in employment have been reported (Alexander-Passe, 2015). In a systematic review of thirty-three studies looking at the impact of dyslexia in relation to work participation, De Beer et al. (2014) concluded that dyslexia negatively affects most domains of functioning at work and that this can be magnified as demands become greater. Although relying on small samples, Klasson et al. (2011) reported medium effect sizes in relation to anxiety and depression amongst dyslexic adults and concluded that, as the literacy difficulties are life-long, that psychological effects also persist into adulthood. Furthermore, anecdotal and systematic reports refer to lack of confidence and embarrassment about memory and performance,
confusion about taking longer to produce written work, and that “simple” tasks such as photocopying, filing and data entry are challenging for a dyslexic person (Gerber, 2002; Hales, 2004; Nalavany et al., 2011).

In contrast, Klassen et al., (2011) found evidence to show that some dyslexic adults overestimate their abilities. Gregg (2009) also reported over-confidence in some dyslexics and suggested three reasons: reference to their peer group not themselves, poor metacognitive awareness and a self-protection strategy. However, other studies have demonstrated that levels of self-worth and self-efficacy are not necessarily lower in dyslexic teenagers and adults (Burden, 2008). Likewise, studies exploring the attributes of successful dyslexic people have also identified similar levels of self-efficacy and self-esteem (Gerber 2012; Logan, 2009; Madaus et al., 2008). Therefore, dyslexic people can be “at risk” of emotional problems, but studies have demonstrated that they can be resilient.

2.4 Dyslexia assessment in adulthood: literacy skills and cognitive profiles

The diagnosis of any learning disorder such as dyslexia depends on a clear definition and delineation of characteristics (Mather & Wendling, 2012). As there is controversy over definitions, it is not surprising that there is little consensus as to how best to diagnose dyslexia. To some extent, definitions have constrained the assessment process, the testing of literacy skills being a key part, particularly for children. In current practice, most frameworks and guidance (McLoughlin, 2012; Swanson, 2009) for the assessment of adults place much emphasis on the assessment of cognitive abilities and individual differences, rather than a deficit in literacy (see Turner, 1997). The assessment process is one of differential diagnosis, attempting to isolate cognitive factors that contribute to under-achievement. It can be complex with adults as many will have adopted strategies, but behavioural observation of the client while they are being tested can detect this (Gerber et al., 1996; McLoughlin, 2012; Pennington, 2009). For example, the use of their fingers or sub-vocalisation to maintain the information in working memory when asked to recall a string of numbers on the digit span test. Furthermore, Reid and Kirk (2001) advocated that the assessment of adult difficulties should begin with an interview during which information concerning medical, educational and occupational history is collected so that the results of testing are placed in context. The relevant recommended literacy measures in the assessment
of adults are the oral and silent reading of texts with measures of speed and comprehension, tests of reading efficiency, single word, sight word and non-word decoding at speed and tests of rapid naming (Pennington, 2009; Swanson, 2012). Measures of these skills were used in this research to establish the presence of dyslexia in the participants.

Measurement of cognitive ability is an essential part of the assessment process. It determines levels of potential, as well as reflect contrasts amongst abilities. Internationally the Wechsler Adult Intelligence Scale-IV is widely used as it provides measures of verbal and non-verbal reasoning abilities, perceptual reasoning, working memory and processing speed. The contrast between the latter two scales and the first two can be characteristic of dyslexia: indeed, many studies have been devoted to establishing this (Pennington, 2009). In a meta-analysis, Swanson (2012) reviewed the research comparing the academic, cognitive and behavioural performance of dyslexic and non-dyslexic adults. His aim was to determine which of the mechanisms underlying a dyslexia diagnosis in children were still relevant to adult assessment. He confirmed that deficits in phonological processing, including phonological awareness, phonological memory, naming speed and verbal memory, persist into adulthood. However, a hierarchical linear regression indicated that phonological awareness, the identification of sounds and the position of those sounds in words, is less important in adulthood than in childhood. He concluded that no single cognitive process clearly dominated others in the assessment of dyslexic adults, and he suggested “the coordination of many processes would provide the best account” (Swanson, 2012, p.28).

Critical Evaluation

The above suggests that the diagnostic process of adult dyslexia should be reviewed. Despite increasing indications that areas of executive functions may be affected in dyslexia, as discussed throughout this thesis, there is little assessment of these in the present diagnostic procedure for adults. The focus remains on levels of literacy, so interventions are literacy-based and potentially inappropriate. Measurement of executive function skill may provide a more comprehensive picture of an individual’s difficulties in a diagnosis of dyslexia and would potentially indicate that metacognitive instruction as an intervention would be more effective (Doyle, 2015; Hock, 2012). Smith-Spark et al., (2004, 2007, 2016, 2017) identified areas of executive functioning deficits in dyslexic students and concluded that these are likely to impact on performance at work but have not suggested how this might inform practice.
Furthermore, currently there is minimal research into the influence of executive function deficits in relation to dyslexia in the workplace.

2.5 Causal theories

There is on-going debate as to the causes of the behavioural characteristics associated with dyslexia (Snowling 2009). Frith (1999) outlined a framework that combined evidence from different research areas. In this model, depicted in Figure 1.1, the biological level (genetics and neurology) interacts with the cognitive level (information processing), leading to behavioural effects which have been outlined previously. At all levels, the environmental influences are acknowledged. Following this model, the potential biological causal factors are briefly discussed, and the influence of the environment considered. The focus of this Thesis is, however, on the cognitive level.

2.5.1 The Biological level

Historically, there has always been the notion that there was a genetic liability to dyslexia. Genetic linkage studies have confirmed this, identifying candidate genes potentially related to phonological processing deficits (Giraud & Ramus, 2013).

There is increasing evidence to suggest that dyslexic people have neural organizational and functional differences to non-dyslexic people. Neuroanatomical and imaging studies have demonstrated differences in hemispheric symmetry, as well as synaptic connections (Colette et al., 2002; Galaburda, 1999; Giraud & Ramus, 2013; Shaywitz & Shaywitz, 2005). There has been much interest in language-related areas because any neuroanatomical or neurofunctional changes in these areas could be causal for dyslexia. However, there are many unanswered questions and it is “unclear whether these brain differences area cause, a consequence or a correlate” (Tannock, 2013, p.8).

2.5.2 The Cognitive level

There is some agreement that dyslexia involves a difficulty with processing information but, despite an abundance of research, there continues to be little consensus at the cognitive level regarding a coherent theoretical framework. This could be because of the range of deficits
reported across a wide variety of tasks (Ramus & Ahissar, 2012). The specific phonological
deficit theory is the foremost hypothesis (Frith, 1999; Shaywitz, 2003; Stanovich, 1996;
is not sufficient to cause dyslexia; the likelihood of diagnosis is increased in the context of
broader oral language difficulties” (p.47). There is an array of other theoretical proposals
acknowledging the importance of phonology, but they too have considered that dyslexia may
have a broader basis. They include: the rapid temporal processing theory (Tallal et al., 1993),
the magnocellular theory (Stein, 2001, 2008), and the cerebellar theory (Nicolson & Fawcett,
1990; Nicolson & Fawcett, 2008), as well as the anchoring deficit proposal (Ahissar, 2007).
They are not discussed in this Thesis but are worthy of consideration to demonstrate the
complexity of definition and diagnosis. (For reviews, see Ramus and Ahissar, 2012;
Snowling, 2009; Vellutino et al., 2004). Duff et al. (2016) acknowledged that impairments in
visual spatial skills and attention are also dyslexia-related traits. Snowling et al. (2011)
commented on the historical lack of terminological agreement and core characteristics of
dyslexia, acknowledging that it “is increasingly accepted it is not an ‘all or none’ condition
but a dimensional disorder underpinned by poor phonological skills” (p.2.)

2.5.3 Phonological processing

Phonological processing has been argued to comprise three general aspects (Wagner et al.,
1999). Phonological awareness, defined as the ability to identify sounds within language and
manipulate individual sounds to construct words; phonological memory, sometimes known as
verbal short-term or working memory, the ability to remember sounds and their order, as well
as new words; and phonological retrieval, including rapid automatic naming, sometimes
known as lexical retrieval, which is the ability to retrieve words from long-term memory
(Wagner, Torgeson, Rashotte & Pearson, 2013).

Poor performance on phonological processing tasks has consistently been demonstrated in
dyslexic children (Reid Lyon, 2003; Shaywitz.et al., 2003; Snowling & Hulme 2012;
Torgeson, et al., 1999), and this has also been shown to be evident in adulthood (Swanson,
2012), even amongst people who have developed competent reading skills (Breznitz, 2003;
Miles, 1990; Pennington, 1990; Ramus et al., 2003; Reid et al., 2006; Vellutino et al., 2004).
There is considerable evidence to support the notion that weak phonological processing undermines the development of reading skills. In fact, Lundberg and Holen (2001) described the relationship between the two as “one of the most robust findings in cognitive psychology” (p.112). However, not every dyslexic person experiences deficits in all three phonological areas (Swanson, 2012), but those who do are likely to find learning to read very challenging. Studies of the double deficit hypothesis (Wolf & Bowers, 1999) have suggested that when problems with phonological awareness/memory and rapid naming combine, individuals will have the most difficulty with reading. Increasingly, it has been argued that rapid naming ability is one of the best predictors of reading attainment, particularly fluent comprehension and most resistant to intervention (Wolf, 2008). Rapid naming deficits are therefore considered to be one of the indicators of dyslexia in adulthood (Fawcett & Nicolson, 1998).

Research exploring the relationship between phonological awareness and reading has shown it to be more strongly related to decoding accuracy, whereas rapid naming was related to fluency (Wolf & Bowers, 1999; Wolf, 2008). Good readers read fluently, accurately and at speed, and this leads to good comprehension (Duff et al., 2016; Shaywitz & Shaywitz, 2005). Shaywitz et al. (2003) argued that slower naming speeds reflect the difficulty in retrieving phonological information. Other researchers have suggested that this is consistent with lower-level temporal processing difficulties (Breznitz & Misra., 2003; Wolf & Bowers, 1999). Some, but not all, dyslexic adults are dysfluent when reading, which means that to understand they read slowly (Fink, 1998). Berninger et al (2006) and Vellutino et al., (2004) outlined the many complex processes involved in effective reading, including linguistic coding/phonological processing, and highlighted the importance of working memory processes.

Reading comprehension is another area of disagreement; some arguing that it is a persistent characteristic of dyslexia (Swanson, 2012), whereas others consider deficits in reading comprehension to be a related but potentially separate syndrome (Cain & Oakhill, 2006; Snowling, 2012). Duff et al. (2016) acknowledged that difficulties with reading accuracy may persist across the lifespan and affect comprehension. These difficulties affect performance in time pressured environments requiring reading and writing, such as examinations. It has been argued that reading comprehension involves working memory and executive functioning skills (Daneman & Carpenter, 1980; Swanson, 2012), and this is discussed later.
Given that slower rapid naming is also related to problems with word finding and verbal fluency, and there is increasing interest in spoken language skills in the early diagnosis of dyslexia, there has been insufficient research on the relationship between rapid naming and spoken language, including difficulties with word finding and tip-of-the-tongue memory. However, Faust, Dimitrovski and Shact (2003) compared word retrieval in a group of dyslexic and non-dyslexic children in their study. They found no difference in the usage of semantic cues between the children, but dyslexic children were able to use the phonological cues less accurately. They concluded that naming problems occur because of an inefficiency in retrieving the phonological representations. Ramus and Szenkovits (2008) and Smith-Sparks et al., (2017) suggested such deficits might be due to difficulties in accessing accurate phonological representation, as it involves broader working memory and executive functioning.

Increasingly, over recent years, the understanding of dyslexia has moved from being a single deficit disorder to a developmental disorder comprised of multiple risk factors (Duff et al., 2016; Pennington 2009). In addition to phonological processing, these risk factors have been argued to include executive attention, spoken language skills and environmental influences. Studies exploring the cognitive profiles of dyslexic adults reported heterogeneity amongst dyslexic participants and concluded that, while the phonological processing theory provides an explanation, other cognitive factors should be considered (Ramus et al., 2003; Reid Lyon et al., 2003). Such cognitive factors may include the role of executive functioning and working memory in dyslexia (Brosnan et al., 2002; Jefferies & Everatt, 2004; Smith Spark et al., 2016, 2017; Swanson, 2015).

There is little doubt that a phonological processing deficit is an underlying cause of literacy difficulties. Initially, these relate to the development of reading and spelling but also affect reading comprehension skills, particularly in adulthood. There is debate as to whether poor reading comprehension is a separate syndrome or is part of dyslexia. In either case, reading comprehension involves executive functioning skills and any deficits in these processes might affect comprehension. In addition, further research identifying deficits in executive functioning would provide additional evidence for characteristics other than literacy that are reported in adulthood.
2.6 Working memory and executive functions

As with many psychological constructs, there are multiple definitions of both working memory and executive functioning (see Miyake & Shah, 1999, for reviews of the former; and Barclay, 2012, and Reid Lyon & Krasnegor, 1996, for the latter). There is also considerable conceptual overlap between working memory and executive functioning. The terms “working memory” and “executive functioning” are sometimes used synonymously (Borkowski & Burke, 1996). Furthermore, terminology such as “executive attention”, “executive skill”, and “selective attention” are used in relation to both constructs (Baddeley, 2007; Conway et al., 2003; Cowan et al., 2005; Diamond, 2013; McCabe et al., 2010). Cognitive variables such as inhibition and processing speed (which will be defined later) also feature in both constructs. There is often little definition of the individual concepts or they are defined differently. Cognitive flexibility, for example, can refer to changing set or attention shifting (see Miyake, Emerson & Friedman, 2000). However, for the purposes of this research, the two constructs of working memory and executive functioning are treated separately.

Working memory is defined as:

“a processing resource of limited capacity, involved in the preservation of information while simultaneously processing the same or other information” (Swanson, 2015 p.176).

Executive functioning is defined as:

‘executive function can be thought of as the set of abilities required to effortfully guide behaviour towards a goal, especially in non-routine situations....... that require some degree of judgment’ (Banich, 2009 p.89).

Prior to the design of this research, three common problems in relation to the assessment of both working memory and executive functions were considered: construct validity; poor reliability; and task impurity (Friedman & Miyake, 2004). Firstly, regarding construct validity, many researchers have not specified and/or justified why measures were selected, and in what way they involved executive processes. Furthermore, researchers may have
different interpretations of that process, i.e., the measure may not be tapping into the intended executive process. Secondly, many assessment measures purporting to tap into executive tasks have shown poor reliability. One reason for this might be that valid measures of executive functioning/working memory are more likely to be related to relatively novel processing tasks that demand high attentional control. Such tasks are likely to be subject to varying strategy use and/or changes due to learning, which can reduce associations between measurement points. Finally, Miyake et al. (2000) highlighted the fact that executive functions necessarily operate on multiple cognitive processes: measurement of any executive task is likely to reflect other processes. There is, therefore, task impurity. For example, some researchers use the Trails Test as a measure of changing set and planning (Salthouse et al., 2000), but it is also a test of speed of processing and therefore ratio scores should be determined (Salthouse, 2005). Miyake et al. (2000) argued that task impurity is also a cause of the poor reliability. To alleviate this problem, they suggested the careful choice of statistical procedures and advocate latent variable analysis, as it extracts the common variance among multiple tasks (see Friedman & Miyake, 2004 for more detail).

The relationship between working memory and executive functioning is an area of debate. Some researchers have argued that executive functioning skills (i.e., the central executive which controls planning, monitoring and attention) are an intrinsic part of the working memory system (Baddeley & Hitch, 1974; Baddeley, 2004, 2010). Many others (Diamond, 2013; Kane & Engle, 2002; Miyake et al., 2000; Salthouse, 2005) have considered working memory to be a core component of executive functioning. This is apparent in the Diamond model of executive function discussed below. In contrast, Eslinger (1996) argued that there is clear delineation between working memory and executive function. Working memory is, by definition, an online process, temporarily holding information to be worked on; whereas executive functions include a variety of goal-directed, problem-solving behaviours over time, which may include prospective or retrospective memory. However, it is apparent that working memory processes are involved with executive functioning activities.

2.6.1 Working memory

There have been frequent attempts over the past 30 years to conceptualise working memory (see Miyake & Shah, 1999; and Osaka, Logie & D’Esposito, 2007, for reviews). Its role has been of interest in dyslexia research (Démonet et al., 2004; Swanson & Siegel, 2001) because
deficits in the phonological loop, as conceptualised by Baddeley & Hitch (1974), are a potential cause of language learning difficulty (Baddeley et al., 1998; Ramus & Szenkovits, 2008).

The Baddeley and Hitch (1974) model of working memory is one of the most influential. They proposed a broad theoretical framework involving a multi-component model, which is comprised of the central executive (domain-general) and two domain-specific slave systems, the phonological loop, which is responsible for retaining (storing) and processing verbal information, and the visual spatial sketchpad, which is the equivalent system, but involves images and spatial information. The central executive is the component that controls attention and coordinates information within the limited capacity of the phonological and visual memory storage buffers. Baddeley later added the episodic buffer which acts as a link between long-term and working memory (Baddeley, 2000). There has been much criticism of this model, particularly in relation to the central executive, which is ill-defined but relates to executive functioning processes (see Towse and Houston-Price, 2001). Despite the criticisms, the Baddeley model has proved resilient. It is used as a basis for research, possibly because of the depictions of the two slave systems, the phonological loop and the visual spatial sketchpad.

A conceptualisation of working memory, partially adopted by Baddeley (1986), is that of the supervisory attentional mechanism proposed by Norman and Shallice (1986). They suggested two levels of control; that of the supervisory attentional mechanism and the contention scheduling mechanism, in which attention is controlled by existing schemata. According to these researchers, the supervisory attention mechanism is utilised in times of novel, ill-learned or highly critical situations. Likewise, Cowan (1999) proposed the Embedded process model of working memory, that also emphasises the role of attention. He argued that the phonological loop and the visual-spatial sketchpad are not comprehensive enough to explain all the cognitive processing involved in working memory. His multi component model includes the following: short-term memory, which demonstrates temporal decay and chunk capacity limits; and long-term memory, comprised of two sub-sets; these are determined by the level of activation on a working memory task. Cowan (2008) suggested that attentional focus has the limited capacity of about four items or chunks (see Figure 1.4). Both Cowan’s and Shallice and Norman’s conceptualisations of working memory have implications for dyslexic adults, as they highlight the role of executive
attention, which is now acknowledged to be a potential risk factor in dyslexia (Snowling, 2014).

Unsworth and Engle (2007) argued that while working memory is essential in many domains, it is not required in all cognitive operations; many cognitive tasks can be carried out on an automatic basis requiring no working memory assistance. This idea is equivalent to Cowan’s short-term memory element. This potentially has relevance in the development of literacy skills: reading and spelling skills ultimately should become automatic. They suggested that working memory is most involved when control is needed, particularly when processing new information and when there is considerable external (e.g., noise) or internal (e.g., emotional interference) distraction, thereby suggesting an element of executive attention. Furthermore, Kane and Engle (2002), as well as Jarrold et al. (2011), argued that it is a mechanism involving executive attention, as there are many strong correlations across diverse memory span and higher-order tasks. They also suggested that domain specificity relates more strongly to aspects of complex cognition.

There has been much discussion about whether working memory is a domain-general construct. In this context, domain is interpreted as modality. A study by Mackintosh and Bennett (2003) showed that verbal working memory was independent of spatial working
memory, suggesting that different tasks (i.e., verbal or spatial) require different processing demands (although see Colom et al., 2003). This is a consideration in this present research, because of the debate regarding the verbal and non-verbal processing differences (Bacon et al., 2010).

A different perspective of working memory is that proposed by Daneman and Carpenter (1980). They explored the concept of working memory in relation to reading comprehension. They conceptualised working memory as a domain-general cognitive resource involving processing and temporary storage within a single flexible system. They argued that differences in reading comprehension performance reflected differences in working memory capacity because of the trade-off between the processing and storage functions. Reading comprehension is a complex task; the reader must process linguistic information (pragmatic, semantic and syntactic) from the text and use this information when integrating it with subsequent text. If either storage or processing is faulty then reading comprehension would be affected. Empirical support for their claim that working memory capacity is a predictor of performance on complex cognitive tasks such as language comprehension came from a study by Daneman and Merikle (1996) providing an example of the overlap in conceptualisations of executive functioning and working memory.

There has been much interest in the relationship between working memory and fluid intelligence but, again, there have been differing perspectives. However, there is a move towards consensus that, while working memory is strongly related to fluid intelligence, it is not the same construct. Salthouse (2014) investigated what might be responsible for the strong relationship and its direction between working memory and fluid intelligence. He argued that, based on a large sample (1,734 participants), relationships could be examined in more detail. His findings were consistent with existing research that shows the two of them to be strongly related. He concluded that a key aspect of fluid intelligence is the ability to deal with novelty as well as complexity, and that working memory is an integral part of this (Salthouse, 2014). It is more likely that as greater demands are imposed on working memory, higher fluid intelligence is required (Colom et al., 2004).

In summary, working memory is one of the most studied aspects of cognitive psychology, but there is still little consensus as to its nature. Despite the on-going debates, there are commonalities emerging: it is a processing mechanism; it has limited capacity; it enables the
encoding and manipulation of information; it is strongly related to but not synonymous with fluid intelligence; and executive control/attention is a component. This brief review has selected a few of the models that may be relevant to the present research because they include aspects of language processing and verbal working memory defined as the temporary maintenance of verbal information (Acheson & Macdonald, 2009). The term working memory is increasingly used in relation to the diagnosis and intervention of dyslexia in adulthood. A clearer understanding of working memory processes and dyslexia might provide insight into the reported difficulties with memory and slips of attention of dyslexic adults (McNamara & Wong, 2003).

2.6.2 Executive function

Executive functions are considered critical to human cognition (Reid Lyon & Krasnegor, 1996). Like working memory, there are many views but most include “those capacities that enable a person to engage successfully in independent, purposive, self-directed, and self-serving behaviour” (Lezak et al., 2012, p.37). Some definitions have elements focusing upon cognitive control processes which operate on lower-level responses to regulate and shape behaviour, and which involve inhibition and delay in response (Friedman et al., 2007; Denckla, 1996); others include goal formation, planning, and implementation of goal-directed plans (Jurado & Rosselli, 2007). The complexity and confusion around executive functions in terms of definition and assessment are illustrated by Packwood et al. (2011), who conducted a literature review of 60 studies on executive functioning and identified 68 different terms for executive function as well as 98 tasks used to assess them.

There have also been several models of executive functions (see Barkley, 2012, for an historical overview; see Reid Lyon & Krasnegor, 1996 for models based on specific perspectives). The most comprehensive model is perhaps that of Diamond (2013). This included the three widely-acknowledged components of executive functioning, working memory, inhibitory control and shifting (Miyake et al 2000). Figure 2.3 displays a representation of Diamond’s (2013) model. As can be seen from the Figure, working memory in the sense of up-dating is one of the components incorporated under the umbrella of executive functions. The other components are cognitive flexibility, (i.e., task switching/shifting) and inhibitory control. Inhibitory control includes three aspects, i.e., cognitive inhibition and selective focused executive attention; response inhibition of
behaviour, i.e., self-control and discipline behaviour. Working memory, cognitive flexibility and inhibitory control are linked to higher-level executive functions such as reasoning, problem-solving and planning. Self-regulation and effortful control are also associated with inhibition, but they are not an intrinsic part of it. A reason for the durability of this multiple component theory is the support provided by neuroimaging studies. The three executive processes of working memory/up-dating, cognitive flexibility/shifting and inhibitory control have been associated with specific prefrontal cerebral areas (Collette & Van der Linden, 2002; Collette et al., 2005). Diamond emphasised that, executive function develops over the lifespan and may be affected by environment, age and individual differences (see Best & Miller, 2010).

**Figure 2.3** An adaptation of Diamond’s Model of Executive Functioning (2013) and Displaying the 3 Core Components of Executive Functioning, Miyake et al. (2000).

There have been many studies exploring individual differences in task performance that confirm there may be distinct sub-components within executive functioning (Friedman et al., 2006; and see Jurado & Rosselli, 2007, for an overview). Diamond’s model is consistent with Salthouse’s (2006) conception of executive functioning in relation to the association
with reasoning, problem-solving and planning (i.e., the higher-level executive functions). However, Salthouse adopted a unitary view of executive function, arguing that it is a basic psychological construct that includes general intelligence, fluid intelligence and processing speed.

Brown (2013), relying on the work of Barkley (2012), described six different clusters of executive function: activation includes planning and prioritising; focus involves sustaining and shifting attention to tasks; effort, regulating alertness and processing speed; emotion modulating; memory, utilising working memory and recall; and action, monitoring and self-regulation. Brown (2013) argued that these would have a significant impact on every-day activities and that deficits would undermine performance in daily living, education and at work. Like Diamond, he emphasised the interaction between the different clusters, suggesting that they interact together in a variety of combinations, which is particularly relevant for individuals who have learning difficulties.

The emotional/motivational aspect of executive functions is the subject of increasing interest. This function is related to inhibitory control (Diamond, 2013) and self-regulation (Barkley, 2011, 2012; Hoffman, et al., 2012). The role of emotion and motivation in executive functioning was already implicit in its early conceptions (Barkley, 2012; Stuss 1992), but there has been little research enabling a clearer understanding of the effect. Barkley (2012) suggested this is because it is much harder to measure emotional responses. Most of the earlier research has focused on the effects of emotion on cognitive performance (see Gray, 2004, for an overview). Mitchell and Phillips (2007) found that when emotion is involved, executive functioning ability decreases, and that mood can affect working memory performance. Schmeichel and Tang (2015) explored the influence of executive function on the regulation of emotion. They concluded that overall, individual differences in executive functioning predicted differences in success with emotional regulation. The most reliable predictor of self-enhancement following negative feedback and coping with daily stress was the up-dating measure/working memory capacity. While investigation of emotional regulation is not part of the present research, the influence of emotions, negative self-perceptions and confidence should always be considered in the performance of dyslexic adults.
Another area of debate is the relationship between executive functions and intelligence. There is increasing evidence to suggest that executive functions are related to intelligence and academic achievement (Best & Miller, 2010). However, this is not surprising because it supports Salthouse et al.’s (2008) findings that aspects of executive functioning, i.e., inhibition and updating/working memory, correlated strongly with fluid intelligence. Research conducted by Friedman et al. (2004) confirmed the results above regarding the working memory component; but inhibition and shifting were not found to be related to the intelligence measures, either fluid or crystallised. The exact nature of the relationship between executive function, working memory and intelligence remains opaque and requires further investigation.

In summary, there is consensus regarding the core components of executive functioning. These are: working memory/up-dating; inhibitory control; set changing/shifting; and higher executive functions, such as planning, reasoning and problem-solving. However, there remains some discussion as to the positioning of working memory in relation to executive functioning and the relation between executive functions and intelligence, as well as emotions/motivations.

The components of executive functioning

Up-dating/working memory. Many researchers consider working memory to be an integral part of the executive functioning system (Diamond, 2013; Lehto, 1996; Miyake et al., 2000). The up-dating component is a working memory process as, in terms of executive function, it is seen as more than maintenance and is additionally a mechanism that actively manipulates relevant information (Diamond 2013; Lehto, 1996; Miyake et al., 2000).

Inhibitory control. Inhibitory control is a broad construct that has several elements. Nigg, (2000) classified eight different kinds of inhibition, arguing that a reference to such a taxonomy would improve accuracy when measuring this component. Diamond (2013), see Figure 2.4, identifies three areas: cognitive inhibition includes the inhibition of thoughts and memories; response inhibition element, which is linked to the over-riding suppression of prepotent learned responses; and executive attention, being able to selectively attend to and focus on a chosen task, while suppressing attention to another one; or equally inhibiting attention to specific stimuli and attending to others, based on the motivational goal. This is
reminiscent to other models (Cowan, 2008). For simplicity, the most common distinction between cognitive and response inhibition were adopted in this research, while acknowledging that some would argue that most inhibition tasks are not pure measures and do not tap into a single inhibitory process.

**Shifting.** Cognitive flexibility is the ability to shift between mental states or between different cognitive domains. It is considered an important aspect of executive function, as being able to cope with rapid and changing environments requires efficient reactions because different aspects of information are being processed. Examples are shifting between visual and verbal tasks or between addition and subtraction in subjects such as mathematics, or between rule sets in tests such as the Wisconsin Card Sorting Test (WCST; Heaton et al., 1993). The latter has been cited as the most frequently used measure of executive functioning (Baddeley, 1996; Diamond, 2013; Stuss & Benson, 1986) and it involves the ability to perform a new operation in the face of previous action or deliberate interference. Best & Miller (2010) argued that it also requires inhibition and working memory processes for effective performance.

Verbal fluency is less frequently used as a measure of executive function (Jurado & Rossilli, 2007; Smith-Spark et al., 2017), and some researchers question its reliability because of its “hybrid nature” (Shao et al., 2014). It can be defined as the ability to retrieve information from long-term memory in accordance with a set of rules. Verbal fluency did not emerge as a component in Miyake et al.’s. (2000) research. However, Fisk and Sharp (2004) conducted a factor analysis on measures of executive functions, including measures of word fluency, to determine which executive functioning components it would map on to. The structure obtained was broadly consistent with Miyake et al.’s findings, supporting the three recognised components, but in the Fisk and Sharp data verbal fluency loaded on to a distinct factor. They suggested that Miyake’s results in the latent variable analysis focused on the analysis of lower-level executive function tasks, such as the Stroop and Keeping Track tasks. Therefore, it would not necessarily have tapped higher-order functioning such as a complex task of verbal fluency.

Processing speed is not an executive function but “a fundamental part of the architecture of the brain and, therefore, also of the cognitive system” (Kail & Salthouse, 1994, p.219). It has been studied largely in relation to changes in performance of cognitive processing in relation
to age (Salthouse, 2012). It is integral to many working memory and executive functioning measures; however, it is rarely clearly defined. It can be seen as a reaction time, the time it takes to respond to presented stimuli verbally or with a key press (see Nigg, 2000); the time it takes to appraise a task before reacting; or the time it takes to conduct a cognitive task which usually involves some more complex motor performance, for example the Trails Test (Salthouse, 2011). Processing speed is often measured by the completion time on tests such as Symbol Search and Coding, from the Wechsler Intelligence Scale, but speed of information processing can be affected by several factors, such as physical nerve conduction times, fine motor skills and attention.

McCabe et al. (2010) explored the relationship between working memory, executive function and processing speed. They investigated 206 adult participants who completed a range of tasks. The working memory tasks included a reading span test: executive function tasks included the Wisconsin Card Sorting Test (Heaton, 1993), a verbal fluency task and a perceptual speed task (how quickly the individual could replace a visually presented symbol), and a digit symbol substitution task. Latent variable analysis revealed that the processing speed construct was distinctly different from either working memory or executive function. Furthermore, the tasks intended to measure working memory and the tasks intended to measure executive functions shared a common construct which they labelled “executive attention”. This supports the theories that the constructs of working memory, executive function and processing speed are independent, but that they are also share some overlapping commonality.

Many definitions of executive functioning also include the notion of planning. It is generally seen as a higher-order processing skill, and it can be defined as a dynamic process involving a deliberate specific sequence of actions to achieve a pre-determined goal (cited in Reid Lyon & Krasnegor, 1996, p.257), i.e., the ability to map out a sequence of moves in preparation for task completion (Lezak et al., 2004). It is both an executive functioning and metacognitive activity (Garner, 2009), but it is rarely defined precisely. Planning inevitably involves cognition and knowledge in generating problem-solving steps and ordering them in a sequence. Arguably, there are different levels of planning, daily planning of activities; planning to problem-solve, achieve a task or overcome difficulties. Identification of the problem/task determines the goal; therefore, goal-setting is an initial and integral part of planning. Planning also involves decision-making and action. Goal intention, setting goals
that are feasible and desirable; goal implementation, as well as staying on track, are two aspects of good planning (Gollwitzer & Oettinger, 2011).

In summary, the Diamond (2013) model highlights the commonly-agreed elements of executive functioning and provides some clarity in an area of conceptual confusion. Some of the executive functioning processes, particularly that of up-dating/working memory processes outlined above, are areas of potential weakness for dyslexic adults. Therefore, the research conducted in this Thesis will draw on the Miyake components of executive function and on the Diamond model.

2.7 Working memory, executive function and dyslexia

As mentioned previously, over and above literacy, research suggests that dyslexic adults experience additional difficulties, including problems with memory and organisation (Berninger et al., 2006; Démondet et al., 2004; Pennington, 2006; Smith-Spark et al., 2016, 2017). Support for the role of working memory and executive functioning in dyslexia also comes from cognitive neuroscience. There is substantial evidence to show that dyslexia’s basis is neurobiological. Wolf, Sambataro, Lohr and Steunbrink (2010) identified differences in brain connectivity in the frontal regions of the brain. The frontal lobes are regarded as being responsible for higher-order processing, lending weight to the theories that executive functioning and working memory are involved in dyslexia (Démondet et al., 2004; Pennington, 2009). In relation to reading comprehension, Richlan et al. (2011) reported lower activation of the inferior frontal gyrus in comparison with controls. Similarly, there is evidence of increased right hemisphere activity in the brains of dyslexic people when they are reading (Eden et al., 2004; Shaywitz & Shaywitz, 2005), which the researchers believed may indicate compensatory activities.

A prominent advocate of the involvement of executive function in reading comprehension in relation to dyslexia is Swanson, who has conducted large and comprehensive studies on both children and adults over the past two decades (see Swanson, 2015). Swanson (1999) explored the role of working memory, and his findings indicated that dyslexic children had difficulty in the efficient allocation of attentional resources during high-demand conditions. He suggested that this might be a result of dyslexic children having difficulties with
executive processing that relate to planning, checking and evaluating their performance, i.e.,
poor metacognitive skills. Swanson & Ching-Ju Hsieh (2009) compared the academic,
cognitive and behavioural performance of dyslexic adults with those of average achieving
adult readers. Overall, they concluded that dyslexic adults experience difficulties in
phonological processing, rapid naming and verbal memory, in comparison with the controls.
Furthermore, their findings indicated that the latter two predicted poor reading
comprehension independently of phonological processing. They concluded that verbal
memory was as, or more, important in adulthood than phonological skill.

Aside from reading comprehension, there have been a range of studies exploring the
relationship between working memory, executive functions and dyslexia but, overall, the
findings have been discordant. Verbal and visual-spatial components of working memory
have been found to be impaired (Alteneier et al., 2008; Brosnan et al., 2002; Helland &
Asbjørnsen, 2000; Jefferies & Everatt, 2004; Menghini et al., 2011; Reiter et al., 2005;
Swanson, 2006; Varvara, et al., 2014). Attention deficits and slower processing speed have
been identified (Jefferies & Everett, 2004; St Clair-Thompson, 2011; Swanson, 2006;
Varvara et al., 2014). Studies by Helland and Asbjørnsen (2000), Moura et al. (2015) and
Berninger, (2006) reported deficits in shifting; however, this contrasts with the findings of
studies conducted by St Clair-Thompson (2011). The findings regarding inhibition are also
inconsistent: some researchers (Everatt, 2004; Goia et al., 2002; Helland & Asbjørnsen
(2000) reported differences between dyslexics and controls, unlike St Clair-Thompson, who
found the two groups performed equally well. Goia et al. (2002) and St Clair-Thompson
(2011) also found deficits in organisation and planning. Booth (2010) conducted a meta-
analysis in which she tried to account for the heterogeneity of performance of children with
reading difficulties. She acknowledged that there were considerable limitations to her
analysis, writing that “many executive tasks implicate several areas of functioning which
limits the conclusion that can be drawn from the meta-analysis” (p.158). Nevertheless, she
concluded that reading difficulties were associated with executive function impairments.

In the population of adult dyslexics, most studies have reported verbal working memory
deficits (Alloway & Alloway, 2013; Beidas, 2013; Brosnan et al., 2002; Everatt, 2004;
identified verbal and visual working memory deficits in comparison to controls, but the
visual working memory deficits were apparent only when there was a high working memory
demand. A study conducted by Smith-Spark et al. (2007) indicated that the novelty of task demands on the initial trials of spatial up-dating also proved more problematic for the dyslexic controls. Furthermore, Smith-Spark et al., (2016) identified deficits among dyslexic individuals in the three areas of shifting, working memory and inhibition, although on the latter component, the deficit in inhibitory control was accuracy (and not reaction time) on a “non-habituated task” (p.331). Studies that included measures of cognitive flexibility (shifting) such as the Wisconsin Card Sorting Test (Horowitz-Kraus, 2014) and the Rapid Automatic Switching task (Berninger et al., 2006) also found deficits in a dyslexic group when compared with controls. Concerning inhibitory control, Brosnan et al. (2002) and Proulx and Elmasry (2014) reported deficits in the dyslexic group. There has been consistency in studies that have incorporated measures of verbal fluency, attention and speed of processing, showing that the dyslexic adults performed less well than the controls (Beidas, 2013; Brosnan et al., 2002; Breznitz & Misra 2003; Smith-Spark et al., 2000). An area in which there are mixed results is in visual-spatial processing Bacon and Handley (2010) reported increased use of visual-spatial processing, in contrast to studies conducted by Brosnan et al. (2002); Everatt et al. (1997, 1999) and Brunswick et al. (1999, 2010).

Smith-Spark et al. (2004) conducted studies in which they examined the cognitive functioning of dyslexic adults from a different more ecologically valid perspective, that of cognitive/memory failures in every-day settings. They investigated the every-day memory/attention difficulties experienced by a group of dyslexic university students and a group of matched controls. The participants were asked to complete the Cognitive Failures Questionnaire (Broadbent, Cooper, Fitzgerald & Parks, 1982), a self-report measure designed to identify slips of attention or action in every-day situations. There was a significant difference between the groups, the dyslexics experiencing a higher frequency of cognitive failure on every item. This supports the findings reported above regarding increased working memory deficits in dyslexic adults, and anecdotally reported slips of memory and attention by dyslexic adults.

To date, perhaps not surprisingly, research into adult dyslexia remains inconclusive. Berninger et al., (2006) and Menghini et al. (2011) suggested a multi-focal approach should not be limited to the linguistic brain, advocating multi-dimensional approaches. Pennington (2009) argued that to understand dyslexia across the lifespan, a multiple neurocognitive deficit model is necessary. He suggested that it is the interaction of multiple cognitive factors
that determines whether someone is dyslexic, and that compensations may lie within the individual. For example, a strength in semantic coding may offset a phonological deficit (Seidenberg & McClelland, 1989; Swanson, 2009). Pennington (2009) proposed a complex model including the following elements: firstly “the aetiology of complex behavioural disorders is multifactorial and involves the interaction of multiple risk and protective factors which can be genetic or environmental”; secondly “these risk and protective factors change the development of cognitive functions necessary for normal development, thus producing behavioural symptoms that define the disorder”; and thirdly “the disorder is continuous and quantitative rather than being discreet therefore the threshold for having the disorder is somewhat arbitrary” (p. 404) (and see Duff et al., 2016). The frameworks of both the Frith (1999) and Pennington provide a possible explanation for the heterogeneity found amongst the dyslexic population regarding the development of literacy, working memory and executive functioning skills.

In summary, this literature review outlines a comparatively small portion of the research into executive functioning, working memory and dyslexia. It demonstrates the complexity of cognitive functioning. However, it does indicate that dyslexic people may experience working memory and/or executive function difficulties. For the purposes of this research, the Miyake framework, as well as models of the visual/verbal systems in working memory, were adopted to determine if differences exist between dyslexic and non-dyslexic people.

2.8. The visual strengths theory

Concurrent with the phonological processing and executive functioning deficits theories, it has been suggested that neurological differences identified in dyslexic brains result in enhanced visual-spatial skills (Galaburda, 1985). The argument, based on the premise of increased processing in the right hemisphere of the dyslexic brain, where visual-spatial skills are lateralised, should lead to strengths in visual processing and creativity. Shaywitz (1996) identified more right hemispheric activity in the dyslexic brain and argued that dyslexia may be “an encapsulated deficit often surrounded by significant strengths in reasoning, problem solving, concept formation and critical thinking” (p. 104).
There is anecdotal evidence regarding the utilisation of these strengths. It has been drawn from personal experience (Davis, 1997; West, 1997), historical surveys of “gifted” individuals (Morgan & Klein, 2000; West, 2010; Wolf, 2008), and from statistics indicating that in occupations such as architecture and engineering where good visual-spatial skills are important, there are a high number of dyslexic employees (Alexander-Passe, 2013; Eide & Eide, 2011). Furthermore, research has indicated that there are a disproportionate number of dyslexic students in art colleges (Wolff & Lundberg, 2002). Most of the research supporting the visual strengths theory has been qualitative and case study based (Franks & Frederick, 2013; Gerber & Raskind, 2013; Leveroy, 2013). Empirical studies have generally presented more mixed results. These have mostly been conducted in assessment settings, comparing dyslexic and non-dyslexic performance on the ability to manipulate shapes and objects. For example, Steffert et al. (1998) found the dyslexic participants performance was superior to the non-dyslexic cohort in rotation tasks. Everatt et al (1999) found evidence of stronger creative abilities but did not necessarily attribute this to enhanced right hemisphere functioning. Von Károlyi (2003) identified increased right hemispheric functioning that is associated with rapid visual scanning and concluded that dyslexics have enhanced global visual-spatial ability. In contrast, some researchers have found that the performance of dyslexic participants on a range of visual-spatial tasks was only as good as or even less good than non-dyslexic participants (Brosnan et al., 2002; Jefferies & Everatt, 2004; Winner et al., 2001). Brunswick et al. (2010) found no main effect difference on a range of visuospatial tasks, but identified sex differences, suggesting that any visuo-spatial advantage might be confined to men. Furthermore, Winner et al. (2000) suggested that it was a question of choice rather than strength, because dyslexic adults might choose to follow courses or occupations that place fewer demands on their literacy skills to avoid reading and writing.

In attempting to find some common ground between these opposing views, Bacon and her colleagues conducted studies which they argued have more ecological validity than the previously discussed measures (Bacon et al., 2007, 2010, 2013, 2014). They explored the role of visual processing in a range of different reasoning tasks. In their 2014 study, they suggested that “verbal and spatial reasoners draw differentially on the verbal and spatial components” (p.89) of Baddeley’s working memory model. In 2007, in a study examining the performance of dyslexics and controls on syllogistic tasks, they concluded that the dyslexic participants, either consciously or implicitly, chose to reason spatially unlike the non-dyslexic group who used more verbal reasoning. However, there were indications that
spatial reasoning might impede processing in high-demand situations, especially those with more semantic and verbal premises, consistent with Smith-Spark and Fisk (2007). Bacon and Handley (2010) explored the importance of visual processing by comparing a dyslexic and a non-dyslexic group while using transitive inference reasoning tasks. Their findings again indicated that the two groups used different resources: the dyslexic group using a visual image when it was presented, as it clarified or anchored the meaning of the problem; the non-dyslexic group having no need for it. Furthermore, the correlation analyses showed no visual spatial deficits and that visual memory was predictive of accuracy. They hypothesised that the dyslexics’ use of visual processing was not one of enhanced ability, although possibly one of relative strength and the “deployment” of skills. Bacon and Handley (2014) conducted two experiments to explore this hypothesis further. The results of the first experiment demonstrated that both groups were equally accurate on reasoning problems and, consistent with previous studies, visual memory ability predicted accuracy but only in the dyslexic group. In the second experiment, once again the reasoning of the dyslexic group was significantly less accurate when the memory load was high, which they suggested indicated executive functioning difficulties, and proposed that dyslexic people use visual strategies to compensate as they are then better able to sustain their attention for the deficits in verbal and executive processing. Although the findings from these studies were indicative rather than conclusive, for this current research, it was anticipated in this current research that dyslexic adults might use visual abilities/strategies when processing information either because of non-verbal strengths or as a compensatory mechanism.

2.9 Risk, Resilience and Metacognition

Despite their cognitive and literacy weaknesses, many dyslexic people achieve success and, increasingly, the reasons for this are being sought through risk and resilience models with a view to informing interventions. “Risk” has been defined as “the serious threats to successful development” (Masten, 2001). Snowling and her colleagues have conducted considerable research into the “at risk” population. Snowling (2014) identified three risk factors: genetic predisposition, phonological processing deficits and poor oral language. Klassen, (2011) argued that being dyslexic and potentially having trouble learning in educational settings is a risk factor; it increases the likelihood of under-achievement in academic settings and subsequent difficulties in adulthood. Early intervention in terms of
literacy support might mediate that risk but still does not guarantee success in adulthood. Nevertheless, the risk factors do not always dictate negative outcomes (Rogan & Hartman, 1990), and sometimes the deficits may have positive relationships with achievement in that overcoming the deficits increases the determination of the individual to succeed (Gerber & Reiff, 1996). There has, therefore, been growing interest into what constitutes “resilience”. Resilience factors are complex and overlapping and may be both internal as well as external to the individual (Gregg, 2009). Researchers conducting longitudinal studies found that external factors include the environment, such as type of education, positive relationships and good family support (Boetsch, et al., 1996; Burden, 2008; Gerber et al., 1992; Madaus, 2010; McNulty, 2003; Nalavaney et al., 2011; Snowling, 2014). The internal control attributes associated with successful adults include: self-regulation skills, self-efficacy beliefs, a positive self-concept and motivation (Goldberg et al., 2003; Masten, 2001), as well as self-understanding, motivation and goal orientation (Gerber, 2012; Goldberg et al., 2003). The latter attributes are aligned to metacognition.

2.9 1 Metacognition

Implicit in the internal resilience factors mentioned above is metacognition. Broadly, it can be defined as “the conscious awareness and control over one’s own cognition, own thinking and learning processes” (Fernandez-Duque et al., 2000, p.290). There are many perspectives on metacognitive processing. In most there is a distinction between four components: firstly, metacognitive knowledge, which includes knowledge of self, of the task and of strategies; secondly, metacognitive skills or control, which is the process of regulating one’s problem-solving and learning activities; and thirdly, metacognitive experience, which relates to feelings of confidence in one’s knowledge and judgements regarding online performance or “concurrent metacognition” (Flavell,1979; Hertzog & Dixon, 1994, Nelson & Naren, 1994). Finally, metacognitive experience also includes an affective component; that is, believing things are either going well or badly and, according to Efklides (2008), this is the conscious or unconscious trigger for metacognitive control to take place.

There is considerable research suggesting that good metacognitive skills improve performance in education and academic settings (Butler, 1998; Dweck & Leggett, 1995; Hock, 2012; Meltzer, 2007; Pintrich et al., 1994), in work settings, including the legal profession (Neidweiki, 2005), the armed forces and emergency services (Cook & Klumper,
1999), the nursing profession (Dale & Aitken, 2007), and in engineering (Vos & de Graaff, 2004), and the mastery of goals which is strongly related to improved academic performance (Elliot & Dweck, 2005; Coutinho et al., 2005, 2007; Moran & Gardiner, 2007). In addition, they are also said to improve decision-making (Batha & Carroll, 2007). Magno (2010) added another perspective in his study of the role of metacognitive skills in developing critical thinking. He used structural equation modelling to determine the effects of metacognition on critical thinking; the results indicated that the greater use of metacognitive skills results in better critical thinking. He argued that this is not surprising as metacognitive skills lead to the discovery of meaningful structures in the organisation of information. This allows for transfer of knowledge, adaptability and flexibility of approach in new situations, the use of effective strategies, plus better decision-making skills and potential improved performance in the workplace. The relationship between metacognition and self-efficacy has long been of research interest (Zimmerman, Bandura & Martinez-Pon, 1992; Pintrich & de Groot, 1990; Zimmerman, 2000; Schunk & Parajes, 2004) and they are core components in developing expertise (Locke & Latham, 1985; Sternberg, 2005; Zimmerman, 2006). Finally, good metacognitive skills are related to higher self-esteem (Poli et al., 2000) and confidence (Coutinho, 2008; Eflikades, 2014; Kleitman & Stankov, 2007).

There are also negative aspects of metacognition. Schraw et al. (1994) pointed out that the improvement of skills is only possible if the self-referent metacognitive beliefs are accurate. False beliefs about cognition result in unsuccessful performance. Furthermore, Sternberg (2005) cautioned that strong metacognitive skills alone can sometimes have a negative effect. In sports such as tennis, for example, a player when serving might over-analyze their performance, increasing their anxiety levels and negatively impact on their performance. Zeidner and Matthews (2005) demonstrated that negative self-belief leads to dysfunctional plans for processing, leading to performance failure. They cited research conducted by Matthews et al. (1999) investigating relationships between metacognition and test anxiety. The authors concluded that excessive metacognition was the strongest predictor of cognitive interference. Hertzog et al. (2000), in their review of metacognition in adulthood and old age, identified the same three major categories outlined above. The authors concluded that age does not necessarily affect metacognitive knowledge and monitoring skills, but that inaccurate beliefs regarding their memory can have consequences in cognitively demanding situations, furthermore, inaccurate beliefs can also lead to over-estimation or over-confidence.
Research into metacognitive processing has stemmed from different branches of psychology: cognitive, developmental (Flavell, 1979; Borkowski, 1996), educational (Butler, 1996; Sternberg, 1985), clinical (Nelson & Narens, 1994), and neuropsychology (Shimamura, 2000; Schwartz, 2007. This multi-disciplinary approach encouraged Butler (1998) to state that “the concept of metacognition has fuzzy boundaries” (p.277). There is an abundance of terms and phrases, including metacognitive skill, meta-components, meta-memory, metacognitive beliefs, metacognitive awareness, higher-order skills, executive processing and self-regulation which, in many cases, are ill-defined (Veenman, 2006). There is a conceptual overlap between executive functioning and metacognition, that is particularly evident amongst the educational models. In the Borkowski (1996) model of metacognition, the authors admitted that the terms “metacognition” and “executive functioning” are used synonymously: the term “executive processes” is also integral in their model of metacognition. Borkowski and Burke (1996) suggested three essential components of executive function: task analysis (planning); strategy control (selection and utilisation of appropriate strategies) and strategy monitoring (the process of evaluating strategy effectiveness).

Other researchers (e.g., Fuster, 2002) conceptualised executive functions as having two fundamental components: first, metacognitive executive functions which include most of the generally-accepted aspects such as planning, strategy development, abstraction and working memory; second, the emotional motivational executive functions which are responsible for coordinating cognition and emotion. This conceptual confusion is particularly evident amongst the educational models. Butler (1996) used terms such as planning, analyzing, revising, allocating attention, and evaluation in relation to metacognitive skill, but these terms are also used to describe executive functioning skills (Denkla, 1996; Meltzer 2007).

Shimamura (2000) and Fernandez-Duque et al. (2000) explored the relationship between executive attention and metacognitive regulation, the latter concluding that metacognition and executive functioning are conceptually very similar, and it is merely the research that has developed from the two different perspectives: cognitive neuropsychology and educational psychology. Coutinho (2008), and Garner (2009) view metacognitive strategies/self-regulation as promoting the use of executive functioning skills, which they defined as an umbrella term incorporating a collection of interrelated processes responsible for goal-directed behaviour.
Another area of conceptual overlap is that of self-regulation. It can be defined as a set of behaviours that are directed towards the maintenance of control and motivation to achieve an external goal (Zimmerman, 2008). Dinsmore et al. (2008) attempted to differentiate between self-regulation and metacognition by exploring their conceptual roots. He argued that metacognition emerged as a construct from the investigation of meta-processes such as metamemory and cognition (Flavell, 1979). Schraw and Moshman (1995) described metacognition as an “endogenous constructivism” (p.393) where metacognitive processing emphasises individual learner development over learning environment interactions. Dinsmore et al. (2008) argued that self-regulation is more exogenous and is related to external stimuli in the environment; that is, the individual must interact with his or her environment, so knowledge is derived from the environment not the individual. Self-regulation also has links to executive functions, (see Diamond’s model, Figure 1.5). Follmer and Sperling (2016), in regression and mediation analyses, explored the role of metacognition in relation to self-regulation and executive functions, specifically inhibition, measured by a test of verbal fluency and shifting measured by the Plus-Minus task (Jersild, 1927). They concluded that shifting and inhibition can be mediated by metacognitive skill and predict better self-regulation skills. Schunk (2008) deplored the fuzziness of the metacognitive construct, arguing strongly for clarity of definition. She stated that defining the processes influences the measures selected and consequently the interpretation of results. Arguably, the study outlined above is an example of this. While the ability to inhibit a response is an element of verbal fluency, there are many more cognitive processes involved in the selection of a word under certain constraints. Likewise, the measure of metacognitive skill used was the Motivated Strategies Learning Questionnaire which Muis et.al. (2007) suggested tapped more self-regulatory than metacognitive processes. Moreover, Meijer et al. (2012) pointed out that operationalisation of metacognition is often different, making research comparisons impossible.

There is also some debate as to whether metacognition is a general skill or specific to certain tasks. Most research is focused on metacognitive behaviour in specific tasks such as reading (Wong, 1996), problem-solving (Swanson, 1990), or what people experience when engaged in metacognitive activity (Efklides, 2008). Schraw et al. (1994) determined that monitoring skills are general by nature, whereas Kelemen, Frost and Weaver (2000) presented evidence in direct contrast to this. Veenman and Spaans (2005) suggested that metacognitive skills initially develop in separate domains, becoming a more generalized ability upon maturation.
Efklides (2008) argued that they develop through an individual’s observation of their own and other’s behaviours to outcomes in specific contexts. McLoughlin et al. (2002) argued that dyslexic adults can be metacognitive (planful and reflective) in some aspects of their life (e.g., in sporting situations), but that this does not transfer to activities such as reading, where they do not change the reading behaviour according to the task demands. For example, many dyslexic adults report they always read every word and continually re-read, even when comprehension is ineffective (Fidler & Everatt, 2012). Stipanovic (2016) explored the role of metacognition in successful career planning and provided a framework arguing that good metacognitive knowledge and metacognitive control, components from the Metacognitive Awareness Inventory (Schraw & Dennison, 1994), enable people to make direct links with work-specific tasks.

**Evaluative summary**

This section has outlined the multi-faceted nature of both the concept and the research into metacognition. Many researchers advocate that metacognitive processing generally improves performance. Furthermore, there is implicit agreement that metacognition involves the awareness of processes that support executive functioning and self-regulation skills. There is little critical debate regarding metacognitive components: researchers from differing research domains acknowledge different approaches and attempt to establish a unifying framework (Shimamura, 2000). In relation to determining the role of metacognitive skill in academic success or improved performance in the workplace, researchers have focused on the first two of the generally-accepted elements of metacognition: metacognitive knowledge; that is, knowledge of one’s cognitive processes; and metacognitive skill, the control and regulation of cognitive processes. For the purposes of this research these two were explored.

**2.9.2 Assessment of metacognition**

A variety of methods have been used in the assessment of metacognitive skills, including self-report questionnaire, interviews, think-aloud protocols and observations. Neuropsychological assessments have also been developed. There are problems associated with all methods. Firstly, no method can guarantee that the assessment tool is only measuring the intended target because, as with any cognitive assessment, a range of cognitive processes are involved. Secondly, Veenman (2011) pointed out that the “prompting of strategy use” may occur in self-report questionnaires, interviews and think-aloud assessments.
just by the questions themselves. Thirdly, the participant must rely on memory to recall earlier performances when answering questions, and this may be faulty or distorted (Veenman, 2012). Fourthly, participants may report what they think is desirable or they may not engage sufficiently in the activity to the required level, but think they do. Fifthly, individual participants may interpret the questions differently. Finally, participants may not be aware of their mental processing or have inaccurate beliefs concerning their cognitive performance (Veenman, 2012).

Despite the problems described above, the dominant method to measure metacognition is the use of self-report questionnaires, possibly because of ease of gaining large sample sizes, meaning that a lot of information can be gathered quickly. Examples of widely-used metacognition questionnaires are: The Metacognitive Awareness Inventory (MAI; Schraw & Denison, 1994); the Meta-Memory in Adulthood questionnaire (MIA; Herzog, 1996); the Learning and Study Strategies Inventory (LASSI; Weinstein, 1987), and the Motivated Strategies for Learning Questionnaire (MSLQ; Pintrich et al., 1994). The titles themselves indicate that these questionnaires explore rather different aspects/components of metacognition. This was confirmed in a multi-trait, multi-method analysis conducted by Muis et al. (2007). They concluded that, even if the facets within each questionnaire were similar, it was unwise to assume convergent validity. It should be also noted that the latter two were specifically designed to explore the learning strategies of students and they have generally remained in the educational domain. The Metacognitive Awareness Inventory has been used in both educational and occupational research so was selected for this study. Muis et al., (2007) suggested that of the inventories, the Metacognitive Awareness Inventory was the clearer measure of metacognitive processing. It measures the two components of metacognition mentioned above: (i) knowledge of cognition, or knowledge of skills, tasks and strategies; and (ii) regulation of cognition, as in planning, monitoring information-management, and evaluation skills. The Metacognitive Awareness Inventory was used in the current research because the two components potentially parallel the factors of self-understanding and internal control outlined in the research conducted to explore the factors of success in dyslexic adults (Gerber, 2012; Schnieders et al., 2016; Stipanovic, 2016).
2.9.3 Metacognition and dyslexia

Despite the obvious close relationships between cognitive processing and executive functioning, metacognition is generally recognised as being independent of intellectual ability (Veenman, 2006; Zimmerman al., 1992); it does not involve reasoning or problem-solving. However, there is some agreement that metacognition contributes to learning performance on top of intellectual ability. Swanson (1990) considered whether high levels of metacognition in children could compensate for low overall aptitude. The results indicated that the higher metacognitive groups performed better than the lower metacognitive group. Furthermore, the lower ability participants who had good levels of metacognition performed better on problem-solving tasks than high ability participants who had weak metacognitive skills. This suggests that development of metacognitive skill could be a compensation for dyslexic children. Trainin and Swanson (2005) examined the way successful dyslexic college students compensated for their processing difficulties when compared to equally successful non-dyslexic college students. Their results were consistent with those of Ruban et al. (2003) and indicated that, when compared to their peers, these dyslexic students relied more on metacognitive learning strategies.

There is some evidence to suggest that metacognitive skills develop less automatically in dyslexic children. Vygotsky (1962) described the relationship between language and thought and its effect on learning. Children with language disorders are thought to be at risk of the poor development of thinking skills, which is perhaps not surprising, as metacognitive skills develop through positive learning situations (Sternberg, 2005). Torgeson (1977), Tumner and Chapman (1996), and Wong (1986) all suggested that students with learning difficulties appeared to demonstrate deficits in strategic processing. Klassen (2002) reported that dyslexic students were less skilled than their peers in two aspects of metacognition: problem-solving and performance monitoring. This is consistent with Butler (1998) who identified three areas in which dyslexic students might be at risk. They proposed that dyslexic children failed to identify the task demands, they often selected the wrong strategy as they were less sophisticated learners so had fewer strategies available, and they had poor monitoring and evaluation skills, so both the intrinsic and extrinsic feedback was negative. The researchers suggested several reasons for the lack of metacognitive development in dyslexic people. These included: the extra time they needed to process information and reflect on performance; low confidence in their learning abilities meant they did not experiment with
their learning; and beliefs in their learning abilities were inaccurate, which might be a result of being taught in ways that are inefficient and less effective. Furthermore, they agreed with Schraw & Dennison (1994) that the initial use of metacognitive strategies was effortful and required practice. Hence children who were struggling to learn were generally less likely to utilise metacognitive skills. In line with these findings, Bergey et al., (2017) and Chevalier et al., (2017) found that the dyslexic students had either weaker metacognitive skills or utilised them less effectively in comparison with their peers. However, the former study also concluded that this lack of metacognitive skill did not influence academic performance, whereas Chevalier and her colleagues reported that greater use of metacognitive skill did result in higher academic grades. These two studies used the same measures of metacognition and similar samples, an example of the heterogeneity of the participants and the difficulty of replicability (Bergey et al., 2017).

In summary, greater metacognitive skill is related to improved performance, both in the dyslexic and non-dyslexic population. It was proposed that these skills are less developed or utilised less effectively by some dyslexic people. In contrast, some dyslexic students appear to be using them effectively as a potential compensatory mechanism for processing difficulties (selection of a strategy and planning and organisation of work reduces the demands made on cognitive processing). Therefore, this research aimed to determine if metacognitive weaknesses exist in dyslexic adults and what role good metacognitive skills potentially play in mitigating processing difficulties, thereby enabling success.

2.9.4 Metacognition and confidence

The relationship between metacognition and confidence is an example of the different operations cited by Meijer et al., (2102). Much of the research regarding confidence is based on the Nelson and Narens’ (1994) conceptualisation of metacognitive experiences, such as feelings of knowing and confidence in judgment. However, in a different operalisation, Stankov (2000) considered self-confidence as being a part of metacognitive processing, as monitoring and reflecting on the accuracy of decision increase self-confidence in one’s judgement and in abilities (Pressley et al., 2010; Zimmerman, 2006). Kleitman and Stankov (2007) explored the role of self-confidence in relation to metacognition. For the purposes of their research they designed a Memory and Reasoning Confidence Inventory (MARCI). This
investigated an individual’s level of confidence in their memory and reasoning ability, and they related the data gathered to that from the Metacognitive Awareness Inventory. They concluded that self-confidence was positively related to metacognitive skills, i.e., better metacognitive skills lead to greater confidence. Confidence is considered a predictor of success (Dweck & Elliot, 2005; Stankov et al., 2012) and improved performance in the workplace (Locke & Latham, 2006). As lack of self-confidence has been identified as a potential characteristic of dyslexia, and dyslexic adults experience difficulties with memory but not with reasoning, this Thesis explored the relationship between confidence and metacognition in a group of dyslexic adults.

2.10 Workplace success

The purpose of this research was to explore the cognitive and metacognitive factors that potentially contribute to workplace success. It was, therefore, necessary to establish some success measures. The notion of success originally referred to any positive outcome, “the accomplishment of an aim or purpose” or, more simply, goal achievement. It has been also associated with “the attainment of fame, wealth, or social status” (The Oxford English Dictionary, 1989). Success is a multi-faceted construct and can be viewed from a variety of perspectives: cultural, gender, societal, social (including family and friends), personal (in relation to health, well-being and personal growth), and career or workplace success. For the purposes of this research, the focus was upon career/workplace success.

Career or work success can be defined as the positive accumulated work and psychological outcomes resulting from one’s workplace experiences (Abele & Spurk, 2009; Hall, 2002; Ng et al., 2005; Judge et al., 1995). This definition, as Arthur et al. (2005) pointed out, is in keeping with the OED definition. It also serves to mirror the early conceptualisation of work success. Hughes (1958) asserted that an individual might view career success in two ways: from an objective/societal perspective, including tangible aspects, such as salary and promotion; and from a subjective perspective, the personal evaluation of performance. Since then there has been a wealth of research exploring the relationship between career success and variables such as personality (Bono & Judge, 2003), gender (Dyke & Murphy, 2006), decision-making (Hartung & Blumstein, 2002), and locus of control (Judge & Bono, 2001).
Arthur et al. (2005) found that, based on a literature search, there was inconsistent use of theory, terminology confusion and a failure to recognize the interdependence of the two facets. Heslin (2005) also argued for conceptual clarity and examined objective and subjective criteria in detail.

2.10.1 Objective career success criteria

Heslin (2005) defined objective career success as the extrinsic measurable indicators of an individual’s career, reflecting a general societal understanding, and included occupation, financial status and job level.

Financial status

Financial status was used as a measure of success in this research. However, Heslin highlighted problems in using this measure to determine true success. For example, some occupations (e.g., nurses and academic staff) are affected by pay norms: high job performance may not be rewarded by a relative increase in salary. Furthermore, high pay and/or promotion do not always make people feel more successful (Hall & Chandler, 2005). Similarly, people often choose a work-life balance option, or a sense of meaning, purpose and contribution to society at the expense of a higher salary. Therefore, Heslin argued that measures of objective societal success should always be seen in conjunction with the subjective personal success criteria and other self-referent factors (Heslin, 2005).

Academic qualifications

Gaining good academic qualifications is believed to ensure career success. The research is, however, equivocal. Nickell (1982), in an economic review of the determinants of occupational success, concluded that academic qualifications were of importance only if they were of a high level. Judge et al. (1995) found that educational level, quality and prestige of education all predicted financial success. Ng et al. (2005) found a moderate correlation between academic attainment and career success. However, Hogan et al. (2013) argued that academic attainment often acts as a filter in personnel selection, and that a certain level of academic attainment is a pre-requisite for many jobs. In addition, they suggested that once a
particular level of academic qualification has been reached, other factors such as motivation and having career aspirations are as important in determining success.

Two other indicators of objective success in Heslin’s (2005) model are having a “Career Goal” and being “On Track” to achieve that goal. A career goal may be to achieve a certain level of financial status, or be in a role of high social standing, or eminent in their chosen field. Whatever the reason for the goal, individuals are likely to be highly committed and therefore experience greater success, both in financial terms, but also from personal satisfaction. Furthermore, those people who have a goal in mind are more likely to maintain motivation and work towards achieving it, to stay on track, consistent with Locke and Latham’s (2006) goal-setting theory.

2.10.2 Subjective career/work success criteria

Subjective career measures are intrinsic to the individual and include job satisfaction, self-awareness (i.e., self-efficacy) regarding performance, adaptability and learning. They are a person’s evaluation across many dimensions in relation to the job, e.g., sense of identity, purpose and work-life balance. However, job satisfaction is frequently the sole measure of subjective success. Heslin (2005) maintained that this should not be the case, because although job satisfaction contributes to feelings of success, that and self-efficacy are conceptually distinct constructs that are not necessarily always related.

Job satisfaction.

Job satisfaction is defined as “the positive emotional response to a job situation resulting from attaining what the employee wants and values from the job” (Locke et al., 1983). Weiss (2003) argued that this definition should be further refined as the emotional response that relates to both affective and attitudinal judgements. He suggested three areas should be addressed in a measure of job satisfaction: firstly, evaluative attitudinal judgements; secondly, affective experiences, and thirdly, self-beliefs regarding the job and performance. Ng and Feldman (2014) conducted a meta-analytic review on subjective career success and distinguished between the affective-based perspective (employees’ feelings and job satisfaction) and the cognition-based perspective (employees’ beliefs about their performance). Consistent with this are Heslin’s (2003) self or other referent criteria. Heslin
argued that other referent criteria, when individuals compare themselves to others (Festinger’s social comparison theory, 1945), will determine job satisfaction. The self-referent criteria are those feelings that individuals consider in relation to their own personal standards, beliefs or preferences. Individuals achieve satisfaction when they are reaching their personal goal or acting in accordance with their beliefs (Bandura, 1997).

Self-efficacy

Self-efficacy is defined “as an individual’s beliefs about their capability to perform or to complete a specific task successfully” (Bandura, 1997). It is, therefore, associated with job satisfaction. Like the construct of job satisfaction, it has been influential in the field of career success as it has long been associated with improved performance (Lunenberg, 2011; Stajkovic & Luthans, 1998; Zimmerman, 2000), it is thus considered an appropriate measure of success. It is an important motivational construct affecting personal choice and outcomes (Gist & Mitchell, 1992). While the definition above is widely accepted, there is still some confusion of terminology in the literature. For example, self-efficacy, self-esteem and self-concept are related but conceptually different (Kanfer & Ackerman, 2005). Self-concept refers to how an individual sees him/herself in terms of ability or competence across a wide range of domains, e.g., academic, physical and interpersonal skills. It can be a normative construct, e.g., “I do this better than others”. Self-confidence is a more general construct in one’s overall ability to perform or behave to a certain level, and it may fluctuate due to environmental factors such as sleep deprivation or stress (Kanfer & Ackerman, 2005), although see Locke and Latham (2006), who defined self-efficacy as “task specific confidence”. Self-esteem is a personal judgement of worthiness, an affective evaluative judgement of how the individual perceives themselves: i.e., is satisfied with themselves in relation to others. It is possible for an individual to have high self-efficacy in a task; for example, they feel they are good at problem-solving, but have low overall self-esteem. They may feel that they are not as intelligent as others because of their weak literacy skills. In career research, all the above have been explored in relation to success and motivation, but often without clear definition (Chen, Gully & Eden, 2004). Chen et al. (2004) maintained that self-efficacy is more strongly related to motivational and achievement processes, whereas self-esteem is more associated with anxiety and avoidance processes. They argued for clarity
to distinguish between the concepts. For the distinction between self-concept and self-efficacy, see Zimmerman (2000).

Self-efficacy is a key component of Bandura’s (1986) Social Cognitive Theory, where learning takes place through social situations and environment, in conjunction with the cognitive processes of motivation, attitudes and response. It has relevance to the workplace because of the social organisational environment in which people work and yet individuals will react according to their unique personal characteristics. Bandura (1993) argued that four processes: cognitive, motivational, affective and selective, influence feelings of self-efficacy, which then affect performance. The cognitive process involves how individuals construe their ability in two ways; either seeking challenges to expand their knowledge and accepting mistakes as part of the learning process, or seeing ability as inherent and unchangeable. The latter viewing mistakes as symbolic of their inability (Dweck & Leggett, 1988).

Self-efficacy is also seen as task-specific, influenced by performance beliefs on one particular domain, how well individuals feel they will do on any given task, and it is possible to feel efficacious in one area of work, perhaps talking to people or working at a high operational level, but have low self-efficacy in relation to coping with paperwork, a potential scenario for dyslexic employees. Motivational processes are based on goal-setting: people can form beliefs about their abilities and then set goals in relation to these. These beliefs are founded on three features: magnitude, the level of task complexity or difficulty; and strength, how competent individuals feel about performing a task. People perform at the level that is consistent with their self-efficacy beliefs (Parajes, 1996; Zimmerman, Bandura & Martinez Pons, 1992), and the higher the self-efficacy, the greater chance of success. Thirdly, generality, where people either develop specific self-efficacy beliefs about a job or role, or more general activities, such as being organised across domains (Stajkovic & Luthans, 1998), although arguably, having good organisational strategies could be a specific skill or ability in itself. Levels of self-efficacy also determine: how much effort will be spent on achieving the goals; length of perseverance in the face of difficulty; resilience to failure (Zimmerman, 2000). Furthermore, on reflection, the more successful individuals are, the more efficacious and motivated they feel, the higher the goal they will set next time. The affective processes of self efficacy include reactions to poor performance, thinking becomes ineffectacious, debilitating and de-motivating, as people lose the belief they can achieve their goal. Betz and Hackett (1986) argued that higher levels of self-efficacy lead to greater interest, more
engagement in career planning and results in enhanced perseverance in the face of difficulties, hence beliefs of self-efficacy are likely to affect career development and choices.

Despite the large body and wide variety of research methodologies demonstrating the positive effects of self-efficacy, research has emerged to challenge this. Although, overall, Gist & Mitchell (1992) supported the positive perception of self-efficacy, they argued for greater clarity and further research around the sources: enactive mastery; i.e., what people have attained, vicarious experience, observation of others in their environment, verbal persuasion and emotional responses (Bandura, 1982). They constructed a model of combining the four sources and introduced three further factors that enabled people to estimate their performance, i.e., self-efficacy. These were task analysis skills, attributional analysis and assessment of personal and other constraints. They also suggested that judgements about self-efficacy become more routinised, automatic and accurate as experience with a task increases (Gist & Mitchell, 1992, p.191). However, they also acknowledged that accuracy in judgements of self-efficacy can be affected by relatively small changes, to that of the job or in team members. Furthermore, it can be vulnerable: it is not stable, as negative experiences or feedback within the four sources can undermine levels of self-efficacy. Vancouver et al. (2006) advised caution when employing interventions to improve people’s performance through developing self-efficacy. They argued that high self-efficacy can lead to over-confidence regarding one’s performance, leading to less time and effort being spent on the task than required. In addition, when within-person analyses were conducted, feelings of self-efficacy were found to be debilitating and negatively related to motivation. Bandura and Locke (2003) refuted such assertions, conducting nine meta analyses contradicting Vancouver et al.’s findings and challenged the latter’s statistical methodology. Schmidt & DeShon (2010) argued that both sets of researchers have suggested that ambiguity of the task, not knowing what is expected and not having feedback on performance will affect efficacy beliefs and, ultimately, performance. However, they concluded that ambiguity alone does not account for the negative self-efficacy effect, as many other influences are at work. They also suggested that the methodologies used when assessing levels of self-efficacy produce misleading results, as people may not engage in the task set in the same way as they do in real-life tasks.

Self-efficacy is a cognitive process; therefore, inevitably it overlaps with other cognitive processes such as self-regulation and metacognition. Some of the components of self-
efficacy are also part of metacognition and self-regulation constructs. For example, task analysis, self-monitoring, goal-setting, strategy use and outcome expectations (Bandura 1993). Zimmerman (2000) reported that self-efficacy and goal-setting enhanced prediction of academic grades and was also related to better monitoring of working time, better problem-solving skills and finally motivated students to utilise learning strategies. However, despite the overlap and the similar mechanisms, they can be seen as different constructs, certainly in emphasis: metacognition is the conscious control and understanding of one’s own cognitive processing; self-regulation is the regulatory control of behaviour, including metacognitive skills, motivation and goal-setting; self-efficacy is one’s self belief in one’s ability to achieve a goal. Arguably, the first two could be included in the sources of self-efficacy, but further research would have to be conducted to substantiate that claim.

This short review of the issues surrounding self-efficacy, its determinants and impact, demonstrates that it should be a measure of workplace success. It is separate from job satisfaction, as it is based in different sources; but it is related to it because people who believe that they can do their job well are likely to happier in their role, and they may strive for promotion (although some feel that their job performance is good, but they derive little satisfaction from it). Low self-efficacy has a negative effect on performance, which can be debilitating. Self-efficacy is task-specific, and this is, arguably, particularly salient for dyslexic people, who may achieve different levels of efficacy in different aspects of their job. Self-efficacy is inherent in planning, goal-setting and metacognition, as all relate to individuals’ decisions to engage and persist and are, therefore, associated with successful outcomes (Kanfer & Ackerman, 2005; Pintrich et al., 1994).

2.10.3 Goal-setting and planning

Goal-setting is an area of research interest associated with career success (Locke and Latham, 2002). As outlined above, it is related to self-efficacy, which influences the level of difficulty of the goal set; the commitment to that goal, the importance of that goal; and the response to failure of achieving the goal. People who maintain their self-efficacy under pressure will raise their performance (Locke & Latham, 1990). Following failure in achieving a goal, self-efficacy levels can change, depending on the types of causal attribution made (Bandura, 1986). Locke and Latham (2002) are the main architects of goal-setting theory, which states that “there is a linear relationship between a specific high goal and task
performance” (p.706). Goal-setting also influences achievement “in that it serves as a standard for evaluating one’s own performance” (2007, p.291). In addition, Locke and Latham (2006) developed a framework, the high-performance cycle, that provides an explanation for the relationship between motivation and successful performance in the workplace: “feelings of success in the workplace occur to the extent that people see that they are able to grow and meet job challenges by pursuing and attaining goals that are important and meaningful” (Locke et al., 2006, p.265). Goal intention is therefore related to higher performance. Goal intention can be defined as setting goals that are feasible and desirable. Goal-setting can affect performance in four ways: it provides a focus of attention, both cognitively and behaviourally; it energises individuals to achieve; it encourages persistence when an end is in sight, working more quickly when time-bound; and finally, action or response changes according to previously-acquired knowledge. Generally, people draw on experience to meet a goal, but if it is new, then planning facilitates attainment and, finally, if the goal is complex or too hard, it is better to lower the goal or expectations, as anxiety resulting from straining to succeed can lead to ineffective use of strategies (see Locke & Latham, 2002, for review).

Planning is inherent in goal-setting, while people can set goals, it is goal implementation, the planning of steps to achieve that goal, that predicts successful outcomes. While there is much research on goal-setting, there is little on goal implementation. Aarts et al. (1999) argued that planning is the volitional act that enables goal achievement. In a study of planning in everyday life, they hypothesised that planning recalls the salient situational features associated with the goal that prompts action towards goal completion. For example, seeing a manager walking by prompts a response to call someone before giving feedback to that manager. Aarts et al. (1999) also hypothesised that planning would increase the rate of the intended action (Locke & Latham, 2002). Likewise, consistent with goal-setting theory, planning increases the chance of goal completion, as it draws upon relevant previous knowledge. The findings of this study confirmed that the goals (a lexical retrieval task) were achieved more quickly if there was a plan. Furthermore, implementation actions were more effective because of the situational cues (Gollwitzer & Schaal,1998). Papes et al. (2009) and Gollwitzer and Oettingen (2011) argued that planning is a form of mental priming, which facilitates goal achievement, enabling people to respond more rapidly and effectively when there is a high cognitive load.
In summary, goal-setting and planning are linked to improved performance in many areas of every-day living, academic success and career prospects.

The interdependence of subjective and objective criteria

In a meta-analysis examining predictors of objective and subjective career success, Ng et al. (2005) hypothesised that the two would be positively correlated but empirically distinct. They argued that objective success should lead to greater job satisfaction but suggested there are other reasons that people stay in their job without high job satisfaction, e.g., accumulated benefits and pensions, for example. Their hypothesis was correct as their findings showed that objective and subjective career success variables were moderately correlated, but conceptually distinct (the shared variance ranged between 3% and 9%). However, the two sides of career success are interdependent as individuals continually reinterpret their work experiences, and people’s goals change over time, according to both subjective observations and the desire for financial success (Arthur et al., 2005).

Abele and Spurke (2009) explored how the two aspects interrelated over time using income and hierarchical position as measures of objective success, and job satisfaction as a measure of self-referent subjective success. Their findings showed financial status influenced job satisfaction less than anticipated, whereas job satisfaction influenced income and hierarchical position more than expected. They reasoned this could be due to subjective success, making a person feel more confident and enhance goal striving, which would lead to increased financial success.
Based on the information above a model of workplace success was derived for this Thesis which is displayed in Figure 2.4. The confirmation of this model was one of the research aims of Study 1. This model shows that, for the purposes of this research, workplace success would be measured in two ways: objective/societal success measures, which included financial status, academic qualifications and promotion; and subjective/personal success measures of job satisfaction and self-efficacy. The measures of career goal and being on track to reach that goal span these two, as they are broadly quantifiable but based on self-report.

\[ \text{Figure 2.4. A model of workplace success.} \]

2.11 Career success and dyslexia

As mentioned previously, there is limited research into dyslexia in adulthood. Price and Patton (2002) commented that research across the lifespan may be “messy” (p.336) because of the difficulty of ensuring that the participants are dyslexic in the sense that they are formally diagnosed and are from similar work environments. Therefore, much research has been conducted in academic settings (Bergey et al., 2017), where it has been easier to recruit participants with a diagnosis of dyslexia. Much of the research focused on exploring the reasons for failure and the subsequent impact of being dyslexic (De Beer et al., 2104). However, some researchers have focused on successful dyslexic people to determine what contributed to their achievement. Gerber, Ginsberg and Reiff (1992), Goldberg et al. (2003) and Madaus et al. (2008) defined success in terms of societal criteria such as educational, occupational and financial status. Gerber, Ginsberg and Reiff (1992) investigated successful dyslexic adults and found that the primary factor contributing to success was that of control, the extent to which they felt in charge of their lives and their work. There were two interrelated factors within this control construct. Firstly, internal decisions, which were conscious decisions about organising and controlling one’s life (i.e., becoming more metacognitive). The internal elements included: a desire to succeed, goal orientation and planning, and a process of re-framing. Secondly, external manifestations, which were being able to adapt to changing situations and move ahead (this is related to executive functioning); persistence; learned creativity (i.e., having a range of strategies to become more adept at
consistent with Gerber’s model of success, Raskind, Goldberg, Higgins and Herman (1999) reported the results from a longitudinal project. Using principal component analysis and stepwise multiple regression, they found six variables that predicted success which explained between 49% - 75% of the variance. IQ and/or academic achievement made a minor contribution (0% - 5%) only. The six best predictors of success were perseverance, self-awareness, proactivity, goal-setting (i.e., metacognition), emotional stability, and using social support systems. In a qualitative study using ethnographic interviews and participants from Raskind et al’s (1999) longitudinal project, Goldberg et al. (2003) also identified six similar predictors of success, including being persistent and flexible to pursue an alternative course of action; having concrete realistic and attainable goals with strategies to reach them, and the effective use of social support. In response to Raskind et al.’s (1999) recommendations for further research into success attributes, Madaus et al. (2002) explored the attributes that contributed to employment satisfaction among dyslexic postgraduates. They designed a job satisfaction scale and a self-efficacy scale with a good construct validity confirmed through factor analysis (Cronbach’s alpha = .95 for the self-efficacy scale; Cronbach’s alpha = .92 for the job satisfaction scale). Their findings supported their hypothesis of a predictive link between self-efficacy and job satisfaction. This suggests that the personal success criteria, job satisfaction and self-efficacy, which have previously been argued as related but separable, seem to be important for dyslexic adults. Madaus et al.’s (2002) investigation also demonstrated evidence that self-regulatory/metacognitive strategies were a predictor of job satisfaction. They concluded that interventions for dyslexic adults should include the development of personalised strategies that can transfer to multiple settings and that this may enhance an individual’s self-efficacy, therefore improving performance in the workplace.

The success model developed by Gerber and his colleagues (1992) has recently been updated (Schnieders et al., 2016). It has the same elements, but identifies planning as an internal factor, and learned creativities (i.e., strategy development) as an external factor. Being proactive and feeling in control is now a linking factor between an individual and his/her environment. Implicit in this is executive skill and metacognitive processing. Much
of the research outlined in this section has informed interventions and good practice. It has also provided a framework and encouragement for dyslexic adults to “adapt to life events through self-awareness .......... to be goal directed, and to establish and use effective support systems” (Gregg, 2013, p.87). However, many of their conclusions would be true of the non-dyslexic population. Furthermore, it does not provide evidence of specific deficits or an explanation for the difficulties experienced by dyslexic adults.

This section has highlighted the paucity of research into dyslexia in the workplace. Research to date has either focused on the negative aspects of dyslexia with a view to ensuring adjustments to the workplace or outlined certain attributes that may contribute to success. While both strands of research have informed interventions, there is little research providing evidence to support reported difficulties (over-and-above literacy), an explanation for these difficulties, nor an examination of the role of metacognitive skill in workplace success.

2.12 Summary

The main issues arising from this overview of the literature can be summarised as: firstly, there is little research into the impact of dyslexia on workplace success. There is evidence to show that that dyslexia persists into adulthood, but the challenges dyslexic adults face extend beyond literacy difficulties, particularly now that many of the latter can be resolved using assistive technology. There is only a little substantive evidence of these challenges, which include problems with planning, multi-tasking and aspects of memory, and are behaviours associated with executive functions and working memory. These would potentially affect performance at work. Secondly, metacognitive skills are said to contribute to good educational and occupational outcomes, but some research suggests that metacognitive skills do not develop in, or are not utilised effectively by, dyslexic people. However, there are also indications that the use of metacognitive skills can compensate for deficits and do contribute to successful outcomes.

The research questions formulated for this Thesis were therefore:

1. Is there evidence that dyslexic people differ from non-dyslexic people in metacognitive skill and executive functioning?
2. Is metacognitive processing (greater self-understanding and increased use of planning skills) related to workplace success? Is there any evidence for any relationships to vary across dyslexic and non-dyslexic people?

3. Do executive function processes influence workplace success? Is there evidence for any such influences to vary across dyslexic and non-dyslexic people?

To answer these questions, the areas investigated are outlined in Figure 2.5.

Legend: 1= Planning  2 = Cognitive control

Figure 2.5. The Areas and Relationships of Research Focus.

Study 1 established the success criteria and explored cognitive processes such as planning and executive attention, performance on the Cognitive Failures Questionnaire (Broadbent et al., 1982), in relation to the workplace success criteria.

Study 2 investigated metacognitive processing, confidence and task performance in relation to workplace success.

Study 3 explored executive functioning processes such as shifting, up-dating and inhibition, and levels of literacy to determine any influences on workplace success.
The purpose of this research was to provide more evidence of the impact of dyslexia in adulthood and to increase the understanding of the factors that may contribute to success.
Chapter 3

3. Study 1: An initial exploration of potential relationships between cognitive measures and workplace success.

3.1 Introduction

The purpose of the first part of this study was to establish measures of workplace success and to investigate aspects of executive functions, specifically around planning skill (a component of metacognitive skill) and cognitive failure (a measure of the efficiency of executive systems, which might impact on workplace success for dyslexic adults).

The second part of this study aimed to compare the dyslexic participants with those of a control group matched for age and occupation. This was to determine if evidence could be found for differences between the groups in planning skill and cognitive failure, and if these skills influence workplace success.

3.1.1 Workplace success

As discussed in Chapter 2, success is a multifaceted construct that can be thought of as embracing personal, cultural, social, academic, career and occupational domains. Generally, society regards academic qualifications, financial status and a good job, either of professional status or stability, as a measure of career success (Greenhaus, Collins & Shaw, 2003; Heslin 2005). It is believed that gaining good academic qualifications leads to good jobs and successful careers (Judge, Cable, Boudreau & Bretz, 1995). Chapter 2 introduces the literature on career success (see also Abele & Spurk, 2009), and the on-going debate regarding the conceptualisation, and the most reliable measures, of success in the workplace; which is not helped by variations in the terminology used: career success, work success, occupational success, career satisfaction and job satisfaction are sometimes used interchangeably (Heslin, 2003).

Much of the research (see chapter 2) has focused around verifiable criteria, such as financial reward, promotion and achieving a career goal; however, increasingly, researchers have
advocated for more subjective measures, such as job satisfaction, to be included as an indicator of success. Job satisfaction can be defined as an individual’s understanding and responses to their career experience and the individual gaining what (s)he wants and values from the job (Bowling & Hammond, 2008). It is widely recognised as a measure of success in its own right. Heslin (2003) and Abele & Wiese (2008) have argued that research focusing on the more external, societal aspects of work or career success provides only a partial picture because personal perception is important; people can value self-satisfaction more highly than material reward (Bandura, 1997). Hall and Chandler (2007) also maintain that individuals construe success in subjective ways that outweigh the more verifiable rewards of career success such as a good salary and promotion.

3.1.1.1 Subjective and objective workplace success measures

Heslin (2005) aimed to bring clarity into this area of research in his model of career success; that of objective (measurable by others) and subjective (personal perspectives) career success. Others concur with this dichotomy and agree that both aspects need to be measured when conducting research into work success (Abele & Spurk, 2009). Heslin’s objective verifiable success criteria include extrinsic factors, such as career status (both in terms of being in a professional career or eminent in their organisation), and salary and promotion (i.e. the higher the salary or the more frequently promoted equating to greater success). These broadly relate to the societal recognition of success and are easily accessible indicators of work success (Hall & Chandler, 2005). Other researchers include having a career goal and being on track as measures of societal success (see discussions in Bowling & Hammond, 2008).

Another measure of success is that of academic qualifications; they are societal goals that society, parents and children aspire to, they evidence a level of education and are recognised as a means of obtaining a good job (Brennan & Shah, 2003). Furthermore, in the dyslexia literature, lack of qualifications has been considered a barrier to successful employment; it is, therefore, relevant for this study. Societal views on work success, as well as the dyslexic’s own view of their ability to succeed, may be determined to some extent by their academic qualifications. Therefore, from now on in the research conducted as part of this Thesis, objective measures of financial status, promotion, academic qualifications, career goals and
being on track will be referred to as societal success measures. These five measures of societal success are based on participant self-report.

Heslin’s (2005) subjective career success criteria include job satisfaction and self-referent factors. The self-referent factors include a sense of purpose and personal aspirations, earning sufficient money to support personal goals and feelings of doing a good job; though referent factors can also include comparisons with peers and work-life balance (Heslin, 2003; Lock & Latham, 2006). Implicit in the self-referent success criteria of doing a good job is self-efficacy, defined as a belief in one’s ability to complete successfully a certain course of behaviour in a situation (Bandura, 1997). Self-efficacy is considered a predictor of job satisfaction (Abele & Spurk, 2009; Madaus, Zhao & Ruban, 2008), with individuals who feel competent in their job (high self-efficacy) typically being more satisfied with that job. However, self-efficacy also has an independent role in terms of its relationship with performance at work (Lunenburg, 2011). The greater an individual’s self-efficacy, the higher the goals people will set themselves and the harder they will strive to achieve them (Bandura, 1986). The achievement of these higher goals leads to personal satisfaction and feelings of success; a self-referent success criterion (Grant & Dweck, 2003; Heslin, 2003; Locke & Latham, 2002). High levels of self-efficacy do not necessarily ensure higher levels of job satisfaction. For example, an experienced nurse who knows she is good at her job may be dissatisfied with her working hours, lack of autonomy and pay structure, but would still consider herself successful in her job. Self-efficacy is, therefore, an important element of success, but distinct from job satisfaction. Moreover, low levels of self-efficacy have been identified as a potential barrier to job satisfaction and career prospects (Bandura, 1997;). Nevertheless, low self-efficacy can be offset by other sources of job satisfaction and financial incentives (see Judge & Bono, 2001; Pinquart, Juang & Sibereisen 2003). Therefore, evidence suggests that self-efficacy is a valid measure of success. For the purposes of this research, job satisfaction and self-efficacy will be referred to as personal success measures.

There is inevitably some overlap between personal and societal success. Firstly, while the success criteria of “having a career goal” and being “on track” are regarded as objective, societal goals, they are not verifiable as such, being based on an individual’s perception. Secondly, if a person experiences high levels of job satisfaction then they are likely to aim for promotion, thereby increasing their financial status and career advancement (Judge & Hurst, 2007), and more frequent promotion together with increased financial reward is likely to
increase job satisfaction (Ng, Eby, Sorensen & Feldman, 2005). Despite this, the correlation between societal and personal career success is only moderate ($r = 0.3$, according to Judge & Hurst, 2007). In addition, the predictors of societal success differ from those of personal success: social demographics, education and gender are predictive of the former, (but see Hogan, 2013) but these are not evident in personal success (Dette et al., 2004; Ng et al., 2005). It has been argued that although individual differences, such as cognitive ability and locus of control, were related to societal success, they were more predictive of personal success because they were “more proximal determinants of one’s sense of psychological well-being” (Ng et al. 2005, p 394). This is an important consideration, given the dyslexic participants in this research potentially have lower levels of academic qualification or less confidence in their abilities (McLoughlin, 2012). Furthermore, the workplace can be a challenging environment, with the demands it makes upon literacy and memory skills. The affective characteristics of dyslexia, including possible lower levels of confidence and self-esteem may affect performance (Carroll & Iles, 2006; Hales, 2004; Kirby, in press; Riddick, 1997). In longitudinal studies of dyslexic graduates, levels of self-efficacy were found to be an important factor in work success (Goldberg et al., 2003; Madaus, 2002, 2003). Therefore, in this population, levels of job satisfaction and self-efficacy provide valid measures of personal career success. Measures of other-referent subjective success, such as comparisons of perceived success with that of others, were not included in this research because dyslexic adults tend to view their performance negatively when compared with others (Carroll & Iles, 2006; Hales, 2004), which might, therefore, bias their assessment of their career success.

In sum, workplace success will be measured from two perspectives: the personal perspective, described in terms of job satisfaction and self-efficacy, and the societal construct, those of financial status, academic qualifications and promotion. Career goal and being on track were also included as measures as they are indicative of long-term planning.

3.1.1 2 Dyslexia and workplace success

There is limited research into dyslexia and workplace success, with much of it focused on the negative aspects of dyslexia (Beetham & Okhai, 2017; De Beer et al., 2014); although there has been research on the attributes of successful dyslexic people (Gerber et al., 1992; Logan, 2009; Taymans et al., 2009). Madaus and his colleagues (2002, 2003, 2008) looked at success and employment satisfaction of university graduates. They identified job satisfaction, self-
efficacy, and self-regulatory strategies (including self-knowledge of strengths and weaknesses, planning and evaluating performance) as leading to positive employment outcomes. Gerber, Ginsberg and Reiff (1992) investigated potential success factors by interviewing 79 successful dyslexic adults. Their measures of success included financial income, job satisfaction and employment level. They determined a key factor related to success was that of “control” (Gerber et al., 1992, 2002, 2012). The components of internal cognitive control were self-understanding (understanding the nature of one’s skills and abilities) and goal orientation (the process of setting goals and planning a course of action to achieve them). The purpose of this present research is to build on Gerber et al.’s (1992) model by providing some quantitative data about the relationship between dyslexia and workplace success. The success measures will be based on Heslin’s (2005) personal (job satisfaction and self-efficacy) versus societal (academic qualifications and financial status) distinction (see above). In addition, the relationship between aspects of cognitive functioning and workplace success will be explored. The investigated cognitive functions will be described in more detail in the next section.

3.1.1 3 Cognitive functioning and its relation to workplace success

Metacognitive skill, defined as the conscious control over one’s own cognition, thinking and learning processes (Fernandez-Duque et al., 2000; Flavell, 1979) and executive functioning, defined as the organisation, integration and maintaining of attention and cognitive processes (Crawford, 1998; Denckla, 1996; Eslinger, 1996) have long been associated with improved performance. The attribute of internal control, planning and goal-setting, which was a focus of Gerber et al.’s (1992) study into the success of dyslexic adults, is a higher-order cognitive skill associated with metacognition. Planning has been considered an inherent part of both metacognition and executive functioning (Borkowski & Burke, 1996; Garner, 2009). Planning and goal-setting are also widely associated with improved performance in academic settings (Dweck, 2005; Gollwitzer & Oettinger, 2011; Zimmerman, 2002) and in employment (Locke & Latham, 2006). The relationships between planning and personal success, particularly self-efficacy, have been evidenced in the literature (Bandura, 1993, 1997): greater self-efficacy leads to higher goals being set and an increase in motivation to succeed, which in turn leads to more efficacious feelings once goals are achieved (Elliot & Dweck, 2005; Locke & Latham, 2002; Lunenburg, 2011). Additionally, aspects of better planning are likely to be related to increased job satisfaction. Madaus et.al. (2003; 2008)
found the use of self-regulatory strategies, including goal-setting and time management, had a small but significant effect ($\beta= .19$) on participants’ job satisfaction levels. Therefore, a measure of planning was included in this research to establish if it showed relationships with the success criteria in a cohort of dyslexics.

Similarly, there are many views about executive functions. It is generally agreed it is a multifaceted construct involving the orchestration of cognitive processing, goal-directed behaviour, planning and problem-solving (Banich, 2009; Diamond, 2013; Miyake, Emerson, Friedman & Howarter, 2000; Reid Lyon & Krasnegor, 1996). Good executive functioning skills have also been regarded as underpinning improved performance in academic settings and for long-term success (Diamond 2014; Reid Lyon & Krasnegor, 1996). As stated previously in this Thesis, research indicates that individuals with dyslexia perform, on average, less well than matched non-dyslexics on measures of working memory and executive functioning (Berninger et al 2009; Brosnan et al, 2002; Jeffries & Everatt, 2004; Smith-Spark et al., 2004, 2016). Behaviours such as memory lapses, forgetfulness and word-finding difficulties are also often associated with dyslexia (Bartlett & Moody, 2010; Smith-Spark et al., 2004; Wong & McNamara, 2003). Smith-Spark et al. (2004) explored the broader difficulties experienced by dyslexic adults by asking their student participants to complete a Cognitive Failure Questionnaire devised by Broadbent et al. (1982). The results demonstrated that, overall, dyslexic students experienced significantly more memory lapses than the control group. Smith-Spark et al. (2016), comparing a group of dyslexic students with a matched control group, explored three key components of executive functioning: inhibition, up-dating and shifting. Significant deficits in all three components in the dyslexic group were noted. They concluded that for dyslexic people, poor literacy is not the only challenge facing dyslexic people in the workplace. Their results provided further evidence to support the findings of their 2004 study (Smith-Spark et al., 2004): dyslexic adults, when compared with controls, experienced increased cognitive failure in terms of greater inattention and distractibility, which they interpreted as aspects of executive functioning. Furthermore, they argued that cognitive failure and executive functioning deficits will impact negatively on the daily life and job performance of dyslexic adults.

In study 1 of this Thesis, planning and cognitive failures (both of which have been considered related to aspects of metacognitive and executive functioning) were measured, and relationships with two aspects of workplace success were assessed. The planning scale used
was specifically devised for the purposes of this study as an internet search had not revealed one of sufficient workplace focus or brevity. The scale was developed through an internet search selecting statements widely associated with goal-setting (Locke & Latham, 2002) and by selecting several statements from the regulation of cognition and planning component of the Metacognitive Awareness Inventory (Schraw & Denison 1994); see Chapter 2. The new planning scale was validated through factor analysis procedures to ensure that it could be used as an independent measure. A measure of executive functioning efficiency in relation to attention and memory was also included. Broadbent’s Cognitive Failures Questionnaire (CFQ, 1982) was selected as it is widely used to explore everyday lapses in cognition for adults who work in a variety of occupations, as with the present sample. Also, performance on the CFQ has been shown not to be related to age and intellectual ability (Rast et al., 2009), an important consideration given the age range of the participants in this study.

Figure 3.1 illustrates the components of cognitive functioning and the success criteria used in this research. This figure outlines the three aspects of workplace success utilised as measures in the study. As can be seen, it is anticipated that both elements of cognitive ability will be linked to all three areas of workplace success.

Figure 3.1 Research model of success criteria
Summary
In summary, this preliminary study aimed to explore the possible cognitive mechanisms of dyslexic participants that might contribute to their success. It was in two parts and had three purposes. Firstly, to establish some clearly-defined workplace success measures, six measures of career success, which broadly fall into the two categories discussed earlier, were selected. Personal success was measured with a job satisfaction questionnaire and a work-focused self-efficacy scale (Madaus et al., 2003); the validity of these scales was established through factor analysis. Societal success was determined by participant self-report on current financial status, gaining promotion, level of academic qualifications, having a career goal, and being on track in terms of career.

The second aim was to explore the impact of aspects of cognitive functioning on workplace success in a group of dyslexic participants. Therefore, this study included the Cognitive Failures Questionnaire (Broadbent et al., 1982) to determine if dyslexics with better scores on this scale (i.e., fewer failures) show evidence of more success. It also included a short planning scale, specifically designed for this study, to assess whether those who showed more evidence of planning also showed evidence of greater workplace success.

The third aim, which is reported in part two of this Chapter, was to compare the data of the participants in the first part with those of a control group (matched for age and occupation) to provide some insight into the research questions from Chapter 1, restated below.

1. Is there evidence that dyslexic people differ from non-dyslexic people in metacognitive skill and executive functioning?
2. Is metacognitive processing (greater self-understanding and increased use of planning and task analysis skills) related to workplace success? Also, is there any evidence for any such relationships to vary across dyslexic and non-dyslexic people?
3. Do executive function processes influence workplace success? Is there evidence for any such influences to vary across dyslexic and non-dyslexic people?
3.1.2 Part 1: Method

3.1.2.1 Participants

A total of 183 dyslexic adults took part in this study. An invitation to participate and a questionnaire were sent out electronically to people who were identified as dyslexic via human resource departments (e.g., in law firms, the emergency services, etc) and via dyslexia network groups. Additionally, people who visited a dyslexia centre for an assessment or training were invited to participate. Initially 175 people completed the questionnaire in 2011. A further eight people were recruited at a later stage in 2013 for completion of a follow-up study and their responses on the questionnaire were included in the present analysis.

Of the 183 respondents, 113 were male and 70 were female. Their ages ranged from 18 to 65 years with 90% falling within the range of 25 to 54 years. The participants were asked if they had been formally assessed for dyslexia. All indicated that they had been diagnosed as dyslexic by a registered educational or occupational psychologist and many provided their reports for inspection. (See Table 3.1 for demographic details.) 37% of the participants had been diagnosed in adulthood, and 22% were assessed while undertaking higher education. All the participants stated that English was their first language.

In terms of specialist intervention, 33% had received none, only 12% had been supported at school, 18% received help when at college or university, and 22% had some support at work. The last figure is higher than might be expected as disclosure rates are generally low (Martin & McLoughlin, 2012) and contrast with the figures quoted by the National Center of Learning Disabilities (NCLD, 2017). The remaining 15% either did not answer this question or received support outside of work or education (see Table 3.1).

Participants’ occupations were classified into 5 categories: see Table 3.1. The emergency service category included those whose job involved operational service: firefighters and police officers. The administrative roles included those in the civil service and management-based roles. Social and training occupations included teachers, trainers, nurses and social workers. Sciences, arts and design occupations included graphic designers, engineers and antique restoration. The professional category included lawyers and accountants. Of the
remaining 5% of the dyslexic group, 1% were unemployed and 4% said they were employed but did not give a job title. Both groups were included in the analysis.

Table 3.1

Descriptive Statistics of the Demographic Composition of Sample

<table>
<thead>
<tr>
<th>Age in years</th>
<th>18-24</th>
<th>25-34</th>
<th>35-44</th>
<th>45-54</th>
<th>55-65</th>
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<tr>
<td>5%</td>
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<td>24%</td>
<td>6%</td>
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</table>

<table>
<thead>
<tr>
<th>First assessed</th>
<th>Primary</th>
<th>Secondary</th>
<th>College</th>
<th>University</th>
<th>At work</th>
<th>Other times</th>
<th>No reply</th>
</tr>
</thead>
<tbody>
<tr>
<td>14%</td>
<td>7%</td>
<td>6%</td>
<td>23%</td>
<td>37%</td>
<td>11%</td>
<td>2%</td>
<td></td>
</tr>
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</table>

<table>
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<tr>
<th>Specialist support</th>
<th>None</th>
<th>School</th>
<th>College</th>
<th>University</th>
<th>At work</th>
<th>Other</th>
<th>No reply</th>
</tr>
</thead>
<tbody>
<tr>
<td>33%</td>
<td>12%</td>
<td>2%</td>
<td>16%</td>
<td>22%</td>
<td>8%</td>
<td>7%</td>
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</table>

<table>
<thead>
<tr>
<th>Employment status</th>
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<th>Unemployed</th>
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<tr>
<td></td>
<td>88%</td>
<td>6%</td>
<td>6%</td>
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</table>

<table>
<thead>
<tr>
<th>Job classification</th>
<th>Emergency services</th>
<th>Administrative roles</th>
<th>Health / Education</th>
<th>Sciences / Arts</th>
<th>Professional</th>
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<tr>
<td></td>
<td>31%</td>
<td>32%</td>
<td>14%</td>
<td>5%</td>
<td>13%</td>
</tr>
</tbody>
</table>

(Note 5% of dyslexics did not indicate a specific job.)

3.1.2.2 Design and materials

This research design was questionnaire-based. This method was chosen to access as big a sample as possible across the age and occupation span. Moreover, as most participants were in employment, data collection had to be time-efficient so as not to encroach on their working day.

The questionnaire was split into four sections designed to provide information on: i) descriptive information (such as age, gender), dyslexia-specific questions (such as assessment date and support), and employment history; ii) measures of success; iii) the Cognitive Failures Questionnaire; iv) the planning scale. The questionnaire included tick box responses and Likert scales. The questionnaire was kept as short as possible and avoided complex
jargon in consideration of any potential reading difficulties. For a complete copy of the questionnaire see Appendix 3.1.

3.1.2.3 Measures of success

Personal success was assessed with job satisfaction and self-efficacy scales (Madaus, 2003). The job satisfaction scale comprised 10 questions, such as “My job gives me a feeling of accomplishment”, “My job allows me to learn new skills”, “There is a match between my skills and abilities and my job”. Responses were rated on a five-point Likert scale; from 1= strongly disagree to 5= strongly agree. Scores for each item were totalled so that a low score (minimum 10) on the scale indicated low job satisfaction; likewise, high scores (50) indicated high job satisfaction. The self-efficacy (SE) scale comprised 16 questions, including “I use creative ways to perform my job”, “I plan how to meet the demands of my job” and “I make good use of my strengths and abilities”. Again, the five-point Likert scale was used for responses and totalled based on guidelines for the scale. The lowest total score of 16 indicated low self-efficacy, a highest total score of 80 indicated high self-efficacy.

Societal success was measured via questions about academic qualifications, financial status and promotion, having a career goal and if the subjects considered themselves “on track” to achieve this goal.

3.1.2.4 Metacognitive and executive skills

*The planning scale*

The participants were also asked to complete a 10-item scale (PL) that focused on questions related to planning and metacognitive awareness. It incorporated four goal-orientated questions and six that were related to metacognitive planning processes. The four items that specifically covered goal-setting included “I organise my time”, “I set myself specific goals” and “I estimate how long it will take”. The remaining six items covered planning and monitoring and reflection activities, for example; “I think of several ways to do something before I start”, “I change my plan if it is not going well” and “I reflect on how well the task has gone”. A five-point rating scale was used for responses: 1= never to 5= very often.
Responses to the 10 items were added to produce a total sum score for the scale. A total score of 50 indicated high levels of planning skill.

*The Cognitive Failures Questionnaire*

The Cognitive Failures Questionnaire (CFQ; Broadbent et al., 1982) was the last scale in the questionnaire booklet. The name of this scale was changed in the questionnaire booklet to ‘Memory Skills’ to avoid causing concern to the potentially self-aware participants and so affecting their responses. This questionnaire is a measure of self-reported failures in perception, memory and motor function. It comprises 25 questions, including “Do you read something and find you have not been thinking about it and must read it again?” and “Do you find yourself suddenly wondering whether you’ve used a word correctly?” The Likert scale this time was 1 = very often to 5 = rarely. Again, item scores were added to produce one total sum score, the minimum score was 25, the maximum score was 125. Low scores on this scale indicated poorer executive functioning as they indicated more cognitive failures, whereas high scores suggested fewer failures and, therefore, better executive control.

*Procedure*

Participants were asked to complete the questionnaire electronically and return it via e-mail or to complete a downloaded or posted copy, which they returned in person or by post. They were also advised that they could complete the questionnaire with support over the telephone. However, nobody asked for this support.

*3.1.3 Results*

The analyses of the data had three purposes: to confirm the validity of the success criteria scales; to explore the relationships between the success and cognitive and metacognitive functioning variables, and to establish if these cognitive variables could predict success.
Table 3.2

Descriptive Statistics of the societal success criteria

<table>
<thead>
<tr>
<th>Academic qualification</th>
<th>GCSE’</th>
<th>A-level</th>
<th>University</th>
<th>Post-graduate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>95%</td>
<td>77%</td>
<td>54%</td>
<td>25%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Promotion</th>
<th>Yes</th>
<th>No</th>
<th>No response</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>57%</td>
<td>34%</td>
<td>9%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Financial status</th>
<th>Under £10k</th>
<th>£10-20k</th>
<th>£20-30k</th>
<th>£30-50k</th>
<th>£50-75k</th>
<th>£75-100k</th>
<th>£100-150k</th>
<th>£150+k</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>9%</td>
<td>8%</td>
<td>29%</td>
<td>41%</td>
<td>7%</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Career goal</th>
<th>None at all</th>
<th>A few ideas</th>
<th>Yes - in broad terms</th>
<th>Yes, a specific goal</th>
<th>Missing data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12%</td>
<td>17%</td>
<td>36%</td>
<td>32%</td>
<td>3%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>On track</th>
<th>Not at all really</th>
<th>In some ways</th>
<th>Mostly</th>
<th>Yes, I am</th>
<th>Missing data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2%</td>
<td>10%</td>
<td>24%</td>
<td>24%</td>
<td>36%</td>
</tr>
</tbody>
</table>

The success criteria

The self-reported responses from the societal success criteria such as Financial status, Promotion and Academic qualifications are shown in Table 3.2. The four items GCSE, A levels, University degree, postgraduate degree were combined as the basis for the measure of academic qualifications. The participants were asked about gaining professional qualifications or training on the questionnaire, 67% said they had such qualifications but there was no way of standardising this measure, so it was not included in the analysis.

Prior to further analysis, the data were checked for missing values, and normality on all the items was explored. The data set included responses from three individuals who were identified as outliers, either on individual scores or based on Mahalanobis distance calculations. The data from these three individuals were excluded from the statistical analyses to avoid potential bias of the results. Therefore, the following analyses were based
on 180 participants. For ease of interpretation, all the scales were recoded, so that high scores meant better skills: on the Cognitive Failure Questionnaire, high scores indicated fewer cognitive failures, which were interpreted as better executive functioning skill.

A factor analysis was carried out on the 36 items from the scales in the questionnaire to assess the coherence of the three scales, job satisfaction (JS), self-efficacy (SE), and planning (PL) to be used as independent criteria (see Appendix 3.2) for these dyslexic adults. The sample size and number of variables were considered, while Tabachnick and Fidell (2007, p.613) recommend larger sizes, they also state factor analyses can be conducted on samples of less than 100. Two of the scales became Factor 1, Job satisfaction, and Factor 2, Self-efficacy. As these scales have been used in previous research (Madaus, 2003), this result was not surprising; though these results confirmed that the scales’ structures were reliable with this new sample. All the items on the planning scale loaded onto the third factor. The Kaiser-Meyer-Olkin value was .906 and Bartlett's Test of Sphericity was significant (p<.001) indicating distinct and reliable factors. The reliability of these scales was then confirmed by calculating Cronbach’s Alpha scores. These scores were as follows: Factor 1, Self-efficacy, \( \alpha = .93 \); Factor 2, Job satisfaction, \( \alpha = .91 \); Factor 3, Planning, \( \alpha = .87 \), thus confirming reliability.

In summary, the factor analysis extracted three factors, i.e. job satisfaction, self-efficacy and planning. These factors were closely related to the original scales on the questionnaire, suggesting internal consistency and validity of the scales. Total scores obtained from these three scales, therefore, were used in the subsequent analyses.
Table 3.3

Descriptive Statistics for the four scales used in the study

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>SD</th>
<th>LL</th>
<th>UL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-efficacy</td>
<td>62.7</td>
<td>10.3</td>
<td>60.6</td>
<td>64.0</td>
</tr>
<tr>
<td>Job satisfaction</td>
<td>37.7</td>
<td>7.9</td>
<td>36.4</td>
<td>38.7</td>
</tr>
<tr>
<td>Planning</td>
<td>37.6</td>
<td>6.7</td>
<td>36.5</td>
<td>38.6</td>
</tr>
<tr>
<td>Cognitive failures</td>
<td>67.0</td>
<td>16.9</td>
<td>63.9</td>
<td>69.6</td>
</tr>
<tr>
<td>questionnaire</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Correlations between questionnaire measures

To assess relationships between the measures in this study, Spearman correlation coefficients were calculated for all comparisons except for those involving promotion, where point biserial correlations were used due to the coded Yes/No answers. Spearman coefficients were used following observations of frequency distributions of the data (not reported here), which suggested some evidence of skew.

The results of these correlation calculations can be found in Table 3.4. Overall, the findings indicated relationships between the two measures of cognitive functioning (Cognitive failures and planning) and measures of personal success (job satisfaction and self-efficacy), but not between the cognitive functioning scores and societal success. The correlations between the planning and personal success criteria were both higher than those between cognitive failures and personal success. The two measures of job satisfaction and self-efficacy were strongly correlated.
Table 3.4

Correlation table of the personal and societal success criteria with the cognitive measures

<table>
<thead>
<tr>
<th></th>
<th>PL</th>
<th>CFQ</th>
<th>SE</th>
<th>JS</th>
<th>FS</th>
<th>AQ</th>
<th>Promotion</th>
<th>CG</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFQ</td>
<td></td>
<td>.258**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SE</td>
<td></td>
<td>.587**</td>
<td>.357**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JS</td>
<td></td>
<td>.437**</td>
<td>.177*</td>
<td>.582**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FS</td>
<td></td>
<td>.078</td>
<td>.110</td>
<td>.108</td>
<td>-.099</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AQ</td>
<td></td>
<td>-.016</td>
<td>.004</td>
<td>.071</td>
<td>.062</td>
<td>-.130</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Promotion</td>
<td>.001</td>
<td>.133</td>
<td>.016</td>
<td>.020</td>
<td>.344**</td>
<td>-.046</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CG</td>
<td></td>
<td>.191*</td>
<td>.156*</td>
<td>.347**</td>
<td>.346**</td>
<td>.020</td>
<td>.125</td>
<td>-.007</td>
</tr>
<tr>
<td>OT</td>
<td></td>
<td>.236*</td>
<td>.193*</td>
<td>.295**</td>
<td>.461**</td>
<td>.115</td>
<td>.111</td>
<td>.119</td>
</tr>
</tbody>
</table>

*p < .05; **p < .01
PL = Planning; CFQ = Cognitive Failures Questionnaire; SE = Self-efficacy; JS = Job satisfaction; FS = Financial status; AQ = Academic qualifications; CG = Career goal; OT = On track

Planning skill and the cognitive failures were also significantly correlated. Career goal and on track were moderately correlated and both were associated with CFQ; career goal and being on track also correlated with the measures of self-efficacy and job satisfaction. Of the societal success criteria, financial status and promotion only correlated (moderately) with each other. Furthermore, academic qualifications did not correlate with any of the other measures in the study.

In summary, the aim of this first part of this study, having established the workplace success criteria of job satisfaction, self-efficacy, academic qualifications and financial status, promotion, having a career goal and being on track to achieve it, was to investigate any relationships between executive functioning processes of planning/metacognition and cognitive failure, and the measures of workplace success within a cohort of dyslexic adults. As anticipated, the findings indicated strong relationships between the cognitive measures and personal success job satisfaction and self-efficacy. However, there were not the expected relationships with the societal measures: neither the cognitive failures measure nor the
planning measure was related to academic qualifications or financial status, or promotion. Likewise, career goal and being on track were also related to the personal success criteria but not the societal measures. The only correlation between the different aspects of societal success was between financial status and promotion, consistent with reports in the literature (Ng et al., 2005).

A relationship was observed between planning and cognitive failures: those dyslexic participants with better planning skills also reported fewer cognitive failures, as well as better job satisfaction and higher work-based self-efficacy. Therefore, developing appropriate planning skills may lead to fewer failures thereby increasing self-efficacy and job satisfaction, but further investigation is required to substantiate this.

3.1.4 Conclusion

In conclusion, the findings suggest that dyslexics’ self-reported planning is linked to personal workplace success measures of job satisfaction and self-efficacy. Furthermore, dyslexic participants’ self-reported cognitive failures were also related to job satisfaction and self-efficacy. These findings provided some evidence for the second and third research questions: aspects of workplace success are influenced by metacognitive and executive functioning processes. The first research question, regarding the possible differences in executive functions and metacognitive skill between dyslexic and non-dyslexic people were explored in the second part of this study, along with potential differences in the relationships between workplace success and executive functions and/or metacognitive skill.
3.2 Part 2

3.2.1 Introduction

It is the overall premise of this research that planning/metacognitive skills underpin success for dyslexic people: in the first part of this study there was some evidence to support this. Therefore, this second part of study 1 investigated whether the findings were specific to the dyslexic participants or if they were also present in a group of matched control adults. It was also to establish if the dyslexic participants differed from non-dyslexic people in metacognitive and executive function skills. With these aims in mind, a control group (n=30), matched for age and occupation with the dyslexics in Part 1, were assessed on the same measures as those used in Part 1. The data of the dyslexic participants and these controls were then compared.

3.2.1.1 The control group

The control group was matched for age and occupation, so it was possible that the two groups would have similar levels of financial status; which would be consistent with the follow-up studies of dyslexic and non- dyslexic graduates by Madaus, Foley, Maguire & Ruban (2002) and Goldberg et al. (2003). However, De Beer et al. (2014) found a pay gap between dyslexics and non-dyslexic people, with the dyslexic adults being less well paid. Additionally, the challenges facing dyslexic adults in the workplace (see Gerber, 2012, for reviews) and poor career planning of people with dyslexia (Stipanovic 2015-16) could impede career progression and, therefore, different levels of financial status could also be anticipated. As the literacy difficulties experienced by dyslexic people might have affected their academic performance, it was anticipated that the level of academic qualifications of the dyslexic group would be lower. However, given that occupational status is often dependent on a level of academic qualification, and the two groups were matched on occupational status, this difference may not be apparent in this study. Finally, it was also hypothesised that there may have been differences between the groups in relation to the personal success criteria. For example, the dyslexic group may have felt lower self-efficacy and job satisfaction because of working memory difficulties, lapses of attention and their possible impact on performance at work (De Beer et al., 2014; Smith-Spark et al., 2004, 2016).
However, it should be noted that Gerber (2012) reported high levels of self-efficacy and job satisfaction for some dyslexic people; specifically, those who had found employment where there was a “goodness of fit” between their skills and work requirements.

3.2.1.2 Hypotheses

As discussed previously, many dyslexic adults reported difficulties with planning and organisation and there is some evidence to indicate that dyslexic people’s metacognitive skills are less effective than the general population (Butler & Schnellert 2015; Bergey et al., 2015; Chevalier et al., 2017). It was, therefore, anticipated that dyslexics would exhibit poorer planning skills than their non-dyslexic peers. Also, this might have led to differences in the relationships between the planning scale and job satisfaction and/or self-efficacy. It was anticipated that differences would exist between the two groups in their scores on the planning scale and in the relationships between this scale and the success criteria, and that personal and societal success may be differently related to planning in the controls compared to the dyslexics.

The Cognitive Failures Questionnaire was included in this research to investigate the suggestion that dyslexic people have deficits in executive functioning (see Chapter 2). Consequently, differences were expected between the two groups in terms of their cognitive functioning skills: specifically, that the controls would have reported fewer cognitive failures than the dyslexics. It was also anticipated that the relationships between the Cognitive Failures Questionnaire and the workplace success criteria would differ between the two groups as a greater degree of cognitive failure, distractibility and lapses in attention were likely to impact on performance at work (Smith-Spark et al., 2004).

In summary, our hypotheses are:

1. That differences would occur between both groups on metacognitive skill; the control group demonstrating superior planning/metacognitive skill than the dyslexic group.

2. That differences would occur on executive function skill; the control group experiencing fewer cognitive failures.
3 That a disparity would occur between both groups in their levels of financial success and academic qualifications.

4 That the two groups would differ in the relationship between the planning scale and Cognitive Failures Questionnaire and the assessments of workplace success.

3.2.2 Methods

A mixed sampling procedure was used to find a matched control group. Participants were recruited by asking the dyslexic participants if any peers, such as colleagues or friends, would be interested in taking part in this research. This was done to recruit controls of similar demographics as the dyslexic sample. Human Resource departments of organisations contacted at the beginning of the research were also contacted to recruit non-dyslexic people who might be willing to participate.

Participants

A total of 30 non-dyslexic controls completed the Study 1 questionnaire for this study. In this control group, there were 17 males and 13 female participants (Mean age = 34.9 years, SD = 10.2). Their data were compared to the data of the 180 dyslexic participants from Part 1 of this present study (109 males, 71 females; Mean age = 34.1 years, SD = 10.0). All the participants stated that English was their first language. Table 3.5 below shows the age distribution of the control group in comparison with the dyslexic group. Table 3.6 shows the occupational demographics of both groups.

Procedure

As described in Part 1 of this Chapter, like the dyslexic group, the control group participants were asked to complete a questionnaire electronically and return it via email. Alternatively, participants could download a hard copy, or they were handed one or the questionnaire was sent to them on request. It could be returned in person or by post.
Table 3.5

**Age descriptives of the two groups**

<table>
<thead>
<tr>
<th>Age in years</th>
<th>18-24</th>
<th>25-34</th>
<th>35-44</th>
<th>45-54</th>
<th>55-65</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controls</td>
<td>n=30</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3%</td>
<td>43%</td>
<td>17%</td>
<td>30%</td>
<td>7%</td>
</tr>
<tr>
<td>Dyslexics</td>
<td>n=180</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5%</td>
<td>36%</td>
<td>29%</td>
<td>24%</td>
<td>6%</td>
</tr>
</tbody>
</table>

**Questionnaire measures**

The questionnaires were the same as in Part 1 of this study. In addition to demographic details, it comprised: (i) measures of personal and societal and workplace success, (ii) a planning/metacognitive scale, and (iii) the Cognitive Failures Questionnaire (Broadbent et al., 1982). Data were analysed in relation to the success criteria established previously.

Table 3.6

**Occupation demographics**

<table>
<thead>
<tr>
<th>Job classification</th>
<th>Emergency services</th>
<th>Administration Management</th>
<th>Health / Education</th>
<th>Sciences / Arts</th>
<th>Professional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controls n=30</td>
<td>26%</td>
<td>37%</td>
<td>14%</td>
<td>7%</td>
<td>13%</td>
</tr>
<tr>
<td>Dyslexics n=180</td>
<td>31%</td>
<td>32%</td>
<td>14%</td>
<td>5%</td>
<td>13%</td>
</tr>
</tbody>
</table>

(Note 5% of dyslexics did not indicate a specific job.)

**Data analysis**

As in Part 1, the data were checked for missing values and tests of normality were conducted on all measures. Groups were compared with t-tests and their questionnaire measures were
correlated using Pearson’s correlations. When variables were non-parametric, Mann-Whitney U tests and Spearman’s correlations were conducted. A summary of the descriptive statistics for the dyslexics and the controls is presented in Table 3.7. Statistical comparisons between the groups for each measure were displayed, p-values were reported, and the effect size r (rather than Cohen’s d) were calculated for both t-tests and Mann-Whitney U tests for ease of comparison.

3.2.3 Results

3.2.3.1 Workplace success

There were no significant differences between the groups on financial success or academic qualifications (Table 3.7). Both groups had achieved similar levels of success in the societal domain: samples were matched for age and occupation, so had similar levels of financial status. The similarity in relation to academic qualifications was less predictable. The two groups also had similar levels of personal success, i.e. job satisfaction and self-efficacy. There were no differences between the groups on the career goal or on track measures. These equivalent success levels in the groups ensured that comparisons between the groups could more easily be made in relation to the impact of dyslexia.

The workplace success criteria

When looking at the correlations between the workplace success criteria as shown in Table 3.8, there were several notable findings. Firstly, there was a strong negative correlation between Financial status and Self-efficacy in the control data that was not apparent in the dyslexic data. The difference between the groups was significant when Fisher’s r to z transformation was calculated (p = .01). However, these findings were unexpected as they showed an association that higher self-efficacy in the control group was associated with a lower financial reward.

Secondly, the correlation identified in Part 1 between Financial status and Promotion with the dyslexic group was not evident in the control data; and this difference between correlations was significant (Fisher’s r to z, p = .04). Thirdly, the correlation between career goal and on
track found with the dyslexic group was not apparent in the control data; a difference which was also significant (Fisher’s r to z, p = .04).

Table 3.7

Descriptives and tests of difference between dyslexics and controls

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Dyslexics</th>
<th>Parametric</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
</tr>
<tr>
<td>SE</td>
<td>63.9</td>
<td>9.6</td>
<td>62.7</td>
</tr>
<tr>
<td>JS</td>
<td>38.3</td>
<td>6.6</td>
<td>37.7</td>
</tr>
<tr>
<td>FS</td>
<td>3.7</td>
<td>1.4</td>
<td>3.8</td>
</tr>
<tr>
<td>AQ</td>
<td>6.7</td>
<td>1.0</td>
<td>6.6</td>
</tr>
<tr>
<td>Prom</td>
<td>1.7</td>
<td>.45</td>
<td>1.63</td>
</tr>
<tr>
<td>OT</td>
<td>3.8</td>
<td>1.0</td>
<td>3.8</td>
</tr>
<tr>
<td>CG</td>
<td>2.7</td>
<td>1.0</td>
<td>2.9</td>
</tr>
<tr>
<td>PL</td>
<td>38.3</td>
<td>6.5</td>
<td>38.0</td>
</tr>
<tr>
<td>CFQ</td>
<td>88.3</td>
<td>13.0</td>
<td>67.1</td>
</tr>
</tbody>
</table>

$u=$ p-value from Mann-Whitney $U$ test, $\chi^2$= p-value from $\chi^2$ test, $\phi_c$= Cramer’s V
SE = Self-efficacy; JS = Job satisfaction; FS = Financial status; AQ = Academic qualifications; Prom = Promotion; OT = On track; CG = Career goal; PL = Planning scale; CFQ = Cognitive Failures Questionnaire

3.2.3.2 Planning and cognitive functioning in relation to workplace success

Contrary to expectations, there was no evidence of differences between the groups in terms of planning (Table 3.7). However, there was a significant difference between the groups on the
cognitive failures scale. These results indicate that although the dyslexic group were equally successful, and reported similar levels of planning, they also reported more “cognitive failures” than the control group.

Table 3.8

Correlation table of the workplace success criteria in both groups

<table>
<thead>
<tr>
<th></th>
<th>CFG</th>
<th>PL (a)</th>
<th>SE (a)</th>
<th>JS (a)</th>
<th>FS (a)</th>
<th>AQ (a)</th>
<th>Prom (b)</th>
<th>CG (a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning</td>
<td>Dys</td>
<td>.258*</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Con</td>
<td>-0.82</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-Efficacy</td>
<td>Dys</td>
<td>.357**</td>
<td>.587**</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Con</td>
<td>-0.084</td>
<td>.719**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Job Satisfaction</td>
<td>Dys</td>
<td>.177</td>
<td>.437**</td>
<td>.582**</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Con</td>
<td>.077</td>
<td>.428*</td>
<td>.597**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial Status</td>
<td>Dys</td>
<td>.110</td>
<td>.078</td>
<td>-.108</td>
<td>-.099</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Con</td>
<td>-.189</td>
<td>.100</td>
<td>.410*</td>
<td>.090</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Academic Qualifications</td>
<td>Dys</td>
<td>-.004</td>
<td>.016</td>
<td>.078</td>
<td>.062</td>
<td>-.130</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Con</td>
<td>.032</td>
<td>.042</td>
<td>-.182</td>
<td>.003</td>
<td>-.114</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Promotion</td>
<td>Dys</td>
<td>.133</td>
<td>.001</td>
<td>.016</td>
<td>.023</td>
<td>.344**</td>
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<tr>
<td></td>
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<tr>
<td>Career Goal</td>
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<td>.191*</td>
<td>.374**</td>
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<tr>
<td></td>
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<td>.377*</td>
<td>.053</td>
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<tr>
<td>On Track</td>
<td>Dys</td>
<td>.193*</td>
<td>.236*</td>
<td>.295**</td>
<td>.461**</td>
<td>.115</td>
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<tr>
<td></td>
<td>Con</td>
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<td>.228</td>
<td>.383*</td>
<td>.337</td>
<td>-.152</td>
<td>-.181</td>
<td>.120</td>
</tr>
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</table>

*p <.05; **p <.01
(a) Spearman’s (b) Pearson’s point-biserial correlation

SE = Self-efficacy; JS = Job satisfaction; FS = Financial status; AQ = Academic qualifications; Prom = Promotion; PL = Planning scale; CG = Career goal; OT = On track

Note: The figures in italics are significant, the figures in bold are significant (p<.05) on a Fisher’s r to z transformation.

Planning and its relation to workplace success

Spearman’s correlations were calculated to assess any relationship between planning and the workplace success criteria, apart from the relationship between promotion and the planning scale, where a point-biserial correlation was calculated (promotion produced dichotomous
data. The results indicated comparable relationships between the two groups. The association between planning and job satisfaction and planning and self-efficacy appeared to be very similar for both groups. Contrary to the hypothesis, but consistent with the findings in Part 1 of the study, there were no significant associations between the planning scale and the societal success measures.

The Cognitive Failures Questionnaire and its relation to workplace success

The correlations between the Cognitive Failures Questionnaire, planning and the workplace success criteria measures are shown in Table 3.8. There were significant group differences in the correlations on a Fisher’s r to z transformation.

Firstly, Self-efficacy was moderately correlated with the Cognitive Failures Questionnaire in the dyslexic group but not at all in the control group, and when a Fisher’s r to z transformation was performed there was a significant difference ($p = .03$), indicating that high cognitive failure or awareness of cognitive failure were related to low self-efficacy: fewer failures meant greater self-efficacy. There were no significant relationships with the Cognitive Failures Questionnaire and job satisfaction in the control group.

The relationship between planning and the Cognitive Failures Questionnaire

Secondly, there was a significant correlation between the planning scale and the Cognitive Failures Questionnaire in the dyslexic group that was not present in the control data. However, the group difference on an r to z transformation was non-significant ($p = .09$).

In summary, the findings of this second part suggest that dyslexic and non-dyslexic people differ in executive functioning skill as measured by the Cognitive Failures Questionnaire. Furthermore, the dyslexics’ relatively low levels of executive functioning skill were also related to self-efficacy: amongst the dyslexics, those with more self-reported cognitive failures showed evidence of lower self-efficacy and this was significantly different when compared to the non-dyslexic group. Therefore, aspects of executive functions may be a specific influence on dyslexic people’s personal workplace success. However, in relation to metacognitive skill there was not the anticipated difference in levels of planning between the
groups. Likewise, for both groups planning skill was related to personal success indicators of job satisfaction and self-efficacy but not to the societal measures of academic qualifications and financial status. The former association is consistent with considerable previous research, however lack of association in both groups with the societal criteria was not predicted. The overall lack of significant findings indicates a need to explore these relationships further in future studies to see if they are sample specific or generalisable across samples.

### 3.2.4 Discussion

The overall aims of this first study were threefold. Firstly, to establish the workplace success criteria. Secondly, to determine if there were differences in performance between the dyslexic participants and the control group on measures of planning (a component of metacognition), and a measure of executive functioning processes (tested via the cognitive failures questionnaire). No differences were observed between the groups on planning, but there were significant differences in the cognitive failures questionnaire results. Thirdly, this study sought to explore the influence any cognitive differences may have on workplace success. A difference was found, but only in terms of the relationship between the cognitive failures measure and one of the personal success criteria. It was anticipated that there would be differences between the groups on the workplace success criteria, these are discussed first.

**The workplace success criteria**

The positive correlations between job satisfaction and self-efficacy in both groups were anticipated but there was no evidence of the expected relationships between the societal and personal criteria, nor between financial status and academic qualifications. For example, there were no associations in relation to academic success and job satisfaction and self-efficacy in either group. This was contrary to much extant research. Self-efficacy in educational research has long been recognised as a predictor of academic success (Bandura, 1993; Schunk & Parajes, 2004). As this study found no relationship between academic success and the self-efficacy measure, this may confirm the validity of the self-efficacy scale used in the present study to the work context only (Lent & Hackett, 1987). Furthermore,
Betz, 2007) has argued that career self-efficacy and academic performance are not related in the general population, suggesting instead that interest in the job determines success. The lack of correlation between academic performance and job satisfaction in either group was unexpected (Eby & Butts, 2003), as educational achievement has been associated with improved performance and greater success (Hogan, 2013).

There was a significant but negative correlation between self-efficacy and financial status in the non-dyslexic group but not in the dyslexic group. In the non-dyslexic group, higher self-efficacy was related to a lower financial status, which seems counterintuitive, but there could be several explanations for this relationship. Judge & Ilies (2004) and Heslin (2003) have argued that financial success is not necessarily the only thing people seek from their career; i.e., work-life balance may be more relevant to them, and some are vocationally driven, desiring a sense of meaning and achievement from their work (Hall & Chandler, 2005). Therefore, some have high levels of self-efficacy but are not necessarily financially rewarded for this. Lent and Hackett (1987) and Bandura (1986) have both discussed the limitations of self-efficacy scales. The level of specificity of the task is a key component: in high salaried jobs, the task complexity, levels of responsibility and negative feedback may mean self-perceptions of efficacy are less consistent; individuals may feel more efficacious about relatively circumscribed tasks. Finally, feelings of self-efficacy can diminish when the demands of the job and levels of responsibility increase, or when people are promoted beyond their competency: The Peter principle (Peter, 1969).

Financial success and promotion were linked in the dyslexic group. This association is predictable and consistent with the career literature (Ng et al., 2005), but was significantly different from the control group, where no such relationship was found. This may be a reflection specific to the non-dyslexic group where, in this smaller sample, other self-referent factors such as a sense of purpose and work-life balance are more important than pursuing financial gain (Heslin, 2005). It could also be attributed to the multi-composite nature of promotion, based on many things including individual attributes, and organisational values (Ruderman & Ohlott, 1994).

Moreover, there were indications that these dyslexic participants, unlike the non-dyslexic group, recognised that career planning was important for them; that they needed to have a career goal and stay on track to achieve this. A potential explanation for this may be that
dyslexic people lack confidence because of their weaker literacy skills. They are aware they are at a disadvantage; they may consider themselves to be less than ideal candidates in an employer’s eyes, or that their career choices are more limited so plan to overcome this. Alternatively, having struggled through school, the workplace may offer greater opportunities to select a job of interest to them, thereby increasing a drive to succeed. The latter is consistent with the model of success outlined by Schnieders et al. (2016), who posited that among the factors contributing to success are goal orientation, perseverance and a goodness of fit.

The lack of findings in relation to the other societal success criteria do support the argument that career success is a multi-faceted complex construct and using societal measures only offers merely a partial picture (Heslin, 2003, 2005).

**Personal success**

Both groups had similar levels of self-efficacy and job satisfaction supporting previous research in the dyslexic population (Madaus et al., 2003) and in the general population (Bono & Judge 2003; Bandura, 1993). However, the equivalent levels were contrary to our hypothesis: indeed, Madaus et al. (2003) found that most dyslexic participants indicated that dyslexia impacted negatively on their performance at work. De Beer et al. (2014), in a systematic review, reported that dyslexics’ difficulties with literacy and memory occurred in every domain of life and increased with age. Unexpectedly, the dyslexic participants involved in the study reported the same levels of personal success as the controls. One potential explanation for this is that the selected dyslexic individuals may have been those who have found the optimum employment for themselves, where there is a “goodness of fit” between their skills and occupation roles, and/or where they could overcome dyslexia-related difficulties through learned creativities (Gerber, 2012; and see Chapter 2). An alternative explanation is that the dyslexic participants were in some way compensating for their cognitive failure, possibly by using metacognitive skills (Madaus et al., 2003; Zimmerman, 2002). These interpretations are hypothetical and require further investigation.

In both groups, the associations between on track and career goal and the personal success criteria of job satisfaction and self-efficacy were comparable. These associations may be because these measures span the personal and social career success dichotomy, as outlined in
Figure 3.1; they were based on personal perspective, although verifiable, rather than on other objective criteria. It suggests that they are better indicators of subjective personal success, not the objective societal success as postulated in previous literature. The direction of results is consistent with the career literature, indicating that the better people felt in terms of self-efficacy and job satisfaction, the more likely they were to have a career goal and be on track (Abele & Spurk, 2009; Bandura & Locke, 2003); or alternatively, if they had a career goal and were on track, they had higher levels of job satisfaction and self-efficacy. Consistent with this, better planning skill was related to having a career goal and being on track. This conforms to career development theory, where planning and metacognitive skill enables people to identify personal goals and make meaningful career choices. Effective career decisions reflect a match between a persons’ knowledge, skills, abilities, and job requirements (Judge et al. 1994).

**Societal success**

It was anticipated that academic qualifications of the dyslexic group might be lower because of literacy difficulties and subsequent educational experiences (De Beer et al., 2014; Nalavany, 2011); however, both groups gained similar levels of academic qualifications (although grade levels and subjects were not obtained). This may be a consequence of matching the two groups on occupation and job roles requiring a standard level of academic attainment.

Similar levels of financial status could be attributed to the fact that most participants had attained an above-average level of education (Office of National Statistics, 2014); duration and levels of formal education has been shown to have a positive effect on workplace performance. In a comprehensive study, Guerra-Carillo, Kativich and Bunge (2017) found that higher levels of education predicted improved critical thinking, reasoning skills and learning performance throughout adulthood, and that new learning opportunities (workplace training) mediated learning gaps in education, improving workplace success. Ritchie et al. (2015) also suggested that executive processes may affect workplace success. They argued that the longer one spends in formal education, cognitive abilities of reasoning and memory become greatly enhanced. Gerber (2012) and Madaus et al. (2003) reported that length in education is related to financial success although, unlike above, they do not suggest a specific link between time spent in education and the development of cognitive skill.
In summary, the findings from the present study suggest that these dyslexic participants, having attained academic qualifications and increased their learning competencies to cope with the demands of their jobs, have thereby achieved equivalent success as the non-dyslexic participants. The parity of these results suggests the matched sampling process was effective and any subsequent differences in results would have to be accounted for in other ways than workplace success itself.

Planning skill and the Cognitive Failure Questionnaire

Dyslexic adults frequently report difficulties with organisation and planning (Bartlett & Moody, 2010; De Beer et al., 2014), but contrary to expectations, both groups in this study reported similar levels of planning. An explanation for this parity in planning skill may be that these dyslexic participants have developed these skills as part of their work-based learning. Ng & Feldman (2010) suggested that through the actual process of being employed, individuals develop good work habits, which lead to improved performance; i.e., they learn what is required from their jobs. Schulz & Rossnagel (2008) conducted a study with over 400 employees exploring the role of learning in the workplace. They argued that in the more “informal learning environment” of work, which may include on-the job-training, mentoring, job rotation and daily routines, learning competence can be acquired, and learning takes place in context-specific situations, in practical experiential situations so is therefore effective. Schulz & Rossnagel (2008) argued that learning competence involves metacognitive skill. The capability to plan, monitor and evaluate, the motivational aspects of learning, identifying one’s own learning needs and effective strategies to overcome challenges. These constituents of learning competence may have enabled the dyslexic participants to become as successful as their non-dyslexic peers. These findings and interpretations are in line with research focused on dyslexia and success (see Schnieders, Gerber & Goldberg, 2016; Raskind, Goldberg, Higgins, & Herman, 1999), which suggests that metacognitive and planning skills are predictors of success for dyslexic people. However, it should be noted that the findings of this study may also argue for dyslexics not having deficits in relation to planning.

There was evidence for differences between dyslexics and non-dyslexics in terms of self-reported executive function, as measured by the Cognitive Failure Questionnaire. The
dyslexic participants reported that they experienced lapses of attention and slips of memory significantly more than that the control group. McNamara & Wong (2003) and Smith-Spark et al. (2004, 2016b) reported similar deficits in samples of dyslexic students in comparison with controls in their studies exploring memory difficulties. Both sets of researchers concluded that the dyslexic students experienced processing difficulties in addition to the widely recognised phonological processing problems. However, such effects could be a self-perceived problem and a possible reflection of lower confidence in cognitive skills.

There was a positive association between planning and the Cognitive Failure Questionnaire in the dyslexic group but not in the control group. The lack of relationships in the non-dyslexic group may reflect less cognitive failure, or less awareness of cognitive failure, so that any memory difficulties experienced were not addressed via metacognitive or planning skill. A potential explanation for this association in the dyslexic group (albeit with a small effect size) is that they may have been addressing their increased cognitive failure, lapses of attention and recall of everyday information through utilising planning/metacognitive skill (Reis, Maguire & Neu 2000; Trainin & Swanson, 2005; Zimmerman et al., 1992).

**Planning skill and workplace success**

In both groups, good planning skills were related to personal success measures, such as job satisfaction and self-efficacy. This similar finding for the control group is consistent with much research: better planning enables people to feel more in control. Bandura (1997), Gist and Mitchell (1992), and Lunenburg (2011) all stated that self-efficacy, job satisfaction and planning in terms of goal-setting are interdependent (see also the findings of Bono & Judge 2003; Gerber, 2002; Madaus, 2008; Sternberg, 2005; Zimmerman, 2006). The findings provide support for the Gerber model of success that postulates that goal setting and self-awareness are “internal” factors that are determinants of success.

Surprisingly, in either group, planning was unrelated to the societal success measures of academic qualifications or financial status. This contrasts with most of the extant research (Meltzer, 2007; Pintrich et al, 1999; Sternberg, 2005; Swanson, 2012). This lack of association suggests it was not a dyslexia-specific finding. It may well be a reflection that the planning scale devised for this study was too general in context to gather relevant information in relation to academic qualifications and financial status. Future research into these areas
could be conducted with more comprehensive context-specific planning scales. More questions regarding study habits, decision-making processes and career planning may make a scale more relevant to academic achievement and financial advancement. See Appendix 3.1 for the scale used in this study.

*The Cognitive Failures Questionnaire and workplace success*

Overall the dyslexic participants experienced significantly more cognitive failures than the control group. Furthermore, these executive functioning processes influenced workplace success, but in the dyslexic group only. Executive deficits in the dyslexic group were related to levels of self-efficacy. Those dyslexic participants with high levels of self-efficacy did not report as many cognitive failures. Alternatively, those dyslexic people who experienced more memory lapses, more slips of attention and more problems with recall of words felt less efficacious at work. Broadbent et al., (1982) argued that these slips of attention, of memory and increased distractibility are indicative of an underlying deficit, rather than a lack of ability or response to a stressful situation. He suggested these misdirected actions interrupt the smooth flow of cognitive function, thus affecting an individual’s performance. Therefore, constant slips of attention are likely to undermine one’s feeling of self-efficacy.

In the dyslexic group, the lack of other relationships between the Cognitive Failure Questionnaire and the societal success criteria were unexpected, because it measures a wide range of everyday cognitive processes and frequent slips of attention are likely to affect performance and impact on everyday situations (McNamara & Wong, 2004; Smith-Spark et al., 2004; 2016). Potentially, these dyslexic participants had mastered their weaknesses in their jobs so that their performance was not compromised: although this then became inconsistent with the interpretation above about self-efficacy. Further research, therefore, is necessary to determine the links between these factors.

It is an important consideration of this research that many of the correlations were on measures of self-reported scales. Such scales are widely used for convenience and allow access to larger sample sizes. If caution is applied in interpretation, then the results are generally seen as reliable (Bandura, 1997). However, it must be acknowledged that results may be governed by individual perception, and individuals were rating their own performance, reflecting their worries about their cognitive functioning, rather than measuring
cognitive abilities of actual observable performance (Wilhelm et al., 2010). However, Broadbent (1982) considered this when constructing the Cognitive Failures Questionnaire. He argued that the direction of the results from the Questionnaire demonstrated that enhanced cognitive failures on the questionnaire were more likely to cause increased stress levels and low self-esteem, as opposed to low self-esteem and high stress levels causing cognitive failure. Furthermore, the Cognitive Failures Questionnaire has a second part to it, “cognitive failures from other perspectives”; spouses were also asked to rate their partners’ cognitive performance on a parallel CFQ scale. The “original participants” and “others’” data were strongly correlated in Broadbent’s data (1982), and that of Smith-Spark et al. (2004), thereby verifying the individual’s own perspective on their cognitive performance.

In conclusion, this study indicates that both groups of participants attained comparable levels of workplace success. However, there were differences between the groups on aspects of executive functioning, as the dyslexic participants reported experiencing significantly more cognitive failures. Furthermore, the dyslexics’ weakness in executive functioning was related to the personal success criteria of self-efficacy (though not job satisfaction). In contrast, no differences between the two groups emerged on the planning measure, a component of metacognition. The measure of planning was related to workplace success in both groups, but only to the personal criteria, job satisfaction and self-efficacy.

Previous research has suggested that planning may mediate executive functioning difficulties. Both cognitive measures used in this study explored only certain aspects of cognition, so further research was conducted to gain further insight in the next two studies using more detailed measures of metacognition and executive functioning.
Chapter 4

4. Study 2: The effect of metacognition and confidence on workplace success

4.1 Introduction

Metacognition has been conceptualised and explored in numerous ways by the disciplines psychology and education (see Chapter 2, page 44). It is widely considered to be the conscious awareness of one’s own cognition, one’s own thinking and one’s own learning processes (Fernandez-Duque et al., 2000; Kuhn, 2000; Follmer & Sperling; 2016). It has also long been recognised as contributing to academic and workplace success in the general population (Kuhn, 2000; Pintrich et al, 1994; Schmidt & Ford, 2003; Zimmerman, 2002). The aim of this second Study was to explore the potential role of metacognition in workplace success using more detailed measures of metacognition than used in Study 1. Confidence and metacognition are related (Efklides, 2008); this Study also measured confidence in memory and reasoning (Kleitman & Stankov, 2007) to investigate their potential role in workplace success. Finally, included were reasoning tasks that required problem-solving skills often considered as requiring higher-order executive functioning (Diamond, 2013; Reid Lyon & Krasnegor, 1996). This allowed the Study to consider the relationship between metacognitive factors and measures of executive functioning that did not rely on self-report. The reasoning measures included verbal and non-verbal items, allowing comparisons across skill areas related to dyslexia.

This Study is presented in two parts. In the first part, a sub-set of dyslexic participants from Study 1 completed a questionnaire containing the measures outlined above to assess any relationships between the different measures in this Study and those included in Study 1. In the second part, these dyslexics’ data were compared with data gathered from the control group used in Study 1 to determine if there were differences between the groups in terms of the metacognitive skills and the impact on workplace success.
4.1.1 Metacognition and Confidence

Metacognition

Many researchers studying metacognition primarily delineated two core components: metacognitive knowledge and metacognitive control (Flavell, 1979; Nelson et al., 1994; Schraw & Dennison, 1994; and see Chapter 2). The first metacognitive component; Knowledge of cognition, includes knowledge of self and of processing skills, understanding of the task, and knowledge of strategies and how and when to deploy them (Schraw & Dennison, 1994). The second component; Regulation of cognition, includes processes of planning, monitoring and evaluation. In this present Study, these two components were measured using a self-report scale (the Metacognitive Awareness Inventory, MAI; Schraw & Dennison, 1994).

The Metacognitive Awareness Inventory (Schraw & Denison, 1994) is a widely-used measure of metacognitive skill in adolescents and adults. In a comparison of three metacognitive and self-regulation inventories, Muis et al. (2007) argued that the Metacognitive Awareness Inventory was more “indicative” (p.194) of metacognitive processes than the others, which were more indicative of self-regulatory processes. As part of the development of the Metacognitive Awareness Inventory, Schraw and Dennison (1994) wanted to establish that the existing conceptualisations of the dual components of metacognition (Brown, 1980; Flavell, 1979) were valid. The authors designed a 52-item questionnaire, with items using a Likert scale. Eight components were developed, with three falling into the Knowledge of cognition category (i.e., declarative, procedural and conditional knowledge), and five comprising the Regulation of cognition category (planning, information management, monitoring the effectiveness of strategy use, debugging or error correction, and finally evaluation strategy). A two-factor restricted factor analysis confirmed the two Knowledge and Regulation components. Cronbach’s alpha coefficients for each factor were .91, indicating a high degree of internal consistency, and the coefficient alpha for the entire inventory reached .95. Schraw and Dennison (1994) demonstrated that these two factors were related but contributed differently to an individual’s performance; Knowledge of cognition was related to higher test performance in contrast to Regulation of cognition. The Metacognitive Awareness Inventory has good construct reliability (Sperling et al., 2004), but previous research has rarely used this scale with dyslexic people. Therefore, the first
research aim of the current Study was to explore relationships between various measures in a dyslexic cohort.

Confidence in memory and reasoning

As discussed in Chapter 2, page 51, confidence and metacognition are related. Some researchers consider that confidence in judgements about a specific task as being correct or incorrect is a component of confidence (Efklides, 2008). However, the aspects of confidence explored in this Study are more closely aligned to self-confidence, in this case in an individual’s competency in memory and reasoning generally. Kleitman and Stankov (2007) explored the role of self-confidence in relation to metacognition. They found that confidence in memory and reasoning and metacognition were moderately correlated and that self-confidence was predicted by accuracy and metacognitive knowledge. Arguably, this is logical: more metacognitive individuals, who monitor their thinking and attribute success to themselves are usually also more confident about their judgement and their abilities (Borkowski, 2011; Jackson & Kleitman, 2016; Moran & Gardner, 2007). The role of confidence in memory and reasoning was of interest to this present research as there is evidence that dyslexic people lack self-confidence in their memory skills (Nalavany et al., 2011; Raskind & Gerber, 2014), and that this can influence general performance (Burden, 2004; Ginsberg et al., 1994; see also Chapter 2). In contrast, reasoning competence may be an area of relative strength for dyslexic people (Eide & Eide, 2011). Therefore, for the purposes of this research, confidence levels in memory and reasoning were held as distinct from the metacognitive processes and were explored to determine if they predicted workplace success in the dyslexic sample. Such relationships within the dyslexic group were the focus of the first part of this Study. Part 2 compared these data with those of the control group. To assess the two areas of confidence that were the focus of the current Study, the Memory and Reasoning Competence Inventory (MARCI, Kleitman & Stankov, 2007) was selected as the confidence measure, given that it comprises two sub-scales: Confidence in reasoning competence and Confidence in memory competence.

Metacognition, confidence in the cognitive failures questionnaire

In Study 1, better planning skills were related to better performance on the Cognitive Failures Questionnaire. To explore this in more detail, relationships between the self-reported
cognitive failures from Study 1 and the metacognitive and confidence measures from this Study were investigated. It was anticipated that better metacognitive skills would relate to fewer cognitive failures, particularly as metacognition has been seen by some as a compensatory mechanism for dyslexic people (Reiss et al., 2000; Swanson, 2015; Zimmerman, 1998). It was also predicted that the cognitive failures scores from Study 1 would be correlated with the confidence in memory scores from Study 2: i.e., that less cognitive failure would mean greater confidence in memory.

4.1.2 Reasoning tasks, metacognition and confidence

To provide additional data to the self-report questionnaires, participants were also asked to solve a range of reasoning tasks so that actual performance could be contrasted with self-reports. Consistent with the relationship between improved performance and metacognition (Kleitman & Stankov, 2007), it was anticipated that accuracy on actual tasks would be related to higher metacognitive skill and increased confidence.

Verbal and non-verbal reasoning tasks were chosen because it is often postulated that dyslexic people process information differently for different domains (Bacon et al., 2007; Shaywitz et al., 2003; West, 2010), and there is evidence that dyslexic people have more confidence in their non-verbal processing skills (Alexander-Passe, 2010; though also see discussions in Brunswick et al., 2010). Therefore, differences in the way the participants performed on the verbal and non-verbal reasoning tasks were expected. Pre-task planning is an aspect of metacognition; therefore, this was also explored in relation to reasoning task accuracy.

4.1.3 Workplace success, metacognition, confidence and reasoning

The final area of interest in this Study was to explore the role of metacognition and confidence in workplace success. As mentioned above, there is evidence for a relationship between metacognitive skills and academic success (Linnenbrink & Pintrich, 2003; Sternberg, 2005) and success in the workplace (Bandura, 1986, 1993; Munby et al., 2003). Relationships have also been found between levels of confidence and success (Kanfer & Ackerman, 2005; Stankov, 1999). Therefore, it was anticipated that both metacognition and
confidence would be related to the workplace success criteria; in this case, assessments of job satisfaction, self-efficacy, academic qualifications, and financial status.

In summary, assessments of metacognition were based on the two components of metacognition (Knowledge of cognition and Regulation of cognition) from the Metacognitive Awareness Inventory (MAI; Schraw & Denison, 1994). Confidence was assessed via two scales from the Memory and Reasoning Competence Inventory (Kleitman & Stankov, 2007). In addition, given that Study 1 found a relationship between planning and cognitive failure, correlations between the Cognitive Failures Questionnaire from Study 1 and the metacognition measures, and the confidence measures of the current Study were calculated. The hypotheses were:

**Hypothesis 2.1** The measures of Knowledge of cognition and Regulation of cognition would be related to measures of confidence in memory and confidence in reasoning.

**Hypothesis 2.2** The measures of Knowledge of cognition and Regulation of cognition would be related to cognitive failure.

**Hypothesis 2.3** Confidence in memory would be related to scores on the cognitive failures measure.

Furthermore, variations in performance on the verbal and non-verbal reasoning tasks with metacognition and confidence were anticipated.

**Hypothesis 2.4** Greater Knowledge and Regulation of cognition would be related to greater accuracy in the reasoning tasks.

**Hypothesis 2.5** Higher confidence in memory and reasoning would be associated with greater accuracy in the reasoning tasks.

**Hypothesis 2.6** Pre-task planning would relate positively to reasoning task accuracy.

To explore the role of metacognition and confidence in workplace success, correlations were conducted with the workplace success criteria used in Study 1. The following was expected:
**Hypothesis 2.7** The metacognitive measures would relate to the workplace success criteria.

**Hypothesis 2.8** Accuracy in the reasoning tasks would be related to workplace success.

### 4.1.4 Methods

#### 4.1.4.1 Participants

Participants were selected from the initial sample from Study 1 to enable comparison across the Studies. An invitation to participate was sent out electronically to 150 of the dyslexic participants from Study 1 who had indicated at the end of their first questionnaire that they would like to participate in future research. In total, 108 people responded and completed the second questionnaire, a response rate of 72%. A year and a half later, an additional eight dyslexic people joined the research for Study 3. These eight participants completed the questionnaires from both Studies 1 and 2, so their responses were included in the analyses. Of the 116 dyslexic participants, 66 were male and 50 were female. Their ages ranged from 18 years to 65 years (M=35.7, SD=9.5 years). Of the 116, 88% specified their job title: 102 people worked in a variety of occupations, including the emergency services (a police force and a fire service), office-based administrative jobs, the health and education sector, the arts and design industry, and the legal and accountancy professions (see Table 4.1). A further 5% of the participants said they were self-employed, and 2% said they had recently become unemployed and were hoping to return to work shortly. The final 5% were employed but did not stipulate their job title.

**Table 4.1**

**Demographic descriptives**

<table>
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<th>Age in years</th>
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<td><strong>Emergency services</strong></td>
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<tr>
<td><strong>Administration/Management</strong></td>
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<td><strong>Health and education</strong></td>
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<td><strong>Sciences</strong></td>
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<td>7%</td>
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<tr>
<td><strong>Professional</strong></td>
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<td>11%</td>
</tr>
</tbody>
</table>
Procedure

The participants were asked to complete a questionnaire electronically and return it via email. Alternatively, participants could download a hard copy or request a hard copy, in which case the questionnaire was to be returned in person or by post. At the end of the questionnaire they were asked once again if they would like to participate in further research.

4.1.4.2 Design and materials

The questionnaire included quantitative data for statistical analyses and qualitative data to capture individual insights and personal perspectives of dyslexia. However, too few people added qualitative comments to allow qualitative analysis, so this Chapter focuses on the quantitative data. Background information had been collected in the first study of the research.

Questionnaire measures

In addition to background information about the participants, the questionnaire comprised questions related to metacognitive knowledge and metacognitive regulation, as well as items concerned with confidence in reasoning and memory. There was also a section in the questionnaire asking participants to complete actual verbal and non-verbal reasoning tasks, and asked questions about how they completed these tasks.

The Metacognitive Awareness Inventory (MAI; Schraw & Dennison, 1994)

Participants were asked to complete the Metacognitive Awareness Inventory (Schraw & Dennison, 1994). This Inventory contains 52 questions such as: “I ask myself periodically if I am meeting my goals”, “I use different strategies depending on the situation”, “I ask myself how well I have accomplished my goals once I am finished”. Their responses were rated on a 5-point Likert scale, from 1 = strongly agree to 5 = strongly disagree. All the scores on these test items were recoded for ease of interpretation so that scores ranged from a possible low score of 52, indicating poor metacognitive skills, to a high score of 260, indicating good
metacognitive skills. As mentioned previously the Metacognitive Awareness Inventory has two factors, Knowledge of cognition (K of C) and Regulation of cognition (R of C). The current data indicated a Cronbach’s alpha score of $\alpha = .83$ for the knowledge of cognition scale when three items (“I learn best when I know something about the topic”, “I know what the teacher expects me to learn”, and “I learn more when I am interested in the topic”) were excluded due to multicollinearity ($r = .104, .153, \text{ and } .162$ Corrected Item Correlation). For Regulation of cognition, the Cronbach’s alpha score was $\alpha = .92$.

**Memory and Reasoning Competence Inventory**

To explore confidence in the participants reasoning and memory abilities, participants were asked to complete the Memory and Reasoning Competence Inventory (Kleitman & Stankov, 2007). Once again, this used a five-point Likert scale and comprised 16 questions including: “I can remember more than the average person”, “In an exam situation I get the answers right mostly by reasoning”, and “Compared to my other cognitive abilities my reasoning is sound.” As on the metacognitive awareness inventory, all the scores on this inventory were recoded so that lower scores, a minimum of 16, indicated less confidence in the individual regarding their memory and reasoning competency. Likewise, high scores, a maximum of 80, indicated higher confidence. In previous research, the Inventory has shown high internal reliability: for the two components $\alpha = .88$ (Kleitman & Stankov, 2007). However, to confirm reliability with the present data, a principal component factor analysis was run and two factors emerged, accounting for 66.2% of the variance. The overall Kaiser-Mayer-Olkin (KMO) value was .88, ranging between the ranges .79 to .91 for the individual items. There was no issue with multicollinearity and the communalities were above .04. The individual items clearly fell into memory and reasoning factors, confirming the original factor structure. Furthermore, Cronbach’s Alphas for both the reasoning and memory factors were $\alpha = .91$. Again, this was consistent with the original scale.

**Verbal and non-verbal reasoning tasks**

Verbal and non-verbal measures were used to investigate performance on reasoning tasks. Dependent measures were task accuracy, time estimation, pre-task planning and pre-task and post-task confidence (the latter being different measures to the confidence in reasoning variable outlined above). Reasoning tasks that required some thought; that is, they were not so easy that they could be solved instantly, were deliberately chosen to allow for assessments
of task analysis and planning and time estimation. An example of one of the verbal tasks used can be found in Figure 4.1. This example was given to the participants as a practice item on the questionnaire.

If you have black socks and brown socks in your drawer mixed in a ratio of 4 black to 5 brown socks, how many socks will you have to take out to make sure of having a pair of the same colour?

*Figure 4.1  Practice example of verbal task  (Taken from The Essential Sternberg: Kaufman & Grigorenko, 2008, p.49)*

The non-verbal reasoning task was taken from the Ravens Progressive Matrices (1991). The practice example is shown in Figure 4.2.

*Figure 4.2  Practice example of non-verbal task.*

The procedure was the same for both problem-solving tasks. In each domain, participants were first given an example. They were explicitly directed not to solve these but they were asked to rate on a Likert scale their feelings of confidence in solving the task (ranging from 1 = very confident to 6 = give up) and the time they thought they might take (ranging from 1 = 15 seconds, 2 = 30 seconds, 3 = 1 minute, 4 = 1 minute 30 seconds, 5 = 2 minutes, 6 = longer than 2 minutes. These data were coded as above). The participants were then presented with an equivalent task to solve. On completion, they were asked the following questions: “*Did you have a plan when trying to find a solution?*”, Yes, Partly, No. These responses were coded as Yes=1, Partly = 2, No = 3. They were also asked “*How confident are you that your answer is correct?*” (1 = very confident to 6 = give up. These data were coded accordingly). Finally, they were asked to estimate how long they took using the same time-scale as the pre-test estimation question. The non-verbal task was presented first and the verbal task immediately afterwards. The accuracy measure was simply if they solved the problem correctly. They were coded as, correct =1 incorrect=2.
See Appendix 4.1 for the full questionnaire.

4.1.6 Results

Prior to the analyses, the data were checked for missing values and tests of normality were conducted on all measures. The data set included responses from one individual who was identified as an outlier on the Metacognitive Awareness Inventory. This participant was excluded from the Metacognitive Awareness Inventory data analyses to avoid bias in the results including this scale. The data gathered in relation to task-confidence and time estimation did not provide interpretable results. They have, therefore, been excluded from the Study. A summary of the descriptive statistics of the variables used in the remainder of the results section are presented in Table 4.2.

Table 4.2

Descriptive statistics for the measures included in this Study

<table>
<thead>
<tr>
<th>Measure</th>
<th>M</th>
<th>SD</th>
<th>LL</th>
<th>UL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge of cognition</td>
<td>60.9</td>
<td>8.3</td>
<td>59.4</td>
<td>62.6</td>
</tr>
<tr>
<td>Regulation of cognition</td>
<td>119.8</td>
<td>17.9</td>
<td>116.4</td>
<td>123.2</td>
</tr>
<tr>
<td>Confidence in memory</td>
<td>19.7</td>
<td>7.6</td>
<td>18.3</td>
<td>21.1</td>
</tr>
<tr>
<td>Confidence in reasoning</td>
<td>27.9</td>
<td>6.6</td>
<td>26.7</td>
<td>29.1</td>
</tr>
<tr>
<td>Cognitive Failures Questionnaire</td>
<td>65.2</td>
<td>16.8</td>
<td>61.8</td>
<td>68.2.0</td>
</tr>
<tr>
<td>Self-efficacy</td>
<td>61.7</td>
<td>11.0</td>
<td>59.6</td>
<td>63.9</td>
</tr>
<tr>
<td>Job satisfaction</td>
<td>36.6</td>
<td>8.3</td>
<td>34.9</td>
<td>38.2</td>
</tr>
<tr>
<td>Financial status</td>
<td>3.7</td>
<td>1.4</td>
<td>3.4</td>
<td>4.0</td>
</tr>
<tr>
<td>Academic qualifications</td>
<td>6.5</td>
<td>1.1</td>
<td>6.3</td>
<td>6.7</td>
</tr>
</tbody>
</table>
4.1.6.1 Metacognition and confidence

Correlations were calculated to investigate relationships between the measures of Knowledge of cognition, Regulation of cognition, Confidence in memory and Confidence in reasoning. It was anticipated that all the variables would be positively associated. The correlations (see Table 4.3) indicated that, as anticipated, Knowledge of cognition was related to both confidence variables. However, Regulation of cognition was related only to increased confidence in reasoning. The lack of relationship between Regulation of cognition and Confidence in memory was unexpected.

*Relationships between the CFQ and metacognitive and confidence factors*

**Table 4.3**

*Correlations between the measures of Knowledge/Regulation of cognition, Confidence in memory/reasoning and the Cognitive Failures Questionnaire.*

<table>
<thead>
<tr>
<th></th>
<th>Knowledge of cognition</th>
<th>Regulation of cognition</th>
<th>Confidence in memory</th>
<th>Confidence in reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulation of cognition</td>
<td>.63**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confidence in memory</td>
<td>.37**</td>
<td>.07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confidence in reasoning</td>
<td>.24*</td>
<td>.20*</td>
<td>.09</td>
<td></td>
</tr>
<tr>
<td>Cognitive Failures Questionnaire</td>
<td>.39**</td>
<td>.13</td>
<td>.29*</td>
<td>.15</td>
</tr>
</tbody>
</table>

*) p < .05  **) p < .01

It was hypothesised that both the metacognitive and confidence measures would be related to the Cognitive Failures Questionnaire (CFQ). As can be seen from Table 4.3, this was only partially supported. Knowledge of cognition and Confidence in memory were both related to the Cognitive failures measure. However, the correlations between the Cognitive failures score and Regulation of cognition and Confidence in reasoning were non-significant.
4.1.6.2. Reasoning task accuracy, metacognition and confidence

T-tests were conducted to explore relationships between the metacognitive and confidence variables and reasoning task accuracy by comparing those who completed the tasks correctly with those who did not.

*Problem-solving accuracy*

There was little difference in accuracy between the two tasks; 33% of the participants correctly answered the non-verbal task and 36% of them produced the correct answer for the verbal task.

*Non-verbal reasoning tasks*

On the non-verbal task, the only significant difference between the participants who solved the task and those who did not was in their self-reported confidence in their reasoning skills ($t_{(112)} = -3.60, p = .01$). Participants who correctly answered the non-verbal task were more confident in their reasoning skills. The descriptive statistics are presented in the Table 4.4 below.
### Table 4.4

*Non-verbal accuracy, metacognition and confidence*

<table>
<thead>
<tr>
<th>Non-verbal accuracy</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Knowledge of cognition</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correct</td>
<td>44.34</td>
<td>8.88</td>
</tr>
<tr>
<td>Wrong</td>
<td>43.71</td>
<td>8.65</td>
</tr>
<tr>
<td><strong>Regulation of cognition</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correct</td>
<td>80.33</td>
<td>18.13</td>
</tr>
<tr>
<td>Wrong</td>
<td>80.71</td>
<td>18.06</td>
</tr>
<tr>
<td><strong>Confidence in memory</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correct</td>
<td>28.88</td>
<td>7.27</td>
</tr>
<tr>
<td>Wrong</td>
<td>28.02</td>
<td>7.82</td>
</tr>
<tr>
<td><strong>Confidence in reasoning</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correct</td>
<td>16.82</td>
<td>5.82</td>
</tr>
<tr>
<td>Wrong</td>
<td>21.45</td>
<td>6.41</td>
</tr>
</tbody>
</table>

*Verbal reasoning task*

On the verbal task (Table 4.5), there was a significant difference between the participants who solved the verbal task and those who did not in Knowledge of cognition ($t (108) = -2.54$, $p = .01$) and Regulation of cognition ($t (104) = -2.05, p = .05$). Furthermore, and in line with the previous analysis, those who solved the problem correctly were more confident in their reasoning skills ($t (112) = -4.28, p = .05$).
**Table 4.5**

*Verbal task accuracy, metacognition and confidence*

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge of cognition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correct</td>
<td>40.76</td>
<td>8.65</td>
</tr>
<tr>
<td>Wrong</td>
<td>45.23</td>
<td>8.40</td>
</tr>
<tr>
<td>Regulation of cognition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correct</td>
<td>75.28</td>
<td>17.73</td>
</tr>
<tr>
<td>Wrong</td>
<td>82.89</td>
<td>17.73</td>
</tr>
<tr>
<td>Confidence in memory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correct</td>
<td>28.86</td>
<td>8.40</td>
</tr>
<tr>
<td>Wrong</td>
<td>28.00</td>
<td>7.31</td>
</tr>
<tr>
<td>Confidence in reasoning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correct</td>
<td>16.35</td>
<td>6.51</td>
</tr>
<tr>
<td>Wrong</td>
<td>21.71</td>
<td>5.95</td>
</tr>
</tbody>
</table>

*Reasoning accuracy and pre-task planning*

The participants were also asked if they planned their answer. The results suggested that participants planned more on the non-verbal tasks (see Table 4.6). Chi-squared tests were conducted to explore if the amount the individual planned increased the chances of correctly solving the task. The results indicated that there was no difference on the verbal task $\chi^2 (2) = 0.83, p = .66$, whereas there was a significant difference in the non-verbal task $\chi^2 (2) = 9.87, p = .007, \phi_c = .29$, which represents a moderate effect. The direction of the results indicated that planning a solution was related to an increased likelihood of correctly answering the non-verbal task. However, planning seemed to make little difference to correctly answering the verbal task.
In summary, on the reasoning tasks, knowledge of cognition was associated with improved performance on the verbal task. Pre-task planning did not affect verbal accuracy, but it did increase the likelihood of accuracy on the non-verbal task. The participants confidence in their reasoning competence was related to accuracy in both domains.

4.1.6.3 Metacognition, confidence and workplace success

In this final section, correlations were conducted to investigate relationships between workplace success and the metacognitive factors of Knowledge of cognition and Regulation of cognition, the Confidence in memory and reasoning measures. There was evidence of a slight positive skew in the success criteria of Job satisfaction and Self-efficacy but this was within normal boundaries, so a Pearson’s correlation was conducted. However, there was evidence of skewness and kurtosis in the data from the Financial status variable, which did not improve with different transformations. Therefore, Spearman’s correlations were conducted for correlations with the Financial Status measure.

As can be seen from Table 4.7, there were medium strength positive associations between Knowledge/Regulation of cognition and the personal success measures of Job satisfaction and Self-efficacy. In addition, Financial status was related to Knowledge of cognition but not

Table 4.6

Table of descriptive statistics of task planning

<table>
<thead>
<tr>
<th>Did you plan?</th>
<th>Yes</th>
<th>Partly</th>
<th>No</th>
<th>Missing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonverbal planning</td>
<td>30%</td>
<td>38%</td>
<td>31%</td>
<td>1%</td>
</tr>
<tr>
<td>% of those correct</td>
<td>51%</td>
<td>23%</td>
<td>25%</td>
<td></td>
</tr>
<tr>
<td>% of those wrong</td>
<td>22%</td>
<td>44%</td>
<td>38%</td>
<td></td>
</tr>
<tr>
<td>Verbal planning</td>
<td>19%</td>
<td>39%</td>
<td>40%</td>
<td>1%</td>
</tr>
<tr>
<td>% of those correct</td>
<td>25%</td>
<td>36%</td>
<td>39%</td>
<td></td>
</tr>
<tr>
<td>% of those wrong</td>
<td>18%</td>
<td>40%</td>
<td>41%</td>
<td></td>
</tr>
</tbody>
</table>
Regulation of cognition. There was also an association between Academic qualifications and Confidence in reasoning but not Confidence in memory. The main consistent finding in the results was between the knowledge and reasoning metacognition components and the personal success measures. The lack of consistent correlations between the metacognition and confidence measures and the more societal workplace success measures was unexpected, as it differed from the literature but, arguably, they were more consistent with the findings in Study 1, in which the planning scale was not related the academic qualifications and financial status.

**Table 4.7**

*Correlation table of the metacognitive, confidence and the workplace success criteria*

<table>
<thead>
<tr>
<th></th>
<th>Job satisfaction</th>
<th>Self-efficacy</th>
<th>Academic qualifications</th>
<th>Financial status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge of cognition</td>
<td>.22*</td>
<td>.36**</td>
<td>.10</td>
<td>.25**</td>
</tr>
<tr>
<td>Regulation of cognition</td>
<td>.32**</td>
<td>.36*</td>
<td>.10</td>
<td>.10</td>
</tr>
<tr>
<td>Confidence in memory</td>
<td>.10</td>
<td>.08</td>
<td>.02</td>
<td>.02</td>
</tr>
<tr>
<td>Confidence in reasoning</td>
<td>.11</td>
<td>.15</td>
<td>.20*</td>
<td>.13</td>
</tr>
</tbody>
</table>

*p < .05  **p < .01
Performance in Verbal and Non-verbal problem-solving tasks and workplace success

The final part of this Study was to explore the individual’s performance in problem-solving (accuracy) and its relation to workplace success. For this, independent sample t-tests were performed on the non-verbal and verbal data separately to compare mean workplace success scores between those who correctly solved the task and those who did not (Table 4.8).

Table 4.8

Descriptive statistics for success measures on non-verbal task result

<table>
<thead>
<tr>
<th>Non-verbal accuracy</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Job satisfaction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correct</td>
<td>37.3</td>
<td>7.5</td>
</tr>
<tr>
<td>Wrong</td>
<td>36.0</td>
<td>8.6</td>
</tr>
<tr>
<td>Self-efficacy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correct</td>
<td>60.5</td>
<td>12.9</td>
</tr>
<tr>
<td>Wrong</td>
<td>61.7</td>
<td>10.6</td>
</tr>
<tr>
<td>Academic qualifications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correct</td>
<td>6.7</td>
<td>1.1</td>
</tr>
<tr>
<td>Wrong</td>
<td>6.4</td>
<td>1.1</td>
</tr>
<tr>
<td>Mean rank</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correct</td>
<td>55.6</td>
<td></td>
</tr>
<tr>
<td>Wrong</td>
<td>56.9</td>
<td></td>
</tr>
</tbody>
</table>

Non-verbal accuracy and workplace success

It can be seen from Table 4.8 in relation to non-verbal accuracy, there was very little difference in the mean of the workplace success measures, particularly for the personal success criteria: JS, \( t(102) = -0.96, p = .39 \) and SE, \( t(106) = -.34, p = .73 \). As mentioned previously the data was recoded so that higher scores on all these scales indicated better workplace success. However, there was a significant difference in the mean scores for Academic qualifications \( t(109) = -2.47, p = .015 \), suggesting that those with more academic
Qualifications did better on the nonverbal task. A Mann-Whitney U test conducted on Financial status did not find a significant mean difference, $U=1224.5$, $z=-.21$, $p=.831$.

Verbal accuracy and workplace success

When comparing the mean scores of the workplace success criteria for the groups who solved the verbal task correctly or incorrectly (Table 4.9), no significant differences between groups were found for Job satisfaction ($t(102)=-0.32$, $p=.75$), Self-efficacy ($t(106)=1.26$, $p=.21$), or Academic qualifications ($t(109)=-0.34$, $p=.73$). However, the Mann-Whitney U test conducted on Financial status, revealed a significant difference with a medium strength effect size ($n=112$, $U=837.5$, $z=-3.27$, $p=.001$, $r=.31$). This suggests that those who were adept at solving the verbal tasks were more financially successful.

Table 4.9

<table>
<thead>
<tr>
<th>Descriptive statistics for success measures on verbal task results</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Verbal accuracy</strong></td>
</tr>
<tr>
<td>--------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Job satisfaction</strong></td>
</tr>
<tr>
<td>Correct</td>
</tr>
<tr>
<td>Wrong</td>
</tr>
<tr>
<td><strong>Self-efficacy</strong></td>
</tr>
<tr>
<td>Correct</td>
</tr>
<tr>
<td>Wrong</td>
</tr>
<tr>
<td><strong>Academic qualifications</strong></td>
</tr>
<tr>
<td>Correct</td>
</tr>
<tr>
<td>Wrong</td>
</tr>
<tr>
<td><strong>Financial status</strong></td>
</tr>
<tr>
<td>Correct</td>
</tr>
<tr>
<td>Wrong</td>
</tr>
<tr>
<td><strong>Mean rank</strong></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
4.1.7 Summary

The results produced the expected relationships between participants’ knowledge of cognition and confidence in their memory and reasoning skills. However, regulation of cognition was related only to their confidence in reasoning, which partially supports the association between confidence and regulation aspects of metacognition. Likewise, in relation to the Cognitive Failures Questionnaire, increased knowledge of cognition and confidence in memory were associated with less cognitive failure. This suggests that greater self-understanding and knowledge of strategies might mitigate memory failure and lapses of attention. However, there were no significant relationships between cognitive failures and regulation of cognition. The lack of relationships with regulation of cognition were unexpected, as planning and monitoring skills, which are components of regulation of cognition, have been suggested as linked with increased confidence (Kleitman & Stankov, 2007) and monitoring skills should mitigate lapses of attention.

On actual reasoning task performance, greater metacognitive skill in both knowledge and regulation was related to improved accuracy on the verbal task only. This may be in line with research advocating that metacognitive skills are a compensatory strategy for dyslexic people (Swanson, 2012; Reis et al., 2000) and so would influence skills in which dyslexics show weaknesses (although this speculation requires further support). Higher confidence in reasoning competence was related to accuracy on both tasks, which is in line with much of the literature (Stankov, 2012).

Metacognitive measures were also related to some aspects of workplace success. Both Knowledge and Regulation of cognition were associated with increased job satisfaction and self-efficacy. This relationship is well documented (Bandura, 1986; Lunenberg, 2011; Munby et al., 2003); better planning and monitoring skills may enhance people’s feelings of being in control (Gerber, 2012), and reflection may enable people to attribute good performance to their own actions. The findings from this analysis are consistent with those of Study 1 in terms of stronger relationships in the personal success criteria.

The findings on the reasoning tasks and workplace success suggested that non-verbal task accuracy was related to Academic qualifications, and verbal accuracy was related to financial
success. These isolated findings need very cautious interpretation, given the number of analyses performed and the inconsistency with other measures of societal workplace success. Further consideration of these findings was, therefore, left until after Part 2 of the current analyses.
4.2 PART 2: Comparisons of dyslexics and non-dyslexics

In this second part of Study 2, the same tasks given to the dyslexic participants were administered to a group of non-dyslexic individuals (n=29). These data were then compared with the data gathered from the dyslexic participants (n=116) to discover differences between the groups in terms of relationships between Knowledge/Regulation of cognition, confidence in memory/reasoning, cognitive failures, reasoning task performance, and the personal and societal workplace success criteria.

4.2.1. Hypotheses

*Metacognition, confidence and cognitive failure*

Recent studies (Bergey et al., 2017; Chevalier et al., 2017) have found that dyslexic students utilise fewer metacognitive and study strategies than their non-dyslexic peers. Therefore, metacognitive skill is likely to be diminished in dyslexic adults compared to a non-dyslexic group.

*Hypothesis 1a*  Metacognitive skills would be better in the non-dyslexic group compared to the dyslexics.

Dyslexic people are known to lack confidence in their memory (De Beer et al., 2014) but there is no evidence to suggest that they doubt their reasoning skills ability (Eide & Eide, 2011; West, 2010).

*Hypothesis 1b*  Non-dyslexics would have more confidence than the dyslexic group on Confidence in memory, but similar levels in Confidence in reasoning.

In Part 1 of this Study, better Knowledge of cognition related to fewer cognitive failures and increased confidence in memory. The current data were used to investigate if the same relationships would be evident in a group of non-dyslexics.

*Hypothesis 1c*  There would be larger relationships between both metacognitive variables and the cognitive failures measure in the non-dyslexic group than in the dyslexic group.
Reasoning tasks

Differences in processing verbal and non-verbal reasoning tasks have been found between non-dyslexic and dyslexic participants, the latter using more visual spatial strategies in comparison with non-dyslexics using more verbal strategies (Bacon & Handley, 2010, 2014). Furthermore, dyslexic strengths in terms of the utilisation of non-verbal reasoning has been advocated (West, 2010), potentially influencing reasoning task accuracy. The findings from Part 1 showed that those dyslexic participants who planned (pre-task planning) achieved greater accuracy on the non-verbal task. This relationship was not present for the verbal task. Therefore, group differences were anticipated in pre-task planning and its effect on reasoning task performance for both dyslexics and controls.

Hypothesis 2a There would be differences in accuracy and planning between the groups on the verbal and non-verbal tasks.

Workplace success

As mentioned previously, metacognitive skill is widely recognised as improving performance. The lack of associations with the societal success criteria of Academic qualifications and Financial success in Part 1 may be attributed to poor development of metacognitive skills as a result of being dyslexic (Butler & Schnellert, 2015; Trainin & Swanson, 2005). Much of the previous research was conducted on general (non-selective) population samples (Borkowski et al., 1996; Kleitman & Stankov, 2007; Sternberg, 2005; Zimmerman, 2002), so the aim of this analysis was to compare the data of the two groups to test this assumption and to determine if the influence of metacognitive skills varies between the groups.

Hypothesis 3a The relationship between knowledge and regulation of cognition and workplace success criteria would differ between the dyslexic and non-dyslexic group. The metacognitive measures would be related to all the success criteria; personal (Job satisfaction and Self-efficacy) and societal success (Academic qualifications and Financial status) in the control group, whereas they were related to personal success criteria only in the dyslexic group (as identified in Part 1).
Furthermore, the findings in Part 1 were only partly consistent with research that confidence is a positive predictor of workplace success in the general population (see Chapter 2, page 52). Nevertheless, only Confidence in reasoning was related to Academic qualifications in the dyslexic group. No other relationships were evident between confidence and success measures. It was of interest to determine if these results were dyslexia-specific.

Hypothesis 3b Confidence in memory and Confidence in reasoning relate to personal and societal workplace success criteria in the non-dyslexic group, whereas only Confidence in reasoning relates to Academic qualifications in the dyslexic group (identified in Part 1). Comparisons were made between task performance of the non-dyslexic group and the dyslexic cohort in relation to reasoning and workplace success.

**Hypothesis 3c** The relationships between verbal and non-verbal accuracy and workplace success for the non-dyslexics and dyslexics would differ.

### 4.2.3 Method

The non-dyslexic sample who participated in Study 2 was the same as described in Study 1, with the exception that one of the 30 participants did not fully complete the Study 2 questionnaire (see Study 1, page 85, for a description of the sampling procedures for the current non-dyslexic sample).

**Participants**

A total of 29 non-dyslexic people completed the Study 2 questionnaire. In this control group, there were 16 male and 13 female participants (Mean age = 34.9 years, SD = 10.2). They were compared to the 116 dyslexic participants in Part 1 of this present Study (Mean age = 35.7 years, SD = 9.5 years). A full description of the dyslexic sample can be found on page 122. The demographic details of both groups, including age and occupation comparisons, can be found in Table 4.10.
Table 4.10

Demographic descriptives of the control and dyslexic participants

<table>
<thead>
<tr>
<th>Age in years</th>
<th>18-24</th>
<th>25-34</th>
<th>35-44</th>
<th>45-54</th>
<th>55-65</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controls</td>
<td>3%</td>
<td>43%</td>
<td>17%</td>
<td>30%</td>
<td>7%</td>
</tr>
<tr>
<td>Dyslexics</td>
<td>4%</td>
<td>34%</td>
<td>28%</td>
<td>27%</td>
<td>7%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Job classification</th>
<th>Emergency services</th>
<th>Administration</th>
<th>Management</th>
<th>Health and education</th>
<th>Sciences/Arts/</th>
<th>Professional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controls</td>
<td>26%</td>
<td>37%</td>
<td>17%</td>
<td>7%</td>
<td>13%</td>
<td></td>
</tr>
<tr>
<td>Dyslexics</td>
<td>28%</td>
<td>30%</td>
<td>14%</td>
<td>7%</td>
<td>11%</td>
<td></td>
</tr>
</tbody>
</table>

Procedure and questionnaire measures

The procedures and questionnaire measures were the same as outlined in Part 1 of this Study (see page 106 of this Chapter).

4.2.4 Results

The main purposes of the data analysis were to establish if there were differences between the groups in metacognitive skill on the Metacognitive Awareness Inventory, and in Confidence in memory and reasoning on the Memory and Reasoning Competence Inventory, and to explore the links between these two scales and the Cognitive Failures Questionnaire and reasoning task performance. It also aimed to determine if there was any evidence for such relationships to vary across dyslexic and non-dyslexic people in relation to workplace success.

As previously, prior to the analyses, the data were checked for missing values and tests of normality were conducted on all measures. Some of the variables (Academic qualifications, Regulation of cognition, Cognitive failures) were non-parametric, so Mann-Whitney U tests were conducted on these data. Spearman’s correlations and Analysis of variance (ANOVAS), as well as log linear analyses, were conducted to explore the associations.
between variables across the two groups. Fisher’s $r$ to $z$ transformations were also conducted on the correlations for comparison across the groups. A summary of the descriptive statistics for the dyslexics and the controls is presented in Table 4.11. Statistical comparisons between the groups for each measure are also displayed.

**Workplace success**

Consistent with Study 1, there were no significant differences between the groups on the workplace success criteria. In the societal domain, the two groups seem to have gained roughly equivalent academic qualifications and financial status, which might be expected, given that the samples were matched for age and occupation. Likewise, in terms of the personal success measures, the two groups showed similar levels of Job satisfaction and Self-efficacy. These results are consistent with Study 1 and are discussed in more detail in that Chapter (page 91).
### Table 4.11
Descriptives and Tests of Difference between Dyslexics and Controls

<table>
<thead>
<tr>
<th></th>
<th>Controls</th>
<th>Dyslexics</th>
<th>Parametric variables</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( M )</td>
<td>( SD )</td>
<td>( M )</td>
<td>( SD )</td>
<td>Control</td>
<td>Dys</td>
</tr>
<tr>
<td>Knowledge of cognition</td>
<td>64.8</td>
<td>6.9</td>
<td>60.9</td>
<td>8.3</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Regulation of cognition</td>
<td>121.2</td>
<td>15.6</td>
<td>119.8</td>
<td>17.9</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Confidence in memory</td>
<td>25.4</td>
<td>4.7</td>
<td>19.7</td>
<td>7.6</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Confidence in reasoning</td>
<td>30.2</td>
<td>4.5</td>
<td>27.9</td>
<td>6.6</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Cognitive failures</td>
<td>88.3</td>
<td>13.0</td>
<td>65.0</td>
<td>16.8</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Self-efficacy</td>
<td>63.8</td>
<td>9.6</td>
<td>61.7</td>
<td>11.0</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Job satisfaction</td>
<td>38.3</td>
<td>6.6</td>
<td>36.6</td>
<td>8.3</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Financial status</td>
<td>3.7</td>
<td>1.4</td>
<td>3.7</td>
<td>1.4</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Academic qualification</td>
<td>6.6</td>
<td>1.0</td>
<td>6.5</td>
<td>1.1</td>
<td>N</td>
<td>Y</td>
</tr>
</tbody>
</table>

* \( u \) = \( p \)-value from Mann Whitney U test

In Table 4.11, \( p \)-values have been reported and the effect size \( r \) (rather than Cohen’s \( d \)) has been calculated for both \( t \)-tests and Mann-Whitney \( U \)-tests for ease of comparison (Field, 2005).

4.2.4.1 Metacognition and Confidence

As shown in Table 4.11, there were significant differences between the groups in the scores on the Knowledge of cognition subscale, with the control group showing higher levels of self-reported knowledge about their own cognitions (as outlined on page 105, all the variables were recoded to indicate that a higher score indicated better performance).

However, the results for the Regulation of cognition measure were not consistent with this
interpretation, the scores of the two groups being nearly identical. Therefore, there was only partial support for Hypothesis 1a that metacognitive skills of dyslexic and non-dyslexic people differ.

Similarly, there was a significant difference between the groups on the Confidence in memory measure, but not for the Confidence in reasoning measure. These findings support Hypothesis 1b that dyslexic and non-dyslexic people differ in their levels of confidence about their memory but not their reasoning.

Correlations between the metacognitive and confidence measures were then conducted and compared, see Table 4.12. Correlations between the two metacognitive variables (Knowledge and Regulation of cognitions) were similar across the two groups (fairly large, \( r > .6 \), and significant). Similarly, correlations between the two confidence measures were roughly the same across the two groups, and for both were small (around \( r = .1 \)) and non-significant. However, relationships between the confidence in memory measure and Knowledge and Regulation of cognitions varied across the two groups. For the dyslexic group, Knowledge of cognition was related to Confidence in memory, but this association was not evident in the control group. For the dyslexic group, confidence in memory was not associated with Regulation of cognition, but these variables were negatively related for the control group. Knowledge of cognition was significantly related to Confidence in reasoning in the dyslexic group, and there was a similar (slightly larger, albeit non-significant due to a smaller sample size) relationship in the control group. Overall, this pattern of correlations suggests that there were not the general positive relationships between metacognition and confidence anticipated based on previous research in either group, and therefore the findings reported in Part 1 on the dyslexic data are not necessarily dyslexia-specific.
Table 4.12

Correlations between the metacognitive and confidence measures

<table>
<thead>
<tr>
<th></th>
<th>Knowledge of cognition</th>
<th>Regulation of cognition</th>
<th>Confidence in memory</th>
<th>Confidence in reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulation of cognition</td>
<td>Dys .63**</td>
<td>Con .59**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confidence in memory</td>
<td>Dys .37**</td>
<td>Con .08</td>
<td>.12 -.42**</td>
<td></td>
</tr>
<tr>
<td>Confidence in reasoning</td>
<td>Dys .25*</td>
<td>Con .21*</td>
<td>.09</td>
<td></td>
</tr>
<tr>
<td>Cognitive failures</td>
<td>Dys .39**</td>
<td>Con .25</td>
<td>.13 .24*</td>
<td>.14</td>
</tr>
</tbody>
</table>

P = < .05*       P = < .01 **

Metacognition and confidence and the Cognitive Failures Questionnaire

Confirming the findings from Study 1, there were significant differences between the groups on the Cognitive Failures Questionnaire: the controls reporting significantly fewer cognitive failures than the dyslexics. There were group differences on Knowledge of cognition, the dyslexics being weaker, but there were associations in both groups (of medium strength in the dyslexic group) between the Cognitive Failures Questionnaire and Knowledge of cognition, the direction suggesting better self-knowledge leading to fewer cognitive failures. There were the anticipated relationships between confidence in memory and the cognitive failures measure, the direction of results indicating that less failure was related to greater confidence. However, Regulation of cognition was not related to cognitive failures in either group. Again, this was unexpected, given that planning and monitoring components of Regulation of cognition could arguably minimise cognitive failures. There were significant correlations between the confidence in memory measure and cognitive failures across the two groups; though the correlations between confidence in reasoning and cognitive failures were non-
significant correlations for both groups. The lack of consistent differences between the groups in terms of the relationships between metacognition and confidence measures and cognitive failures suggests that explanations of group differences found on the Cognitive Failures Questionnaire will need to look further than overall metacognitive interpretations; the findings are not consistent with dyslexics having a general weakness in metacognitive processes, specifically the cognitive regulatory processes that leads to failures in cognition.

4.2.4.2 Metacognition and Reasoning task accuracy

It was anticipated that the non-dyslexic group would show larger associations between metacognitive and confidence variables and reasoning task accuracy than the dyslexic group; however, as suggested below, there was insufficient evidence to confirm this.

Pre-task planning, Verbal and non-verbal reasoning and accuracy

It was predicted that controls would be more accurate than dyslexics in the verbal task, and that dyslexics would be better than controls in the non-verbal task. To test this hypothesis, log-linear analyses were performed. The findings partially support the hypothesis; the controls were more accurate than the dyslexics on the verbal task, but there was no evidence of the predicted corresponding greater non-verbal accuracy in the dyslexic group. Given the differences in performance for the verbal tasks, the following analyses considered the two tasks separately.

A three-way log linear analysis was carried out to investigate the relationship between Group (dyslexics vs. controls), Accuracy (correct vs incorrect) and Planning (yes, partly, no) on the non-verbal task results. From the saturated model, K-way results showed that there was no significant three-way interaction ($p = .97$). However, the two-way interactions indicated a significant result ($p = .013$) and partial associations effects showed only the two-way interaction between accuracy and planning was significant ($p = .002$). This suggests that those who planned the solution were more likely to get it correct, those who partly planned or did not plan the solution were more likely to get it wrong. However, given that the three-way interaction was not significant, there was no reliable evidence for the relationship between planning and accuracy to differ across the two groups of participants.
To investigate relationships between the groups in pre-task planning and verbal task accuracy, a three-way log-linear analysis was also carried out. The results of the K-way effects showed a non-significant three-way interaction ($p = .89$). However, the two-way interactions on their own were significant ($p = .019$). Partial associations effects indicated a significant two-way interaction between accuracy and groups ($p = .037$). This interaction between accuracy and groups indicated that more controls than dyslexics performed the verbal task correctly: 55% of controls compared to 31% of dyslexics. There was also an association for the two-way interaction between groups and planning ($p = .066$), whilst it is not significant, it does suggest a marginal effect i.e. that more controls than dyslexics planned their answer to the verbal task; however, further research will be needed to confirm this partial effect.

In summary, the findings for the verbal task suggest some evidence for the non-dyslexic group to plan more and to be more accurate than the dyslexics. However, there was no evidence of differences between the two groups on the non-verbal task. However, planning did not influence the accuracy levels more in one group compared to the other (no three-way interactions for the verbal and non-verbal task). There was no evidence for overall planning problems for the dyslexics: notably there was an interaction between planning and accuracy in the non-verbal task, suggesting that those participants who planned were also more accurate independent of whether they were dyslexic or not.

4.2.4.3 Workplace success, metacognition, and task reasoning

In Part 1 of this Study, metacognitive skill was related to both personal workplace success criteria (Job satisfaction and self-efficacy), but not to the societal criteria. Comparisons between the groups in terms of these relationships were performed to determine if such relationships were dyslexia-specific.

**Metacognition and workplace success**

Spearman’s correlations were conducted to investigate the relationships between the success measures and the metacognitive sub-scales of Knowledge of cognition and Regulation of cognition (Table 4.13). Fisher’s r to z transformations were conducted to determine any significant differences between the groups on these measures of relationships.
Overall, the non-dyslexic group showed similar associations to those found with the dyslexic participants between the metacognitive variables and the personal success criteria, contrary to the Hypothesis 3a. As in the dyslexics’ data, significant associations were found with the personal workplace success criteria but not the societal success criteria. The only significant difference between the groups in terms of the size of relationships was when the Financial status measure was correlated with the Knowledge of cognition measure ($p = .046$).

However, this is only one effect in 20 comparisons presented in Table 4.13, and so should be interpreted with caution. Overall, there was no evidence of differences between the groups in terms of these relationships with the workplace success criteria.

Confidence and workplace success

As shown in Table 4.13 (and contrary to Hypothesis 3b), there were no associations between the Confidence in reasoning and the Confidence in memory variables and the workplace success criteria. Again, there was no evidence of differences between the groups in terms of these relationships with the workplace success criteria.

**Table 4.13**

_Correlation table with r to z transformations of the workplace success criteria and the metacognitive and confidence variables_

<table>
<thead>
<tr>
<th></th>
<th>Job Satisfaction (a)</th>
<th>Self Efficacy (a)</th>
<th>Academic Qualifications (a)</th>
<th>Financial status</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dys Con p</td>
<td>Dys Con p</td>
<td>Dys Con p</td>
<td>Dys Con p</td>
</tr>
<tr>
<td>Kof C</td>
<td>.22* .30 .70 .36** .41** .79 .10 .10 .92</td>
<td>.25** -.18 .05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rof C</td>
<td>.32* .23 .65 .36** .43** .72 .10 .17 .75 .10 -.13 .38</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CiM</td>
<td>.10 .11 .96 .08 .03 .83 .02 -.10 .56 .02 -.11 .46</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CiR</td>
<td>.11 .07 .85 .15 .12 .98 .20 .31 .36 .13 -.11 .29</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*) $p < .05$  * *) $p < .01$

SE = Self-efficacy; JS = Job satisfaction; FS = Financial status; AQ = Academic qualifications; Kof C = Knowledge of cognition; R of C = Regulation of cognition; CiM = Confidence in Memory; CiR = Confidence in reasoning.
**Reasoning task performance and workplace success**

**Non-verbal accuracy and workplace success**

As can be seen from Table 4.14, comparisons for the non-verbal task indicated very little difference between the groups in the means/medians of the workplace success criteria (the medians of Self-efficacy, Financial status and Academic qualifications have been reported here for ease of comparison as some of the control data variables were non-parametric). This conclusion was based on the results of Mann-Whitney U tests to avoid violations of the assumptions of parametric analyses.

**Table 4.14**

*Descriptives of the workplace success criteria for the non-verbal task*

<table>
<thead>
<tr>
<th></th>
<th>Dyslexics</th>
<th>Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M/Mdn</td>
<td>SD/IQR</td>
</tr>
<tr>
<td><strong>Non-verbal Accuracy</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correct</td>
<td>37.3</td>
<td>7.5</td>
</tr>
<tr>
<td>Wrong</td>
<td>36.0</td>
<td>8.60</td>
</tr>
<tr>
<td>SE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correct</td>
<td>61.0(^{\text{mdn}})</td>
<td>22.0(^{\text{iqr}})</td>
</tr>
<tr>
<td>Wrong</td>
<td>62.0(^{\text{mdn}})</td>
<td>11.7(^{\text{iqr}})</td>
</tr>
<tr>
<td>AQ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correct</td>
<td>7.0(^{\text{mdn}})</td>
<td>2.0(^{\text{iqr}})</td>
</tr>
<tr>
<td>Wrong</td>
<td>6.0(^{\text{mdn}})</td>
<td>1.0(^{\text{iqr}})</td>
</tr>
<tr>
<td>FS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correct</td>
<td>4.0(^{\text{mdn}})</td>
<td>8.0(^{\text{iqr}})</td>
</tr>
<tr>
<td>Wrong</td>
<td>4.0(^{\text{mdn}})</td>
<td>1.0(^{\text{iqr}})</td>
</tr>
</tbody>
</table>

\(M = \text{Mean}\) \quad SD = \text{Standard Deviation}\quad \text{Mdn} = \text{Median}\quad \text{iqr} = \text{Inter Quartile Range}
Verbal accuracy and workplace success

The mean/median differences between the two groups in the verbal task are displayed in Table 4.15. Again, Job satisfaction was the only parametric variable. Therefore, medians have been reported for Self-efficacy, Financial status and Academic qualifications.

When Self-efficacy was the dependent variable, the non-dyslexics who answered correctly on the verbal task had higher levels of job self-efficacy than dyslexics who answered correctly (U = 148.0,  z = - 2.48, p = .013). In contrast, the dyslexics who answered incorrectly felt more self-efficacy than the controls who answered incorrectly (U= 286.5, z= - 2.37, p = .02).

When Financial status was the dependent variable, those dyslexics who answered the verbal task correctly were more financially successful than the non-dyslexics who answered correctly (U =168, z = - 2.28, p = .02). In contrast, those dyslexics answering incorrectly earned less than the controls answering incorrectly (U = 294, z = - 2.57, p = .01).

Finally, the non-dyslexic participants who answered the verbal tasks correctly felt greater job satisfaction than dyslexics who answered correctly (t (46) = 1.95, p = .05).
Table 4.15

Descriptives of the workplace success criteria for the verbal task

<table>
<thead>
<tr>
<th></th>
<th>Dyslexics</th>
<th></th>
<th>Controls</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M/Mdn</td>
<td>SD/IQR</td>
<td>M/Mdn</td>
<td>SD/IQR</td>
</tr>
<tr>
<td>Verbal Accuracy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JS Correct</td>
<td>35.0</td>
<td>8.8</td>
<td>41.6</td>
<td>3.6</td>
</tr>
<tr>
<td>JS Wrong</td>
<td>36.8</td>
<td>8.0</td>
<td>33.7</td>
<td>7.4</td>
</tr>
<tr>
<td>SE Correct</td>
<td>61.0&lt;sup&gt;mdn&lt;/sup&gt;</td>
<td>16.7&lt;sup&gt;iqr&lt;/sup&gt;</td>
<td>69.0&lt;sup&gt;mdn&lt;/sup&gt;</td>
<td>8.0&lt;sup&gt;iqr&lt;/sup&gt;</td>
</tr>
<tr>
<td>SE Wrong</td>
<td>62.0&lt;sup&gt;mdn&lt;/sup&gt;</td>
<td>13.0&lt;sup&gt;iqr&lt;/sup&gt;</td>
<td>58.0&lt;sup&gt;mdn&lt;/sup&gt;</td>
<td>4.5&lt;sup&gt;iqr&lt;/sup&gt;</td>
</tr>
<tr>
<td>AQ Correct</td>
<td>7.0&lt;sup&gt;mdn&lt;/sup&gt;</td>
<td>1.7&lt;sup&gt;iqr&lt;/sup&gt;</td>
<td>7.0&lt;sup&gt;mdn&lt;/sup&gt;</td>
<td>1.0&lt;sup&gt;iqr&lt;/sup&gt;</td>
</tr>
<tr>
<td>AQ Wrong</td>
<td>7.0&lt;sup&gt;mdn&lt;/sup&gt;</td>
<td>1.0&lt;sup&gt;iqr&lt;/sup&gt;</td>
<td>7.0&lt;sup&gt;mdn&lt;/sup&gt;</td>
<td>1.5&lt;sup&gt;iqr&lt;/sup&gt;</td>
</tr>
<tr>
<td>FS Correct</td>
<td>4.0&lt;sup&gt;mdn&lt;/sup&gt;</td>
<td>1.0&lt;sup&gt;iqr&lt;/sup&gt;</td>
<td>3.0&lt;sup&gt;mdn&lt;/sup&gt;</td>
<td>2.0&lt;sup&gt;iqr&lt;/sup&gt;</td>
</tr>
<tr>
<td>FS Wrong</td>
<td>4.0&lt;sup&gt;mdn&lt;/sup&gt;</td>
<td>1.0&lt;sup&gt;iqr&lt;/sup&gt;</td>
<td>4.0&lt;sup&gt;mdn&lt;/sup&gt;</td>
<td>1.0&lt;sup&gt;iqr&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

M = Mean    SD = Standard Deviation    Mdn = Median    iqr = Inter Quartile Range

Again, to avoid violations of the assumptions of parametric tests, Mann-Whitney U tests were performed.

It should be noted that if Bonferroni corrections were applied to avoid Type 1 errors, the corrected significance level would be p = .0125 and only one of the above effects would remain significant (i.e., dyslexics answering incorrectly earning less than the controls answering incorrectly). Therefore, again, caution needs to be involved in the interpretation of these potential effects and further research would be advisable before firm conclusions are established.

Summary

Overall, in this second Part of Study 2, there were differences between the groups on metacognitive skill, but only in relation to knowledge of cognition. There was no difference
between the groups on Regulation of cognition. In both groups, metacognitive skill did relate to personal workplace success, with both knowledge and regulation of cognition being positively associated with job satisfaction and self-efficacy. However, there was little evidence for relationships between the societal criteria and metacognition for either group; and there was little evidence for levels of confidence to be linked to workplace success criteria. Finally, the controls performed the verbal reasoning task more accurately than the dyslexics, but the two groups appeared to be as accurate as each other on the non-verbal task. However, any differences between the two groups in problem-solving ability did not seem to be consistently associated with the workplace success criteria.

4.2.5 General discussion

Good metacognitive skills are widely associated with improved performance, and it was an underlying premise of this research that such skills contribute to the workplace success of dyslexic people (Gerber, 2012). Metacognitive skills develop over time (Kuhn, 2000; Veenman et al., 2004) and, as has been mentioned previously, these skills may not develop automatically in dyslexic children because of competing learning demands in the education system (Butler & Schnellert, 2015; Meltzer, 2007), or they may not be utilised effectively by dyslexic students (Bergey et al., 2017; Chevalier et al., 2017). Therefore, the focus of this Study has been to explore two generally recognised components of metacognition: Knowledge of cognition and Regulation of cognition (Flavell, 1976; Schraw & Dennison, 1994) and two measures of confidence, specifically in memory and reasoning competency (Kleitman & Stankov, 2007), to determine any differences between dyslexic and non-dyslexic participants in these areas and their relationship to workplace success. Metacognitive skill did contribute differentially to the success criteria and this is discussed below. However, concerning the confidence measures, no difference was found between the groups in relation to the workplace success criteria. This was unexpected, as self-confidence is seen as a predictor of success (Stankov, 2012).

Levels of metacognitive skill did differ between the two groups, but only in relation to Knowledge of cognition, consistent with the research of Bergey et al. (2017). It suggests that, compared to their non-dyslexic peers, the dyslexic group may have had a poorer understanding of their cognitive processing, were less aware of their task analysis skills and
less cognisant of the utilisation of strategies. However, the two groups did not differ on the Regulation of cognition measure. This component involves planning, monitoring, management of information and reflection strategies, which were expected to be areas of weakness among dyslexics. These findings, and those in Study 1, suggest that planning skills may not be areas of weakness for dyslexic people. Alternatively, this group of comparably successful dyslexic people may have developed their planning skills to a competent level because of their experience in the workplace. It has been argued that workplace learning is different from academic/educational learning (Schultz & Roßnagel, 2010). It may be that the implicit structures and routines of the workplace potentially enable people to develop metacognitive processing (Munby et al., 2003) and planning skills might develop through the systemised routines of the workplace, such as feedback meetings and appraisals (Munby et al., 2003). However, this is speculative, nor does it explain why dyslexic people do not improve their self-understanding/Knowledge of cognition at the same time. Further research is needed to inform our understanding of the development of metacognitive skill in the workplace.

For both groups, Knowledge and Regulation of cognition were related to personal workplace success; i.e., measures of Job satisfaction and Self-efficacy. Self-knowledge leads to greater cognitive flexibility and improved performance (Sternberg, 2005; Zimmerman, 2002), and cognitive flexibility leads to good decision-making (Batha & Carroll, 2007; Cook & Klumper, 1999). This is likely to lead to improved self-efficacy (Bandura, 1997; Bandura & Locke, 2003; Sternberg, 2005) and job satisfaction (Judge & Bono, 2001; Lunenburg, 2011).

The dyslexic group had significantly less confidence in their memory skills that the non-dyslexic group. However, increased Knowledge of cognition in the dyslexic group was related to confidence in memory, as well as confidence in reasoning. Participants who had a better level of self-understanding and/or self-awareness of their thinking skills potentially had more strategies to deploy effectively leading to greater confidence in their memory skills (Stankov & Kleitman, 2014). Knowledge of cognition was also related to confidence in reasoning, potentially because the declarative, procedural and conditional knowledge elements of the knowledge of cognition variable are closely affiliated with memory and reasoning, and can be mediated by strategies (Markovitz, 2010; Sternberg, 2004). Likewise, those with better self-knowledge experienced fewer cognitive failures. It is widely postulated (Moran & Gardner, 2007; McLoughlin et al., 1994; Meltzer, 2007; Swanson, 2012) that good
strategy use (a metacognitive process) can ameliorate memory problems. However, further research is required to determine if these interpretations are accurate: that knowledge of cognition can account for fewer cognitive failures, through greater strategy use; and that this leads to increased confidence in memory and less cognitive failure.

Another possible explanation of the link in the dyslexic group between the Cognitive Failures Questionnaire and confidence in memory is that it adds support to the prediction that the more memory lapses a person experiences, the less confident they would be in their memory skills and this would be reflected in a self-report scale. It is argued that the Cognitive Failures Questionnaire may reflect an individual’s confidence in their memory (Wilhelm et al., 2010), rather than measuring cognitive lapses. However, this scale has been validated using “an others cognitive failures scale”, where husbands, wives and partners confirmed the original participants’ responses (Broadbent et al., 1982; Smith-Spark et al., 2004, 2016). Moreover, similar problems, such as “remembering names and places”, are commonly reported difficulties (Bartlett & Moody, 2010) for dyslexic people. Therefore, further research will be necessary to clarify this.

The lack of relationships between the Cognitive Failures Questionnaire and the Regulation of cognition measure was surprising, particularly given the relationship in the first Study between planning and the Cognitive Failures Questionnaire; however, one possible reason may be that the regulation of cognition is made up of several components: planning, but also monitoring, debugging information management and reflection. (Schraw & Dennison, 1994). Therefore, further research is needed to see what other factors might account for the dyslexics’ increased cognitive failure despite similar levels of self-regulatory processes as the non-dyslexics. In addition, further research might also provide insight into the specific aspects of regulation of cognition and their differential impact on memory performance.

Differences between the groups on the verbal and non-verbal reasoning tasks were anticipated, based on the literature, and there were two areas of significant difference. Firstly, Reasoning task accuracy was improved by pre-task planning in both groups, but the non-dyslexic group planned more and were more accurate than the dyslexic group. This raises the question as to why the dyslexic group did not plan on the verbal task. There are several possible explanations: it might a result of weaker verbal processing in general, it
could be that the dyslexic participants were focusing more on reading and therefore experienced greater demands on their working memory (Bacon, 2014). Further research is needed to inform our understanding of these differences in planning. Secondly, Knowledge of cognition was linked to accuracy on the verbal task but not the non-verbal task in the dyslexic group. One possible explanation for this is if dyslexia affects verbal processing, then having cognitive strategies to support the reasoning process may improve performance. (Bacon, 2010). Future research with a larger and perhaps more diverse range of reasoning tests and comparable sample sizes would provide more substantial findings.

In conclusion, this Study identified the potential for there to be some differences in the metacognitive processing skills between dyslexic and non-dyslexic participants, particularly in terms of self-understanding, of knowledge of their skills, task analysis and strategies. However, these differences are not uniform across the measures included in the Study, and they do not explain variations in the levels of workplace success measured in the research nor differences in cognitive failures. Study 3 (Chapter 5), therefore, shifted the focus from investigations of metacognitive processing to assessments of executive functioning to inform explanations of workplace success specific to dyslexic adults.
Chapter 5: Study 3

Executive function, dyslexia and workplace success

5.1 Introduction

The main aim of this Thesis is to establish if metacognitive and executive functioning skills differ between dyslexic and non-dyslexic people and to determine if these differences affect workplace success. Studies 1 and 2 indicated that differences existed between groups in elements of cognitive functioning and that some of them were related to success.

Study 1 established that both groups had achieved similar levels of success and, demonstrated the same levels of planning skills. However, consistent with previous research, the dyslexic participants experienced more cognitive failures than the control group (Smith-Spark et al., 2004). Evidence from Study 1 also showed that those dyslexics who self-reported fewer cognitive failures, but who possessed superior planning skills, achieved greater personal workplace success. This correlation was less pronounced in the non-dyslexic group.

In Study 2, differences were found between the groups on metacognitive skill, but only that of knowledge of cognition; levels of regulation of cognition with its encompassing measure of planning skill were similar in both groups (see Chapters 2 p.59; Chapter 4 p.100). This was unexpected, although consistent with Study 1. Metacognitive skill was related to personal workplace success in both groups but not to societal success. To gain greater insight into the influence of executive functioning on workplace success the third Study (reported in this Chapter) aimed to investigate potential relationships between cognition and workplace success by means of one-to-one psycho-educational assessments.

Study 3 considered differences between dyslexics and non-dyslexics in executive function, based on the views of Miyake (2000). Relationships between executive function and metacognition were also considered, as were relationships between executive function and personal and societal success. Results from the dyslexic and non-dyslexic groups were compared to determine if any such relationships were specific to a dyslexic population.
Finally, the Study also considered whether the identified literacy difficulties experienced by the dyslexic participants had any impact on their workplace success.

It was important to confirm that participants were appropriately allocated to a dyslexic group and a control group, hence literacy skills of all the participants were assessed. It was anticipated the dyslexic group’s literacy skills would be weaker than the controls (this was Hypothesis 3.1).

There is much research exploring the relationship between executive functioning and intelligence (Salthouse & Davis, 2006). To ensure that any differences in executive function could not be attributed to differences in intellectual ability, a measure of fluid intelligence was included as a control variable. Therefore, Hypothesis 3.2 was that there would be no differences in fluid intelligence between the two groups.

5.2 Executive function and dyslexia

There is increasing research interest in the role of executive function, working memory and literacy, as any deficits might account for the broader spectrum of difficulties dyslexic people experience and impact on performance in the workplace (Altemeier et al., 2008; Berninger et al., 2006; Swanson, 1999, 2012, 2015).

As previously discussed, both executive function and working memory are difficult to conceptualise. However, this current work considered that, broadly speaking, executive functions are the cognitive control mechanisms that direct and coordinate human behaviour (Packwood et al., 2011). More specifically, they are “...a set of domain general control processes that involve Inhibition and delay in responding... and the organization and integration and maintaining of cognitive and output processes at the time” (Denckla, 1996, p. 263). Executive processes are considered to involve “higher level processing and lower level processing” (Diamond 2013, p.41), and “planning and carrying out goal directed behavior” (Jurado & Rosselli., 2007, p.213). They can be defined as “self-government for regulating mental functions” (Altemeier et al., 2008, p.588), leading to effective performance (Blair & Ursache, 2011). These latter aspects of executive functioning are said to be particularly relevant in novel or non-routine situations, when new or unfamiliar information
must be processed (Diamond, 2013; Banich, 2008; Norman & Shallice, 1986). There is also agreement that individual elements of executive functions develop at different rates through childhood into adulthood, supporting the sub-components of executive functioning (Best, 2011; Diamond, 2013). Different intrinsic factors, such as individual differences, and extrinsic factors, such as social environment, may also influence development (Bernstein & Waber, 2007).

Miyake et al. (2000) investigated “the unity and diversity of executive functions” (p. 49). They conducted a latent variable analysis in an attempt to clarify the construct of executive functions and to address the problem of task impurity. Their research confirmed that different executive functions components (Shifting, Inhibition, and Up-dating) were all moderately correlated, but separate, factors. They established that specific assessment measures related to individual components; for example, the Wisconsin Card Sorting Test (WCST) related most strongly to the Shifting component. Therefore, this Study used the same three factors: set Shifting, Inhibition and Up-dating, as there is some evidence relating executive function deficits across these different components and dyslexia (see Lyon & Krasnegor, 1996).

Helland et al. (2000) looked at Inhibition and the inability to change set in relation to dyslexia and found evidence to support an executive function weakness in their dyslexic cohort. Brosnan et al. (2002) found their dyslexic participants were weaker on measures of Inhibition and Up-dating. There is also research indicating that dyslexic people, on average, perform less well than matched non-dyslexics on Up-dating/working memory, particularly measures of Listening Span and Reverse Digit Span (Jeffries & Everatt, 2004); Smith-Spark et al., 2004; 2007; Swanson & Sachs-Lee, 2001). Smith-Spark et al., (2016) conducted a study exploring the same three areas of executive functioning in 30 dyslexic students and 30 controls. Their findings revealed that the dyslexic students performed less well on tasks of Shifting and Inhibition, although on non-habituated tasks only, and confirmed their previous research in relation to deficits in working memory processes. To build on this research, similar measures of Shifting, Inhibition and Up-dating were selected in this Study to explore differences between the dyslexic and the non-dyslexic adults.

The exact relationship between working memory and executive function is an area of academic debate. The Up-dating factor from Miyake et al.’s (2000) research potentially
could be seen as a working memory process underlying many executive tasks. They described Up-dating as being linked to working memory, and suggested it is arguably an attentional and maintenance function. They then argued that the Up-dating component involved more than that, its main function was “to actively manipulate relevant information in working memory” (p. 57). Some researchers see the Up-dating component of Miyake’s research as inherent in working memory (Diamond, 2013), and most models see working memory as integral to executive function (Towse & Cheshire, 2008). For the purposes of this Study, the Up-dating aspect of executive processes were considered as closely related to the processes that are hypothesised to occur within working memory, in contrast to the executive processes of Shifting and Inhibition.

In an attempt to determine how the three components of executive functioning outlined above contribute to more complex executive functioning processing, defined as tasks involving higher order processes of planning and reasoning, Miyake et al (2000) also included measures of Random Number Generation (RNG) and Dual Tasking in their seminal research. RNG has been used by Baddeley and his associates (1998; 2012) to clarify their concept of the Central Executive. They proposed that RNG was an effective measure to investigate memory capacity and different elements of the Central Executive. They argued that generating numbers randomly requires the use of, and interruption of, well-established habits in long-term memory which entail Inhibition skills. They also suggested that RNG involves the constant monitoring (Up-dating) of responses to avoid repetition of a number. This was confirmed when Miyake et al. (2000) conducted a principal components analysis on the RNG task which revealed three factors. Firstly, an Inhibition factor that loaded on measures where the participant had to suppress stereotypical responses, such as counting forward or backwards to produce a sequence of numbers that were random. Secondly, an Up-dating factor loading on measures such as those in which the participant had to monitor their response to try to ensure randomness (Diamond, 2013; Salthouse, 2005). A third factor of memory span measured the length of a sequence of random numbers before a number was repeated. Towse (1998) conducted a series of experiments exploring performance on Random Number Generation tasks to provide insight into the different cognitive substrates that may be operating in complex tasks. He concluded that the RNG also reflected levels of attentional control; the ability to focus attention for a period of time in working memory. He hypothesised that although RNG involved “multiple mental operations, the information load
is nonetheless carried by a single channel, or a general device sharing resources amongst processing operations” (p.79), which he called working memory.

Much of the research into executive functioning and working memory is primarily verbal in nature (Brosnan et al., 2002; Just & Carpenter, 1977). However, the current Study also considered the possibility of the dyslexic participants performing better on the non-verbal measures; it is possible, for example, that a dyslexic’s difficulties in verbal processing may, in part, be responsible for the development of visual strengths (Davis, 1997; Galaburda, 1993; Von Karolyi, 1999, 2003; West, 2008) or that such visual skills may act as a compensatory mechanism for difficulties in the development of verbal skills (Bacon & Handley, 2010). Although the visual spatial domain has not been as extensively researched as the phonological/verbal domain, there is evidence that dyslexic people show no impairment of their visual spatial abilities (Brosnan et al., 2002; Brunswick et al 2010; Jefferies & Everatt, 2004). Performance on Visual Spatial Tasks may fluctuate with processing demands (Smith- Spark et al., 2003; Swanson et al., 2009). Consistent with this, in a study exploring reasoning and visual processes, Bacon et al. (2010) concluded that dyslexic people use visual processing strategies when problem-solving. However, when the tasks are novel (Smith-Spark et al., 2007) and task demands high (Smith-Spark et al., 2003), visual strategies in the dyslexic group become less effective. Therefore, verbal and non-verbal measures were selected in this research to explore performance.

When they investigated planning and organisational skills in a group of dyslexic and non-dyslexics students, Brosnan et al. (2002) found there to be no significant differences on semantic recall. Similar assessment measures were included in this present Study to confirm this finding, as well as to ensure that any differences in executive functions in relation to the retrieval of information could not be attributed to variances in semantic processing. While measures of semantic recall involve memory, it is part of the declarative long-term memory system, and may make different demands on memory processing to that of working memory.

Hypotheses in relation to executive functioning and dyslexia were:
**Hypothesis 3.3:** Significant differences would exist between the dyslexic and non-dyslexic groups in Shifting, Inhibition and Up-dating. The non-dyslexic group would achieve higher scores than the dyslexic group, especially on the verbally-based measures.

**Hypothesis 3.4:** Differences would exist in the Random Number Generation factors (Inhibition, Up-dating and Memory Span) between the dyslexic and the non-dyslexic groups, with non-dyslexics performing better on these measures because of the demands on working memory.

**Hypothesis 3.5:** Dyslexics were expected to perform equally well or better than the controls on the non-verbal executive function tasks.

**Hypothesis 3.6:** There would be no differences between the groups on measures of semantic recall.

### 5.3 Metacognition and its relation to executive functions

There are also differing perspectives on the relationship between metacognition and executive functioning. Some researchers (Eflikdes, 2008; Zimmerman, 2006) have postulated that metacognition is the deliberate use of executive skill. Others have argued that executive functions are a component of metacognition (Borkowski et al., 1996; Sternberg, 1985). Fernandez-Duque et al. (2000) and Follmer and Sperling (2016) argued for a similarity between the constructs because there are elements common to both. Additionally, Shimamura (2000) likened the monitoring and control elements of metacognition to working memory. There is also research suggesting that metacognitive skill, particularly regulation of cognition is related to greater inhibitive control (Follmer & Sperling, 2016; Garner, 2009). The present Study, therefore, aimed to explore the relationship between the measures of metacognition and executive function in more detail to gain a better understanding of any findings in relation to workplace success.

**Hypothesis 3.7:** It was anticipated that metacognitive skill (knowledge of cognition and particularly regulation of cognition) would positively relate to executive function measures of Shifting, Inhibition and Up-dating in both groups.
5.4 Executive functions and their relationship to workplace success

As argued in Chapter 2, there is evidence linking executive functioning skills to improved performance: there is therefore the potential for relationships between executive functioning and the measures of workplace success which were tested in the current Study.

*Hypothesis 3.8:* Positive relationships between executive functions and the societal success measures, academic qualifications and financial status were anticipated.

Metacognition and executive skill are important for the development of competence and expertise (Pressley et al., 2010; Sternberg, 2005) and increasing competence can lead to greater self-efficacy (Dweck, 2005; Kanfer & Ackerman, 2005). Therefore, it may be assumed that higher executive functioning skill should relate to the personal success measures of job satisfaction and self-efficacy. Data from the two previous Studies were also indicative of this. In Study 1, the planning scale was positively related to both personal workplace success criteria, and in Study 2, metacognitive skill and reasoning task accuracy were related to workplace success criteria.

*Hypothesis 3.9:* Positive relationships between executive function and the personal workplace success criteria of self-efficacy and job satisfaction were anticipated.

5.5 Literacy skill and workplace success

Finally, adequate literacy skills are essential in gaining good academic qualifications (Rose Report, 2006), and the latter are seen as leading to a good job and thus a successful career: good literacy skills are one of the key skills demanded by employers (BIS Report, 2015; Brennan & Shah, 2003). In contrast, poor educational qualifications are considered a barrier to successful employment (Gerber & Price, 2008; Gregg, 2013). Furthermore, the demands on literacy skills in the workplace are ever-increasing with the arrival of the internet. Therefore, those people with poor literacy skills are likely to be at a disadvantage in terms of academic achievement and gaining employment (National Literacy Trust Report, 2014), promotion (National Literacy Trust Report, 2014) and financial success (Gregg, 2009). Given that dyslexic children struggle to achieve adequate levels of reading and writing (Snowling, 2012), and most dyslexic adults continue to experience difficulties with reading
speed and written expression (McLoughlin, 2012), literacy levels of the dyslexic participants were investigated to determine the impact on societal workplace success.

Likewise, dyslexic people with weak literacy skills often have lower levels of self-esteem and self-worth (Burden, 2007), and those who work more slowly when reading and writing are likely to find the increasing demands in the workplace more challenging, thereby undermining their feelings of job satisfaction and self-efficacy (De Beer et al., 2014; Doyle, 2013; Nalavany, 2012).

**Hypothesis 3.10:** It was anticipated that the weaker literacy skills of the dyslexic group would be negatively related to personal and societal workplace success.

In summary, the aims of this Study are: firstly, to establish if there are differences between the two groups on executive functioning and working memory; secondly, to investigate the relationship between metacognitive skills and executive functions; thirdly, if these skills relate to workplace success; and finally, to explore levels of literacy and their relationship to workplace success.

### 5.6 Methods

**Participants**

Dyslexic participants were selected from those who participated in Study 2. An invitation to participate in the third and final stage of this research was sent out electronically to 116 people; 52 people accepted the invitation, equaling a response rate of 44%. All participants indicated that they would be happy to participate in future research at the end of their questionnaire response. A further eight dyslexic participants joined the research for Study 3 as a result of the opportunity sampling procedure. These eight participants completed the questionnaires from Studies 1 and 2; their data were included in the analyses of the previous Studies. For this third Study there were 60 dyslexic participants (31 males, 29 females), with ages ranging from 18 to 65 years (M = 43, SD = 8.9, see Table 5.1 for the age distribution).
An age and occupation matched control group of non-dyslexic people was recruited using opportunity sampling procedures, by asking the dyslexic participants if any colleagues or friends would be interested in taking part. In addition, the Human Resources departments of organisations contacted at the beginning of the research were also asked if any non-dyslexic employees were willing to participate as controls. In total, 30 participants (17 males, 13 females) were included in the control group. Their range in ages was 18-65 years, with a mean age of 44 years (SD = 9.2). See Table 5.1 for age distribution. The non-dyslexic participants also completed the questionnaires from Studies 1 and 2 in order to provide measures of workplace success and metacognitive skills, which were also used in analyses.

### Table 5.1

**Age descriptives of the two groups**

<table>
<thead>
<tr>
<th>Age in years</th>
<th>Controls (n = 30)</th>
<th>Dyslexic (n = 60)</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-24</td>
<td>3%</td>
<td>2%</td>
</tr>
<tr>
<td>25-34</td>
<td>43%</td>
<td>40%</td>
</tr>
<tr>
<td>35-44</td>
<td>17%</td>
<td>27%</td>
</tr>
<tr>
<td>45-54</td>
<td>30%</td>
<td>25%</td>
</tr>
<tr>
<td>55-65</td>
<td>7%</td>
<td>6%</td>
</tr>
</tbody>
</table>

The 90 participants were drawn from a variety of occupations: the emergency services, police and fire services; office-based professions (including the civil service; the health and education sector; legal and accountancy professions) and the arts and design industry. (See Table 5.2 for more details.)
Table 5.2

*Occupation demographics*

<table>
<thead>
<tr>
<th>Job Classification</th>
<th>Emergency Services</th>
<th>Administration/Management</th>
<th>Health / Education</th>
<th>Science</th>
<th>Professional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controls ((n = 30))</td>
<td>26%</td>
<td>37%</td>
<td>17%</td>
<td>7%</td>
<td>13%</td>
</tr>
<tr>
<td>Dyslexics ((n = 60))</td>
<td>32%</td>
<td>30%</td>
<td>18%</td>
<td>5%</td>
<td>15%</td>
</tr>
</tbody>
</table>

*Procedure*

The procedure for this Study involved psycho-educational assessments to determine the participants’ cognitive functioning. These assessments were carried out in the researcher’s office or in a quiet office free from any distractions at the participants’ place of work. The participants were informed that the assessment would last about two hours and that they would be asked to complete a variety of spoken response or paper and pencil tasks. In an attempt to diminish any test anxiety, participants were reassured that the process itself, i.e., what they were doing, was as important as accuracy. If they felt unable to finish a task, they could simply move on to the next task. They were also advised that they could take a break of up to five minutes, if required. Only three dyslexics and one control participant requested this break.

5.6.1 Materials and design

The order of task administration was fixed for all participants (see Appendix 5.1). The schedule was designed so that the task engagement was varied: executive functioning tasks, that were primarily either verbal or non-verbal, and dyslexia-specific tasks were presented in mixed order. This was to avoid two tasks measuring the same function following each other which might result in a task order effect (e.g., the single word spelling and reading tests might reduce the dyslexic participants’ confidence on following tests). There were three main areas of assessment: measures of literacy to determine dyslexia; control measures of
fluid intelligence and semantic recall; and measures of executive functioning. In addition, the workplace success criteria established in Study 1 and measures of metacognition and confidence from Study 2 were included in analyses. A brief description of the processes involved in each test appears below.

Nine measures of literacy or literacy-related skills were used, selected because they are commonly incorporated in a diagnostic dyslexia assessment. Firstly, literacy attainment measures of spelling, single word reading (The Wide Range Achievement Test, WRAT 3, 1993), reading comprehension and reading speed (Spadafore, 1983) were used to assess reading and spelling skills. Secondly, underlying reading skills were assessed through measures of single word sight recognition fluency and non-word decoding fluency (using the Test of Word Reading Efficiency, TOWRE, 2011). Finally, rapid naming of letters, numbers and objects (taken from the Comprehensive Test of Phonological Processing, CTOPP, 1999) were used as a measure of word retrieval from long-term memory, and have been found to be associated with weaknesses in reading (e.g., Wagner et al., 2013; Wolf, 2007). Both the TOWRE and the CTOPP are normed up to the age of 24 years 11 months; although rapid naming slows with age over adulthood, this decrease is only one second per decade up to the age of 55 years (Jacobson et al., 2004) and therefore should not greatly influence variability on these measures.

Spelling ability was assessed using The Wide Range Achievement Test (WRAT3,1993) Spelling (Blue Form). Participants were asked to write down a series of words of increasing spelling complexity that were presented to them orally. Each word was said once and then put into a sentence to provide context. There was a maximum of forty-two words to be spelled; however, the test was discontinued after ten consecutive errors. The measure was the number of words that were correctly spelt.

Reading attainment, in terms of word recognition ability, was determined using the Single Word Recognition (Blue Form) scale from The Wide Range Achievement Test (WRAT3, 1993). Participants were given a card on which was written 55 words of increasing complexity. They were asked to read the words across the card as fluently (i.e., quickly and accurately) as they could. The Test was discontinued after 10 consecutive errors.
Reading comprehension was assessed using the Spadafore Diagnostic Reading Test (1983). Participants were given an oral text to ensure competent levels of reading skill and a text to be read silently. Five comprehension questions were asked after the participant had read aloud a short piece of text. Having established the level of reading skill; vocational, technical or professional, participants were asked to read a passage at the appropriate level silently to themselves at their normal speed. They were told that questions would be asked at the end. The measure of comprehension was formed from the total number of correct answers in both the appropriate level reading conditions, the maximum being ten correct answers.

Reading speed was assessed while the participants silently read the second passage from the Spadafore Diagnostic Reading Test. After one minute had elapsed, the participant was asked to point out where they had got to in the text. They were then told to carry on reading to the end. The measure of reading speed was calculated by totaling the number of words that had been read in one minute: the higher the number, the faster the reading speed.

The Test of Word Reading Efficiency (TOWRE, 2011) measures the ability to identify and pronounce words/non-words fluently and accurately. It is comprised of two tasks: a measure of the ability to recognise familiar words as whole units or sight words (Sight Words Efficiency), and a measure of decoding ability and phonological processing by reading non-words (Phonemic Decoding Efficiency). The administration for both tests was the same. The participant was given a card with 104 familiar words (such as “book”, and “instruction”) for the sight word efficiency test, or with 104 non-words (such as “barp”, “guddy”), and asked to read down the list as fast as they can until told to stop. Each test was ended after 45 seconds and the total of correctly read words in that time formed the measures for reading efficiency and decoding ability; a higher score meaning better reading skill.

Rapid Naming measures were used to determine the efficiency of lexical access from long-term memory. Rapid naming requires speed in the processing of visual and phonological information. Rapid naming procedures from the Comprehensive Test of Phonological Processing (CTOPP, 1999) were used in the Study. Object rapid naming measures the speed an individual can name a series of objects. Participants were presented with an A4 sheet containing four rows and nine columns of six pictures of objects (pencil, star, fish, boat, key, chair), which were arranged randomly. They were instructed to name the objects, as quickly as they could, from left to right along the top row and then move to the next row until all the
objects had been named. They were then given a second page and asked to repeat the procedure. The measure was the total number of seconds taken to name the objects on both pages. The longer the participant took, the poorer they were at the retrieval of words.

The other rapid naming tests measured how fast an individual could name letters and digits respectively. The procedure was the same as for the object naming but the two pages contained either six letters (a, c, k, n, s, t) or six numbers (2, 3, 4, 5, 7, 8), and the participant had to name them as quickly as they could. As with object naming, the measure was derived from the total number of seconds the individual had taken to complete the two pages. Once again, the longer the participant took, the weaker they were at word retrieval.

Matrix Reasoning from the Wechsler Adult Intelligence Scale 3 (2008) was included to ensure that any differences between dyslexics and non-dyslexics were not due to fluid intelligence. The Matrices Reasoning test is an established measure of this non-verbal reasoning ability (Wechsler, 2008). The participants were presented with a stimulus booklet of 26 pages. On each page there was an incomplete matrix, or series of pictures, beneath which were six alternatives, one of which completed the matrix or series. Participants were asked to select the alternative that best completed the matrix or series in their own time. There were three practice questions to ensure comprehension of the task. Each answer was recorded on the response form as either correct or incorrect. The measure of fluid intelligence was the total number of correct responses, the maximum score being 26; higher scores reflected greater fluid intelligence.

A test of Semantic Recall was included to investigate if the level of semantic recall was similar across dyslexic and non-dyslexic groups. It was based on that described by Brosnan et al. (2002). Recall was assessed in two conditions, both of which used a set of 30 line drawings of everyday objects (from Snodgrass & Vanderwart, 1980) which comprised three categories: fruit, animals and household items. In the first trial, which was a test of spontaneous organisation of memory (SMR1), the 30 drawings were presented in random order. Participants were asked to look at three A4 sized cards, each of which had ten of the line drawings arbitrarily placed on them. Participants were asked to name the items; they were then told they had one minute in which to try to memorise the items; at the end of the minute they were asked to recall as many objects as possible verbally. Once the minute had elapsed, the researcher removed the cards and then asked the participants several questions.
regarding their occupation and job satisfaction levels. This questioning was a “filler task” that took approximately one minute. The aim of this was to minimise any recency effects and focus on recall that was more dependent on long-term memory processes (Brosnan et al., 2002). Participants were then given two minutes (Brosnan et al., 2002) to recall verbally as many of the 30 items as they could. The researcher noted down the responses, as well as the order in which they were given in case the participant had spontaneously organised their responses. The total number of items recalled formed the measure, with a higher score reflecting better recall of objects.

In the second trial (SMR2), the same procedure was carried out as in the first. It was administered approximately 40 minutes later, with other assessment tasks being completed in those 40 minutes. Again, participants were asked to look at and recall the 30 line drawings of different everyday items, but this time the items had been categorised into the three groups (fruit, animals and household items) on three A4 sheets. This time the “filler task” questions were different and included length of time in their job and future career plans. The total correct number recalled on the first trial (SMR1) was a measure of the simple semantic recall and the difference (SMRD) between the two raw scores (SMR2-SMR1) was a measure of performance (potential improvement) as a result of categorisation.

For the executive function measures, items that directly measured the Shifting, Inhibition and Up-dating components described by Miyake et al. (2000) were included. In addition, as mentioned above, a measure that primarily explored either verbal or non-verbal domains in each of the executive functioning areas was included. For example, to explore Inhibition the Stroop task was chosen as a verbal measure and the Group Embedded Figures Test as a non-verbal measure. The Dual Task measure tapped both domains, because of its verbal fluency and maze completion (non-verbal) components. Finally, a Random Number Generation test was included as it has been argued that different measures derived from the task assess different aspects of executive functioning (Towse, 1998).

Shifting can be defined as “task switching” backwards and forwards, between multiple tasks or cognitively different operations. The ability to shift between tasks is seen as an indicator of executive control. The following tasks were used to assess performance in Shifting: the Plus-Minus task (used by Miyake et al., 2000) and the Wisconsin Card Sorting Test (Heaton, et al., 1993). We also included the Trail-Making Task (TMT, based on the test devised by
Partington & Leiter, 1949), as it has been used extensively in neuropsychological research to reflect the executive process of task switching (Salthouse et al., 2000). Although there is an inhibitory processing element, Arbuthnott and Frank (2000) describe this element in the TMT as “task set Inhibition”, and Mayr and Keele (2001) found that this “task set Inhibition” was not present when there were visual/perceptual prompts. The Dual Task measure, which investigates performance differences when shifting between visual scanning and verbal fluency domains (Duncan, 1995), was included in this section.

The Plus-Minus Task (PMT, based on Jersild, 1927) required participants to shift between the arithmetical calculations of addition and subtraction. This type of activity is generally accepted as a verbal activity (numeric calculation is on the verbal scale of the Wechsler Scales and participants often verbalise as they are performing the task). Participants received a sheet of paper on which there were three lists of 30 two-digit numbers, which ranged between ten and 99 and were randomised. On the first list, the Plus-Minus Addition baseline task (PMAdd) participants were asked to add 3 to each number and write the answer beside the number. On the second list, the Plus-Minus Subtraction baseline task (PMSub), they had to subtract 3 from each number. Finally, on the third list, the Plus-Minus Alternating task (PMAltern), participants were asked to alternate between adding 3 and subtracting 3 from each number. The participants had to remember the instructions as there were no visual prompts, such as plus or minus signs on the papers. They were asked to work as accurately and quickly as possible, and the time they took was measured by stopwatch; the baseline measure was the number of seconds that they took to complete the list: i.e., the lower the score, the quicker the task was completed. The Plus-Minus shift measure (PMSM) was calculated as the difference between the time taken to complete the alternating list and the average times of the first two lists. This was the measure of Shifting cost between the operations of adding and subtracting: the lower the time (number of seconds) score, the more able the participants were in Shifting between the two arithmetic operations.
The Trail-Making Test (TMT) comprised two parts. For “Trail A” participants were asked to connect the number 1 to number 25 in consecutive order by drawing a pencil line between them (see Figure 5.1, Trail A). Their completion time was recorded by stopwatch. The lower the time, the better the performance. “Trail B” consisted of a sheet of paper with both letters, A-M, and numbers, 1-13. The participants were asked to connect the first number to the first letter and then the second number to the second letter; i.e., draw the sequence 1→ A → 2 → B → 3 → C and so on. Again, the completion time was recorded and again the lower the time the better the performance. The time of Trail B was divided by the completion time of Trail A to provide an interference score (Trails B/A), as outlined in Corrigan and Hinkeldey (1987). This measure, a ratio score, provided a direct measure of set Shifting (Arbuthnott and Frank, 2000) and it largely eliminates the element of speed of processing (Salthouse, 2011). Lower time scores reflect better performance: i.e., less Shifting costs between letters and numbers.

The Wisconsin Card Sorting Test (WCST; Heaton et al., 1993) was administered to assess Shifting on a task with more of a non-verbal processing element. It is widely used as a measure of an individual's ability to shift their attention due to rule changes. The rule may be determined by colour, number or shape. The participants were given a pack of cards. The cards have items on them that varied along the three dimensions of colour, number and shape with each dimension having 4 values (e.g., number: 1 2, 3 or 4 items; shapes: a triangle, a
square, a circle or a cross; colours: blue, red, green or yellow). Figure 6.2 below illustrates the row of target cards and the card to be sorted.

Figure 6.2. An example of a problem from the Wisconsin card sorting Test downloaded from https://www.google.co.uk/imgres Hogrefe on 14.02.18

The participants were asked to match the cards from their single pile with one of four target cards, which were placed in front of them at the beginning by the researcher. They took the top card from their single pile and placed it underneath one of the target cards by deciding which rule to follow: colour, number or shape. They were then told whether this choice was correct or incorrect. It was the only other information the experimenter provided. In the example above the rule was to match according to shape (a circle) or colour (red) or number (3). The participants then took another card from their single pile and placed this card under the target cards, either applying the same rule as the previous card if that was correct or selecting another dimension if incorrect. Once the participant established the first category rule and correctly matched the cards a number of times, the category rule changed unbeknownst to them, and the participant had then to recognise this shift and identify the new rule. The participants continued matching the cards and receiving feedback from the experimenter until they identified the rule change quickly or until they had used all the cards in the pack. There was no time limit on this test although the experimenter encouraged participants to “keep going” if they appeared to get stuck. Therefore, the test aimed to establish how easily the participants could adapt to the rule change. In contrast to the research reported by Miyake et.al. (2000) concerning perseverative errors, the measure used in this Study was the percentage of errors that the participant made in the total test: the higher the percentage error, the less ability to change set, to shift thinking processes. One of the
reasons for using percentage errors was its higher reliability score (alpha = .63), compared to the perseverative errors measure (.52).

The Dual Task measure involved the simultaneous performance of word generation and the completion of mazes, which required the ability to switch between domains: the process requires verbal fluency and spatial scanning. First, participants were asked to generate verbally as many words as they could, beginning with a designated letter (e.g. S) that were not proper nouns. This is a baseline measure for the Dual Task, but it is also a measure of phonemic verbal fluency. Every 20 seconds, the designated letter changed for ease of task completion and to maintain fluency. The designated letters for both parts of the test were selected on the basis of the letter frequency in the dictionary. Nine letters were used (S, M, D, H, G, N, L, W, and E). This part of the task took three minutes. The generated words were recorded on paper and the sum resulted in the Verbal Fluency A score (VFA): the higher the number of words, the greater the verbal fluency. The participants were then asked to complete as many mazes as they could for three minutes without removing the pencil from the paper during each maze. The number of completed mazes was recorded as the Maze A score (Maze A): once again, a high score reflected a better performance. Finally, the participants were asked to complete the two tasks simultaneously, thus Shifting between visual and verbal processing; they had to complete as many mazes as they could (Maze B score), whilst using another nine designated letters (P, C, T, B, O, F, R, V, A) to generate as many words as they could in three minutes to gain a Verbal Fluency B score (VFB). The scores for the three conditions were then used to calculate a verbal ratio (i.e., VFB/VFA = Verbal Ratio score) and a maze ratio (Maze B/Maze A = Maze Ratio). Finally, to determine the interference measure, the cost of Shifting between the two tasks was calculated based on the method described in Miyake et al. (2000):

\[
(Maze A - Maze B / Maze A) + (WG A - WG B /WG A)
\]

\\[
\frac{\text{ }}{2}
\]

For this Dual Task Interference measure (DTI), a low score reflected better performance, as the cost of Shifting or interference between the measures was less.
Inhibition. As discussed previously, Inhibition is a multi-faceted concept, but for the purposes of this Study it was measured based on the ability to "override dominant or prepotent responses" (Miyake et al., 2000, p.57) and the capacity for "resistance to interference", or the ability to inhibit misleading or irrelevant information. To investigate such inhibitory processes, we used the Stroop task (based on the Stroop Test, 1935) and the Group Embedded Figures Test (GEFT, Witkin et al., 1971). The Random Number Generation Inhibition factor (RNG Inhibition) was also included in this group of test measures.

The Stroop Task involves visual recognition and verbal labelling; it measures the individual’s ability to inhibit or override previously learned, automatic prepotent responses. Participants were presented with an A3-sized board with a large number of squares, each of which was filled with one of five different colours (red, black, green, yellow and blue). The participants were asked to name each of the colours as quickly as possible within one minute. The sum of the number of correctly named coloured squares provided the Stroop A score; the higher number of squares named reflecting better performance. Immediately after this, a second board was presented, this time comprising a large number of colour-words, written in capital letters (RED, GREEN, YELLOW, BLACK and BLUE). Each colour-word was written in a different ink colour to its actual meaning; i.e., the name and the ink colour were incongruent, meaning that the participant would need to inhibit one of the potential responses. Again, the participants were asked to name as many of the colours within one minute providing the Stroop B measure. Stroop Percentage Interference (PCI) was then calculated. This was done by working out the difference between the two conditions (Stroop A – Stroop B), dividing this value by the average of the two conditions (Stroop A + Stroop B divided by 2) and multiplying it by 100 to get a percentage. The higher the score, the less able the participants were at inhibiting their prepotent, previously learned dominant response; i.e., a high score reflected a poor performance.

The Group Embedded Figures Test (GEFT, Witkin et al., 1971) involves visual perceptual processing. To complete the task, participants were asked to identify given shapes in increasingly complicated figures. To successfully do this, the participant had to suppress or discard irrelevant context information. The participants completed three sets comprising nine figures each. For each problem they were given a shape and they had to identify that exact
shape, “a simple form”, hidden within a complex pattern by drawing the simple form on the complex pattern. See Figure 5.3 for an example of the task.

![Complex form, Simple form, Correct answer](image)

**Figure 5.3.** Example of a trial of the GEFT.

The first set was a practice set to ensure participants understood what was required; it had a two minute time limit. Participants were then told that they had five minutes to complete the next set of nine problems (Set B). They were then asked to stop and move on to the final set of nine figures (Set C), again with a five minute time limit. The total of the correct answers for Set B and Set C formed the measure of inhibitory control. Higher scores (Maximum score was 18) indicated better performance: i.e., the participant could better inhibit irrelevant visual context material.

**Up-dating.** In the present Study, measures of Up-dating were considered as most closely associated with the processes of working memory. The set of measures chosen to assess Up-dating therefore reflected this background in working memory research. A Listening Span Task was devised specifically for this research. It was presented orally, (it was therefore a verbal task). The Visual Spatial Span Test from the Wechsler Memory Scales (WMS-111; Wechsler, 1997) was also used to investigate Up-dating in the non-verbal domain. This has two components: Spatial Span Forwards (Spatial Span F) and Spatial Span Reversed (Spatial Span R). It is said to be a measure of working memory as information has to be retained and manipulated before being recalled (The Psychological Corporation, 2002 p.6.).
The Listening Span Task was based on Daneman and Carpenter’s (1980) Listening Span Test. It measures the ability to retain and update a list of words while processing other information. Participants were asked to listen to a sentence and answer the question “Is the information true or false?” This was to ensure that the whole sentence was processed, rather than participants concentrating on the final word only. The sentences were taken from general knowledge quiz books and covered a variety of subjects. The sentences were presented in sets of three; the first set comprised two sentences, for example, “We hear things through our eyes” (False) and “There are seven days in a week” (True). After listening to sentences and answering “true” or “false”, participants had to recall the last words of each sentence in that set. From the example above, the correct answer was “eyes” and “week”. The second set of three comprised three sentences, and three words had to be recalled from each set. The third set had four sentences, meaning that four words had to be recalled. The longest set comprised three sets of six sentences. The maximum score was 60 although only two participants reached the final set of 6 sentences (see Appendix 5.3 for examples). The average length of each sentence was 9 words. The length of words also considered to avoid the necessity of recalling long words. The words to be recalled were in the 120 most frequently used nouns list, selected from Word Frequencies in Written and Spoken English: based on the British National Corpus (Leech, Rayson & Wilson, 2001, Chapter 5). Some words such as ‘year’ had a very high frequency, others such as ‘name’ had lower frequency but were selected for their common usage in language. Care was taken when choosing sentences to avoid similarity or repetition either in sound or meaning. The sentences in each group were presented quite quickly, one after the other, to avoid the participant rehearsing the answers. The test was stopped when the participant failed to recall all the end words in the correct order for two consecutive sets. The measure was the total number of final words the participant correctly recalled in the order that they were presented; the higher the score, the better the ability to update incoming information.

Spatial Span Tasks were based on the measures from the Wechsler Memory Scales (2009) and test the ability to follow a sequence of spatial movements across visually identical items. The participant was shown an A4-sized board which had ten blue cubes arranged on it (as in figure 5.4 below). In the Spatial Span Forward (Spatial Span F) task, which measures the ability to retain information and repeat it without modification, the examiner tapped the cubes in a specified sequence and asked the participant to repeat the sequence.
The length of the sequences increased, with two trials of a different sequence at each length. The researcher recorded if the participant correctly repeated the sequence; i.e., tapped the cubes in the same order. The test was discontinued when two errors are made at the same length. The total number of correctly repeated sequences formed the Spatial Span Forward (Spatial Span F) measure: the minimum score was 0, the maximum score was 16. For Spatial Span Reversed (Spatial Span R), the procedure was the same in that the examiner tapped the cubes in a specified sequence, but this time the participant had to reverse the sequence when tapping the cubes. The examiner recorded if the sequence was correct. On the Spatial Span R, the total number of correctly reversed sequences formed the measure of the ability to retain and manipulate information (i.e., reverse the order). Again, the minimum to maximum scores ranged from 0-16. It is advised that the two scores are not combined as potentially they are tapping different processing components (Kaplan et al.,1999).

Random Number Generation (RNG) is a complex verbal task that engages a range of executive processes as it involves the Up-dating of information and the suppression of habitual counting sequences. Participants were asked to produce a sequence of random numbers selected from 1 to 9. It is the task of randomness that presents the challenge. To explain the concept of randomness to the participants a “hat” analogy was used (as in Baddeley et al., 1998). Participants were asked to visualise a hat full of small squares of paper each of which had a number between 1 and 9 written on it. They were asked to visualise taking the papers out one by one, reading the number aloud and putting it back afterwards. Participants were shown a metronome and were told they would be asked to say numbers from 1 to 9 in a random order at the rate of 80 numbers per minute, which was

Figure 5.4. An illustration of the Spatial Span board.
synchronised with the metronome beat. A trial of a sequence of ten numbers was administered to ensure participants understood what was required and so that they could work at the required response speed. They were then asked to do the same for a period of two minutes. The experimenter recorded the responses.

Responses were entered in Towse and Neil’s (1998) RgCalc program. This program was designed by Towse and Neil to provide measures that were available for researchers to interpret the response distributions of the participants. For example, RgCalc provides measures of the ordinal relationships between items and the tendency to repeat numbers over different lengths. The current Study focused on the areas of executive functioning suggested by Miyake et al. (2000), so the same ten indices that they used to produce measures for analysis were selected. A PCA factor analysis was run on these indices which produced three factors broadly consistent with those of the Miyake analysis. Moreover, Miyake et al. (2000) argued that their three-factor solution generally replicated Towse and Neil’s (1998) interpretations. The first two factors identified one component relating to Up-dating and another component to Inhibition. However, they were unable to specify the target executive function for the third component; this comprised phi indices. Miyake et al. (2000) postulated that the phi indices measured “repetition avoidance”, which is broadly consistent with Towse and Neil’s phi factors of repetition length. These three factors were incorporated into the current analysis with Component 1 (RNG Inhibition) being included in the Inhibition measures, and Component 2 (RNG Up-dating) being included in the Up-dating measure. Miyake et al.’s third component was included as a general measure of memory span (RNG Span) (Towse & Neil, 1998). Baddeley (1996) suggested that Shifting is a component of RNG, but Miyake et al. (2000) conclude from their research that Shifting does not play a part in RNG.

The Inhibition factor (RNG Inhibition) includes the Turning Point Index (TPI), which measures changes between ascending and descending runs of numbers; a low score on the TPI indicates a lower degree of randomness as there are too few changes. Adjacency (A) measures the number of digits that are adjacent to each other; a high adjacency score means less randomness and suggests that participants may be less able to inhibit a repetition response. Runs describe the variability within a response set (Ginsberg & Karpuik, 1994); the number of items in successive ascending sequences is determined and the variance of these sequences is derived, providing the runs score. A high score on runs means there is
more variability, therefore more randomness. The Random Number Generation score (RNG) considers the randomness of the sequence or the association of one choice and the next: i.e., how often any response alternative follows another alternative; for example, three follows five. The higher the RNG score, the more predictability within a sequence and therefore less randomness.

The Up-dating factor (RNG Up-dating) includes the following indices: Redundancy (R), the Repetition Gap, and Coupon. Redundancy (R) measures the distribution of response frequencies, with a high score indicating that the same choice has been used throughout, or that other choices are redundant. The Repetition Gap (mean RG) is a measure of the repetition of performance. It is derived from the mean median and mode gap measures; i.e., how often and at what distance a number is repeated. If the gap is high, then there is a greater degree of randomness. The Coupon score identifies a cycling strategy and is based on the mean number of responses, working through a set of possible responses, for example, 1, 3, 2, 5, and 4. A higher score is indicative of more cycling and is therefore less random.

Finally, the RNG Span factor was included in the analysis. It is a measure of repetition tendency over different lengths labeled as Phi (φ). In RgCalc phi (φ) counts the number of repetitions in a string of numbers: the greater the lengths the more positive the value, but if there are more repetitions than predicted, there is less randomness. Phi is computed for six orders of analysis, but only Phi 2, 3 and 4 were used in this analysis for consistency with the Miyake research.

5.6.2 Data analysis

The data were checked for missing values and tests of normality were conducted on all measures prior to the analysis. There was some evidence of skew and kurtosis and outliers were excluded if their z-scores exceeded ±3.29 (Field, 2005).

To ensure that both groups were comparably successful, measures of workplace success were compared using independent t-tests for measures that fulfilled the normality assumption, and Mann-Whitney U Tests on the non-normally distributed data. For the promotion variable, the two groups were compared using chi-square goodness of fit tests (to see if more participants
reported being promoted in one group compared to the other) and the data were weighted for overall group sizes \( n_{\text{control}} = 30, n_{\text{dyslexics}} = 60 \).

Tests of difference were used to determine if differences between the groups existed on the dyslexia measures confirming group membership, and if there were differences on the control variable, fluid intelligence. To analyse executive functioning skill and determine any differences between the groups, tests of difference were also used. Across all tests of difference, \( p \)-values were reported, and the effect size \( r_{es} \) calculated for ease of comparison across different analyses (Field, 2005).

To explore relationships between metacognitive skill, executive functioning, workplace success measures and literacy skills between the groups, Pearson’s and Spearman’s correlations were conducted. Potential differences between the groups in terms of the size of correlation coefficients were compared using \( z \)-tests, by first transforming \( r \)-values to \( z \)-values using Fisher’s transformation.
5.7 Results

Workplace success

First, to ensure both groups were comparable on the workplace success criteria, they were compared on job satisfaction, self-efficacy, academic qualifications and financial status. (Recall that the dyslexic group was drawn from a sub-sample of those included in previous Studies.) Results showed that there were no significant differences between the groups on the workplace success criteria (for details see Table 5.3). This suggests that, overall, the two groups experienced equivalent levels of success consistent with the analyses in the previous two Chapters.

Table 5.3.

Descriptive statistics and results of tests of difference between dyslexics and non-dyslexics on the workplace success criteria.

<table>
<thead>
<tr>
<th></th>
<th>Dyslexics</th>
<th>Controls</th>
<th>Normal distribution</th>
<th>Inferentials</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Job satisfaction</td>
<td>35.3</td>
<td>8.6</td>
<td>38.3</td>
<td>6.6</td>
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<td>Self-efficacy</td>
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<td>11.1</td>
<td>63.9</td>
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<td>1.0</td>
<td>6.7</td>
<td>1.0</td>
</tr>
<tr>
<td>Financial status</td>
<td>3.6</td>
<td>1.3</td>
<td>3.7</td>
<td>1.4</td>
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<td>Promotion</td>
<td>56 freq</td>
<td>-</td>
<td>28 freq</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: ^a Y indicates “Yes” for normally distributed data, and N indicates “No” for not normally distributed data. ^u = The p-value from Mann-Whitney U Test. ^freq = observed frequency counts reported; ^v p-value from $\chi^2$ test; ^w Cohen’s w used instead of effect size r, as variable compared is categorical (Cat).
The first hypothesis anticipated that the two groups were different on the measures of dyslexia. Nine measures, hypothesized to be indicative of dyslexic difficulty in adulthood, were compared across dyslexics and controls. The results showed that there was significant difference between the groups on all the literacy measures (see Table 5.4 for details). Across all measures of literacy, except reading comprehension, effect sizes exceeded $r_{es} = 0.5$ (using correlation coefficients to calculate effect sizes). The weakest effect size was for reading comprehension, but this was still $r_{es} = .33$ and, as with all of the other analyses indicated poorer performance among the dyslexics. Poor performance on these tests is likely to reflect weaker underlying literacy-related processing skills and/or a lack of literacy experience/practice due to problems during acquisition. Hence, this supported the first hypothesis and confirmed group membership.
Table 5.4.

*Descriptive statistics and results of tests of difference between dyslexics and controls on all literacy measures.*

<table>
<thead>
<tr>
<th></th>
<th>Dyslexics</th>
<th>Controls</th>
<th>Normal distribution&lt;sup&gt;a&lt;/sup&gt;</th>
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<td>SD</td>
<td>Dys</td>
<td>Con</td>
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<td></td>
<td>41.4</td>
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<tr>
<td>WRAT SW Reading</td>
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<td>SD</td>
<td>M</td>
<td>SD</td>
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<td>SD</td>
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<td>Con</td>
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<td>Con</td>
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<td>SD</td>
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<td>SD</td>
<td>Dys</td>
<td>Con</td>
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<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td>Dys</td>
<td>Con</td>
</tr>
<tr>
<td></td>
<td>44.2</td>
<td>13.6</td>
<td>60.3</td>
<td>3.44</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td><strong>Rapid naming</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>CTOPP Letters</td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td>Dys</td>
<td>Con</td>
</tr>
<tr>
<td></td>
<td>34.4</td>
<td>11.2</td>
<td>24.3</td>
<td>3.7</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>CTOPP numbers</td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td>Dys</td>
<td>Con</td>
</tr>
<tr>
<td></td>
<td>32.6</td>
<td>9.56</td>
<td>23.0</td>
<td>3.81</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>CTOPP Objects</td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td>Dys</td>
<td>Con</td>
</tr>
<tr>
<td></td>
<td>53.3</td>
<td>9.8</td>
<td>41.4</td>
<td>4.60</td>
<td>N</td>
<td>N</td>
</tr>
</tbody>
</table>

Note: <sup>a</sup> Y indicates “Yes” for normally distributed data, and N indicates “No” for not normally distributed data. <sup>u</sup>the p-value from Mann-Whitney U Test. WRAT = Wide Range Achievement Test; TOWRE = Test of Word Reading Efficiency; CTOPP = Comprehensive Test of Phonological Processing.
**Matrices**

Matrices were included as a measure of fluid intelligence, and a t-test (see Table 5.5) indicated a non-significant difference between the groups on this variable. The similarity in performance of the two groups on this task suggested that any differences on measures of executive functioning and literacy were not due to differences in fluid intelligence.

**Table 5.5**

*Descriptive statistics of the matrices variable to control for intelligence.*

<table>
<thead>
<tr>
<th></th>
<th>Dyslexics</th>
<th>Controls</th>
<th>Normal distribution(^a)</th>
<th>Inferentials</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Matrices</td>
<td>20.1</td>
<td>2.9</td>
<td>19.5</td>
<td>3.2</td>
</tr>
<tr>
<td></td>
<td>Y</td>
<td>Y</td>
<td></td>
<td>(r_{es})</td>
</tr>
</tbody>
</table>

Note. \(^a\) Y indicates “Yes” for normally distributed data.

**Semantic memory recall**

A test of semantic memory recall (Brosnan et al., 2002) was included to explore the level of recall in both groups. As can be seen from Table 5.6, there were no differences between the two groups in any of the conditions. Both groups recalled more items in the second condition, confirming that semantic categorisation aided recall for both groups. The similarity of results across the two groups meant no further analyses were conducted. Any identified group differences in other tasks were considered unlikely to be due to semantic memory processes.
Table 5.6

*Descriptive statistics and tests of difference on semantic memory recall.*

<table>
<thead>
<tr>
<th></th>
<th>Dyslexics</th>
<th>Controls</th>
<th>Normal distribution</th>
<th>Inferentials</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>SMR1</td>
<td>15.6</td>
<td>4.3</td>
<td>16.1</td>
<td>3.2</td>
</tr>
<tr>
<td>SMR2</td>
<td>18.17</td>
<td>4.14</td>
<td>19.57</td>
<td>3.12</td>
</tr>
<tr>
<td>SMRD</td>
<td>2.60</td>
<td>3.37</td>
<td>3.07</td>
<td>3.54</td>
</tr>
</tbody>
</table>

Note: *Y* indicates “Yes” for normally distributed data, and *N* indicates “No” for not normally distributed data. The *p*-value from Mann-Whitney U Test. SMR = semantic recall; SMRD = Difference of score between SMR1 and SMR2.

**Executive functioning**

Measures of executive functioning related to Shifting, Inhibition, and Up-dating were compared between groups. For the purposes of the analyses, the three RNG components identified by Miyake et al. (2000) were adopted. As can be seen from Table 5.7, significant differences between the groups were found in each of the areas of executive function. Importantly, the baseline measures (i.e., Trail A, and Stroop A) also showed significant differences between the groups, with a large (0.5 or above) to medium (0.3 to 0.5) effect size. Verbal Fluency A was also significantly different. However, these differences were not sustained in the final (ratio) measures. This pattern of results suggested that these baseline measures were tapping into speed of processing, rather than underlying executive functioning differences.

For the measures of Shifting, there was a significant difference on the Plus-Minus Shifting Measure (PMSM), with a medium effect size (*r* = 0.3). There were also significant differences between the groups on the three baseline tasks of this measure (Plus-Minus add, Plus-Minus subtract, Plus-Minus alternate); the dyslexic participants took longer, indicating that they experienced significantly more difficulty than the non-dyslexics throughout this task. In contrast, there was no difference between the groups on the Wisconsin card sorting Test. Furthermore, on the mazes measure, the two groups performed equally on the baseline
measure and the ratio measure, suggesting that both groups experienced similar levels of interference. In addition, as mentioned above, there was no difference between the groups on the verbal fluency ratio measure despite significant differences in the baseline task.

On the Inhibition measures, the only difference between the groups was on the RNG Inhibition component, which approached a medium effect size. The dyslexic group had greater difficulty inhibiting the previously learned pre-potent responses than the controls. However, the two groups did not differ statistically on the Stroop percentage difference, and there was no difference between the groups on the Group Embedded Figure measure.

There was a clearer set of results on the measures of Up-dating. The dyslexic group were weaker than the control group on most measures involving Up-dating. On the listening span task, there was medium to large effect size ($r = .45$). On the Spatial Span tasks, the effect size was medium on the forward version, but only small on the backward procedure ($r = -.43$ and -.23 respectively). Unexpectedly, there was no difference between the groups on the RNG Up-dating measure, but there was a significant difference between the groups on the RNG Span measure with a medium effect size ($r = .33$).

Overall, there was no evidence in these data to support the hypothesis that the dyslexic group would perform better than the non-dyslexic group on the non-verbal executive function measures (Hypothesis 3.7).

In summary, there is evidence to suggest that both groups differed in some aspects of executive functioning (Hypothesis 3.3). Where these differences were evident, the dyslexics performed less well than the non-dyslexic group. However, the results indicated that this was not a general deficit across the three components of executive functioning assessed in the current Study. In the Shifting tasks, the performance of the dyslexic group was significantly weaker than the non-dyslexics only on the Plus-Minus Shifting Measure (PMSM). On the Inhibition tasks, there was only one measure where the two groups differed significantly, that of RNG Inhibition. The results were more consistent on the Up-dating tasks; though even here, the RNG Up-dating measure showed comparable performance (Hypothesis 3.4). Finally, there were differences in the processing speeds between the groups; the dyslexic group were significantly slower on all baseline measures.
### Table 5.7.

**Results for the dyslexics and controls on the EF measures.**

<table>
<thead>
<tr>
<th></th>
<th>Dyslexic</th>
<th>Control</th>
<th>Normal distribution</th>
<th>Inferentials</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
<td>$M$</td>
<td>$SD$</td>
</tr>
<tr>
<td><strong>Shifting</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trails B/A</td>
<td>2.4</td>
<td>.70</td>
<td>2.6</td>
<td>.94</td>
</tr>
<tr>
<td>Trail A*</td>
<td>32.1</td>
<td>11.5</td>
<td>25.8</td>
<td>9.3</td>
</tr>
<tr>
<td>PMSM*</td>
<td>38.9</td>
<td>21.0</td>
<td>27.1</td>
<td>13.5</td>
</tr>
<tr>
<td>PMAdd*</td>
<td>68.1</td>
<td>24.1</td>
<td>43.9</td>
<td>10.9</td>
</tr>
<tr>
<td>PMSub*</td>
<td>76.7</td>
<td>30.1</td>
<td>48.2</td>
<td>13.6</td>
</tr>
<tr>
<td>PMAtern*</td>
<td>113.4</td>
<td>36.8</td>
<td>70.9</td>
<td>21.6</td>
</tr>
<tr>
<td>WCST</td>
<td>25.0</td>
<td>13.6</td>
<td>19.3</td>
<td>9.5</td>
</tr>
<tr>
<td>VFR</td>
<td>.20</td>
<td>.11</td>
<td>.19</td>
<td>.14</td>
</tr>
<tr>
<td>VFA*</td>
<td>63.4</td>
<td>16.9</td>
<td>79.6</td>
<td>17.3</td>
</tr>
<tr>
<td>Maze ratio</td>
<td>.22</td>
<td>.14</td>
<td>.20</td>
<td>.13</td>
</tr>
<tr>
<td>Maze A</td>
<td>10.3</td>
<td>1.7</td>
<td>10.5</td>
<td>1.6</td>
</tr>
<tr>
<td>DTI</td>
<td>.21</td>
<td>.10</td>
<td>.25</td>
<td>.11</td>
</tr>
<tr>
<td><strong>Inhibition</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stroop PCI</td>
<td>41.9</td>
<td>9.7</td>
<td>41.0</td>
<td>6.8</td>
</tr>
<tr>
<td>Stroop A*</td>
<td>84.9</td>
<td>16.6</td>
<td>108.2</td>
<td>14.1</td>
</tr>
<tr>
<td>GEFTS</td>
<td>13.17</td>
<td>3.4</td>
<td>13.5</td>
<td>4.05</td>
</tr>
<tr>
<td>RNGI*</td>
<td>60.5</td>
<td>20.0</td>
<td>49.8</td>
<td>19.1</td>
</tr>
<tr>
<td><strong>Up-dating</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>List Span*</td>
<td>18.7</td>
<td>7.3</td>
<td>26.7</td>
<td>8.33</td>
</tr>
<tr>
<td>SSF*</td>
<td>7.98</td>
<td>1.7</td>
<td>9.3</td>
<td>1.17</td>
</tr>
<tr>
<td>SSR*</td>
<td>7.6</td>
<td>1.5</td>
<td>8.31</td>
<td>1.59</td>
</tr>
<tr>
<td>SSRS*</td>
<td>15.5</td>
<td>2.9</td>
<td>17.7</td>
<td>2.04</td>
</tr>
<tr>
<td>RNG Up</td>
<td>19.2</td>
<td>4.1</td>
<td>19.6</td>
<td>3.9</td>
</tr>
<tr>
<td>RNG Span*</td>
<td>15.1</td>
<td>2.0</td>
<td>16.4</td>
<td>1.6</td>
</tr>
</tbody>
</table>

Note: * the p-value from Mann Whitney U Test. * p < .05.
Legend for table 5.7

Trails B/A = ratio of two baseline tests trail A and Trail B.

PMSM = plus minus score ratio measure; PMAdd = plus minus baseline measure - addition; PMSub = plus minus baseline measure - subtraction; PMAlt = plus minus baseline measure - alternating between plus and minus.

WCST = Wisconsin card sorting test

VFR = verbal fluency ratio; VFA = verbal fluency baseline measure A; DTI = dual task interference score

Stroop PCI = Stroop percentage interference score; Stroop A = baseline measure A of Stroop

GEFTS = group embedded figures test

RNGI = Random number generation inhibition factor; RNGUp = Random number generation updating factor; RNG Span = Random number generation span factor

List span = listening span test

SSF = spatial span forwards; SSR = spatial span reversed; SSRS = spatial span total raw score

Metacognition and executive functioning

In Study 2 some differences between the groups were found on metacognitive skill, particularly knowledge of cognition. In the current Study the interest was in the relationships between these metacognitive data and the executive function measures. As conceptually metacognition and executive functioning skills overlap, and metacognition has a mediating influence on executive functioning (Follmer & Sperling, 2016 and see Chapter 2p.46), some relationships were expected to emerge. Furthermore, it was anticipated that there might be differences between the two groups and such differences might influence workplace success. Spearman’s correlations were used to explore relationships between the metacognitive variables and the executive functioning variables used in Study 3. The anticipated relationships between the two constructs were not evident, see Table 5.8. There was only one significant finding which, given the large number of correlations conducted, could have simply been due to chance. Therefore, interpretation of these correlations (or lack thereof) were left until after further analyses. The lack of relationships between metacognition and executive function was contrary to Hypotheses 3.8. This lack of clear relationships is discussed in more detail later.
Table 5.8.

Correlation table of metacognition and executive functioning criteria.

<table>
<thead>
<tr>
<th></th>
<th>Knowledge of cognition</th>
<th></th>
<th>Regulation of cognition</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control</td>
<td>Dyslexic</td>
<td>Control</td>
<td>Dyslexic</td>
</tr>
<tr>
<td>Trails</td>
<td>-.15</td>
<td>-.01</td>
<td>.07</td>
<td>-.07</td>
</tr>
<tr>
<td>Plus-Minus measure</td>
<td>-.07</td>
<td>.00</td>
<td>.04</td>
<td>.22</td>
</tr>
<tr>
<td>Wisconsin Card Sorting Test</td>
<td>.16</td>
<td>-.23</td>
<td>.01</td>
<td>-.19</td>
</tr>
<tr>
<td>Stroop</td>
<td>-.20</td>
<td>.17</td>
<td>-.17</td>
<td>.01</td>
</tr>
<tr>
<td>Group Embedded Figures Test</td>
<td>.01</td>
<td>-.02</td>
<td>.11</td>
<td>.19</td>
</tr>
<tr>
<td>Listening Span</td>
<td>.24</td>
<td>.18</td>
<td>.23</td>
<td>.06</td>
</tr>
<tr>
<td>Spatial Span Forward</td>
<td>.02</td>
<td>-.16</td>
<td>.09</td>
<td>-.10</td>
</tr>
<tr>
<td>Spatial Span Reversed</td>
<td>.13</td>
<td>.05</td>
<td>-.14</td>
<td>.10</td>
</tr>
<tr>
<td>Dual Task Interference</td>
<td>-.30</td>
<td>.21</td>
<td>-.35</td>
<td>.20</td>
</tr>
<tr>
<td>Random Number Generation Inhibition</td>
<td>.17</td>
<td>.21</td>
<td>-.26</td>
<td>.15</td>
</tr>
<tr>
<td>Random Number Generation Up-dating</td>
<td>-.11</td>
<td>.14</td>
<td>.06</td>
<td>.21</td>
</tr>
<tr>
<td>Random Number Generation Span</td>
<td>.01</td>
<td>.04</td>
<td>.43*</td>
<td>-.06</td>
</tr>
</tbody>
</table>

* p < 0.05.  ** p < .01

Workplace success

Workplace success and Matrices

Research indicates the existence of relationships between fluid intelligence and success at work (Bailey, 2007). Therefore, Spearman’s correlations were conducted on the workplace success criteria and the matrices measure to determine if fluid intelligence had a bearing on
success. The lack of significant correlations argues against fluid intelligence influencing workplace success greatly (see Table 5.9).

Table 5.9

Correlation table of matrices and workplace success criteria.

<table>
<thead>
<tr>
<th></th>
<th>Job satisfaction</th>
<th>Self-efficacy</th>
<th>Academic qualifications</th>
<th>Financial status</th>
<th>Promotion (Pearson’s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Matrices</td>
<td>-.097</td>
<td>-.158</td>
<td>-.006</td>
<td>.246</td>
<td>.076</td>
</tr>
<tr>
<td>Control</td>
<td>.129</td>
<td>.129</td>
<td>.320</td>
<td>-.174</td>
<td>.142</td>
</tr>
</tbody>
</table>

* p < 0.05.  ** p < .01

Executive function and workplace success

To explore any relationships between the two groups on the executive functioning measures and workplace success criteria, correlations were conducted and then Fishers r–z transformations were performed to confirm significance as the sample sizes were unequal. The results are shown in Tables 5.10 and 5.11. However, despite the large number of comparisons performed, only two results suggested differences in the size of correlations between the executive functioning measures and the workplace success criteria. Given that these could be due to chance effects (because of the large number of correlations performed), these effects will be discussed only when additional confirmatory evidence is considered.
Table 5.10 *Correlation table of workplace success and the shifting EF variables*

Note: (a) Pearson’s or Spearman’s correlation. (b) Point-biserial correlation. * P < 0.1. Dys = Dyslexic group; Con = Control group. The p-value reported in from the comparison of the two groups’ r-values r to z transformation.

<table>
<thead>
<tr>
<th></th>
<th>JS (a)</th>
<th>SE (a)</th>
<th>AQ (a)</th>
<th>FS (a)</th>
<th>Promotion (b)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dys</td>
<td>Con</td>
<td>p</td>
<td>Dys</td>
<td>Con</td>
</tr>
<tr>
<td><strong>Shifting</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trails B/A</td>
<td>.14</td>
<td>.03</td>
<td>.60</td>
<td>.13</td>
<td>-.06</td>
</tr>
<tr>
<td>P MSM</td>
<td>.05</td>
<td>.03</td>
<td>.94</td>
<td>.10</td>
<td>.08</td>
</tr>
<tr>
<td>PM Add</td>
<td>-.02</td>
<td>-.23</td>
<td>.37</td>
<td>.01</td>
<td>.04</td>
</tr>
<tr>
<td>PM Sub</td>
<td>-.02</td>
<td>-.08</td>
<td>.77</td>
<td>-.02</td>
<td>.04</td>
</tr>
<tr>
<td>PM Alter</td>
<td>-.01</td>
<td>.06</td>
<td>.79</td>
<td>-.04</td>
<td>.18</td>
</tr>
<tr>
<td>WCST</td>
<td>-.25</td>
<td>.22</td>
<td>.06</td>
<td>-.25</td>
<td>-.12</td>
</tr>
<tr>
<td>VF Ratio</td>
<td>.16</td>
<td>-.15</td>
<td>.20</td>
<td>.03</td>
<td>-.10</td>
</tr>
<tr>
<td>Maze Ratio</td>
<td>.01</td>
<td>-.18</td>
<td>.45</td>
<td>.10</td>
<td>-.09</td>
</tr>
<tr>
<td>DTI</td>
<td>-.21</td>
<td>-.18</td>
<td>.13</td>
<td>.11</td>
<td>-.10</td>
</tr>
</tbody>
</table>

from the comparison of the two groups’ r-values r to z transformation.
Table 5.11. *Correlation table of workplace success and the remaining EF variables.*

<table>
<thead>
<tr>
<th></th>
<th>JS (a)</th>
<th>SE (a)</th>
<th>AQ (a)</th>
<th>FS (a)</th>
<th>Promotion (b)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dys</td>
<td>Con</td>
<td>p</td>
<td>Dys</td>
<td>Con</td>
</tr>
<tr>
<td><strong>Inhibition</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GEFT</td>
<td>-.18</td>
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<td>.85</td>
<td>-.11</td>
<td>.17</td>
</tr>
<tr>
<td>Stroop PCI</td>
<td>.20</td>
<td>.02</td>
<td>.34</td>
<td>.10</td>
<td>.16</td>
</tr>
<tr>
<td>RNG Inhibition</td>
<td>.19</td>
<td>-.05</td>
<td>.57</td>
<td>.13</td>
<td>-.04</td>
</tr>
<tr>
<td><strong>Up-dating</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Listening Span</td>
<td>.02</td>
<td>-.01</td>
<td>.99</td>
<td>-.05</td>
<td>-.09</td>
</tr>
<tr>
<td>Spatial Span R</td>
<td>-.26*</td>
<td>.03</td>
<td>.23</td>
<td>-.19</td>
<td>-.37</td>
</tr>
<tr>
<td>Spatial Span F</td>
<td>-.18</td>
<td>-.03</td>
<td>.54</td>
<td>-.11</td>
<td>-.08</td>
</tr>
<tr>
<td>RNG Up-dating</td>
<td>.05</td>
<td>.08</td>
<td>.62</td>
<td>.05</td>
<td>-.35</td>
</tr>
<tr>
<td><strong>WM Span</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RNG Span</td>
<td>-.05</td>
<td>.07</td>
<td>.95</td>
<td>-.20</td>
<td>-.03</td>
</tr>
</tbody>
</table>

Note. (a) Pearson’s or Spearman’s correlation. (b) Point-biserial correlation. * p < 0.05. ** p < .01. Dys = Dyslexic group; Con = Control group. The p-value reported is from the comparison of the two groups’ r-values using r to z transformation.
To summarise, based on previous research as outlined above, differences were anticipated between the groups on all three of the executive functioning components, and some were evident in the t-tests, particularly in the Up-dating working memory measures. However, the correlational analyses did not provide a clear picture: even if differences did occur between the groups in executive functioning, these data provided no evidence that they were related to workplace success across the dyslexic and non-dyslexic groups.

**Literacy and workplace success**

The increasing use of the internet in the workplace has inevitably placed demands on literacy skills. Morissroe in The National Literacy Trust report (2014) stated poor literacy was a barrier in employment and “higher literacy levels were associated with higher earnings” (p.6). Therefore, it was predicted that the weaker literacy skills of this dyslexic group would be related negatively to the measures of workplace success.

Spearman’s correlations were performed to assess any relationships between workplace success measures and assessments of literacy and literacy-related skills (such as non-word reading and rapid naming) (see Table 5.12). No relationships were identified between literacy and the personal success criteria but, perhaps predictably, relationships were found for the dyslexic group between spelling and academic qualifications, and between speed of reading and academic qualifications, but these did not transform into significant differences between the groups on Fisher tests. Likewise, faster naming speeds of letters and numbers were related to financial success in the dyslexic group but again the differences between the two groups were not significant.
Table 5.12 Correlation table of workplace success and the literacy variables

<table>
<thead>
<tr>
<th>Test</th>
<th>Dys</th>
<th>Con</th>
<th>p</th>
<th>Dys</th>
<th>Con</th>
<th>p</th>
<th>Dys</th>
<th>Con</th>
<th>p</th>
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<th>p</th>
<th>Dys</th>
<th>Con</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>WRAT spelling</td>
<td>.05</td>
<td>.07</td>
<td>.86</td>
<td>-.21</td>
<td>-.12</td>
<td>.70</td>
<td>.47*</td>
<td>.21</td>
<td>.19</td>
<td>.18</td>
<td>.09</td>
<td>.70</td>
<td>.08</td>
<td>-.27</td>
<td>.14</td>
</tr>
<tr>
<td>WRAT SWR</td>
<td>.09</td>
<td>.06</td>
<td>.90</td>
<td>-.14</td>
<td>.06</td>
<td>.41</td>
<td>.13</td>
<td>.36*</td>
<td>.29</td>
<td>.20</td>
<td>.07</td>
<td>.56</td>
<td>.09</td>
<td>-.04</td>
<td>.60</td>
</tr>
<tr>
<td>Reading comp</td>
<td>.03</td>
<td>.24</td>
<td>.37</td>
<td>-.14</td>
<td>.12</td>
<td>.29</td>
<td>.02</td>
<td>-.01</td>
<td>.90</td>
<td>.23</td>
<td>-.04</td>
<td>.26</td>
<td>-.11</td>
<td>-.07</td>
<td>.88</td>
</tr>
<tr>
<td>Reading speed</td>
<td>-.05</td>
<td>.09</td>
<td>.85</td>
<td>-.06</td>
<td>.30</td>
<td>.53</td>
<td>.33*</td>
<td>.10</td>
<td>.30</td>
<td>.21</td>
<td>.01</td>
<td>.40</td>
<td>-.04</td>
<td>-.35</td>
<td>.18</td>
</tr>
<tr>
<td>TOWRE Sight word</td>
<td>.16</td>
<td>.24</td>
<td>.73</td>
<td>.11</td>
<td>-.04</td>
<td>.53</td>
<td>.12</td>
<td>.04</td>
<td>.73</td>
<td>.34</td>
<td>-.09</td>
<td>.07</td>
<td>.18</td>
<td>-.23</td>
<td>.08</td>
</tr>
<tr>
<td>TOWRE Non-Word</td>
<td>.26</td>
<td>-.07</td>
<td>.40</td>
<td>.07</td>
<td>-.20</td>
<td>.26</td>
<td>.19</td>
<td>-.07</td>
<td>.26</td>
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<td>.37*</td>
<td>.41</td>
<td>.18</td>
<td>-.29</td>
<td>.05</td>
</tr>
<tr>
<td>CTOPP letters</td>
<td>-.17</td>
<td>.09</td>
<td>.73</td>
<td>-.10</td>
<td>.19</td>
<td>.21</td>
<td>-.12</td>
<td>-.30</td>
<td>.42</td>
<td>-.31*</td>
<td>.10</td>
<td>.08</td>
<td>-.25</td>
<td>.05</td>
<td>.21</td>
</tr>
<tr>
<td>CTOPP numbers</td>
<td>.01</td>
<td>.06</td>
<td>.83</td>
<td>.10</td>
<td>-.08</td>
<td>.92</td>
<td>-.06</td>
<td>-.51*</td>
<td>.008</td>
<td>-.28*</td>
<td>.16</td>
<td>.07</td>
<td>-.28*</td>
<td>-.08</td>
<td>.40</td>
</tr>
<tr>
<td>CTOPP objects</td>
<td>-.13</td>
<td>-.15</td>
<td>.93</td>
<td>.02</td>
<td>-.11</td>
<td>.60</td>
<td>-.20</td>
<td>-.32</td>
<td>.58</td>
<td>-.22</td>
<td>.38*</td>
<td>.010*</td>
<td>-.14</td>
<td>.13</td>
<td>.25</td>
</tr>
</tbody>
</table>

Note. (a) Pearson’s or Spearman’s correlation. (b) Point-biserial correlation. * p < 0.05. ** p < .01. Dys = Dyslexic group; Con = Control group. The p-value reported is from the comparison of the two groups’ r-values using r to z transformation.

WRAT = Wide Range Achievement Test; SWR = single word recognition; Reading comp = reading comprehension; TOWRE = Test of Word Reading Efficiency; CTOPP = Comprehensive Test of Phonological Processing.
5.8 Summary

This Study was designed to explore differences in executive functioning skills amongst dyslexic and non-dyslexic people and relationships with workplace success. Executive functioning is multi-faceted, and there are many views on its measurement. Therefore, this Study drew upon the established research of Miyake and his colleagues (2000). The same or similar measures were used to investigate performance on the three core components of executive functioning identified in their research: Shifting, Up-dating and Inhibition. As in the Miyake et al. model, several measures for each component were used. Additionally, this Study included verbal and non-verbal measures to explore processing differences between the dyslexic and non-dyslexic participants. Deficits in executive functioning in the dyslexic group were predicted based on previous research (Brosnan et al., 2002; Berninger et al., 2008; Smith-Spark et al., 2003).

The results of the current Study indicated some differences between the groups on the executive functioning measures, but these varied across the three components. Only the Up-dating/working memory component showed some consistency in terms of significant weaknesses among the dyslexic group. Both Shifting and Inhibition showed inconsistent effects. In addition, there was no evidence that dyslexics performed significantly better than the non-dyslexics on the non-verbal measures. This Study also aimed to assess potential relationships between metacognition and executive functioning, but there were few significant correlations between the measures. Likewise, there were not the anticipated relationships between workplace success and executive functioning measures. In contrast, the dyslexic group were weaker than the non-dyslexics on measures of literacy and literacy related skills. However, levels of literacy were also not associated with workplace success.

The findings did not therefore present a clear picture indicating relationships between dyslexia, executive functioning, and workplace success. Each of these areas are summarised briefly below before moving to a final Chapter in which the implications of the results of all three Studies will be discussed.

Executive function and dyslexia

Shifting is sometimes called changing set or cognitive flexibility. The Plus-Minus measure, Trails and the Dual Task require being able to shift between mathematical calculation of
subtraction and addition; letters and numbers; non-verbal and verbal domains, respectively. Of these measures, the Plus-Minus measure was the only one that showed a significant difference between the groups, after the influence of processing speed had been eliminated. Once speed of processing had been eliminated as a factor on the Trails and Dual Task measures, there were no significant difference between the groups. The fourth measure of Shifting was the Wisconsin Card Sorting Test, which Miyake et al. (2000) concluded was an accurate measure of Shifting requiring higher-order problem-solving (see Diamond, 2013). There was also no difference between the groups on this task.

Inhibition refers to the ability to monitor and control automatic or previously learned responses. On the measures of this aspect of executive functioning, only the RNG Inhibition measure showed a significant difference between the groups. There was no difference on the Stroop interference measure when speed of processing was eliminated, nor on the Group Embedded Figures Test, findings which were unexpected, given the previous research literature (Brosnan et al., 2002; Everatt, 1997; Jefferies & Everatt, 2004).

There was more evidence of deficits in the dyslexic group in the Up-dating component. Updating in this current Study was seen a synonymous with working memory, which is seen as the system that retains information and is able to process or manipulate it (i.e., up-date it). Three out of four of the measures produced significant group differences. These results are in accordance with poorer performance on measures of working memory amongst dyslexic people (Brosnan et al., 2002; Everatt, 2004; Smith-Spark et al., 2003; Smith-Spark & Fisk, 2007). The Listening Span measure, based on the test devised by Daneman and Carpenter (1980), requires both processing and storage functions of working memory, and it also places demands on phonological processing, phonological memory and declarative/semantic memory. As the semantic recall in the two groups was similar, differences were less likely to be a result of deficits in semantic processing, suggesting that poorer performance on this task may more likely be due to weaker working memory and/or phonological processing skills. Similarly, on the non-verbal measure, the Spatial Span Task, the dyslexic participants performed poorly in comparison to controls. These results contrast with Brosnan et al (2002) and Everatt (2004) who found no differences between the groups on Visual-Spatial Tasks. The differences between the groups in the present data were greater on the Forward Spatial Span measure. The fourth measure was the Up-dating measure from the RNG. While it loaded onto the Up-dating component in their research, Miyake et al (2000) argued that the measure may tap several aspects of executive processing, such as Inhibition and attention.
More detailed research on the actual components RNG may provide greater insight (Towse, 1998).

Miyake did not allocate to a specific component the RNG Span length measure. However, it may be considered as resembling the Digit Span Test (Wechsler, 2008) which dyslexic people often find more difficult than non-dyslexic people. The results from this Study suggest that the dyslexic participants had lower RNG Span lengths than the controls.

There was insufficient evidence to suggest that the dyslexic participants outperformed the controls in non-verbal processing. This lack of evidence of visual strengths is in line with a growing body of research (Alloway & Alloway, 2013; Brosnan et al., 2002; Bacon & Handley, 2010; Everatt, 2004; Smith-Spark et al., 2003). Moreover, there was evidence to indicate the dyslexic participants were weaker in some aspects of non-verbal processing; they were slower than the controls on maze completion (see also Menghini et al., 2011; Smith-Spark & Fisk, 2007).

An area where the dyslexic participants consistently performed less well than the controls was on any speeded verbal task. The dyslexic group were significantly slower on the base line tasks of Trails, Plus-Minus and Stroop; and slower on the Rapid Naming tasks. Poor performance was also evident on the verbal fluency task which requires the retrieval of words from long-term memory within the constraints of the initial letter, arguably involving phonological processing and semantic recall. As with the Listening Span Test, such deficits in the dyslexic group may be related to the phonological processing difficulties.

**Executive functions and metacognition**

As mentioned previously, the lack of associations between the executive functioning and metacognitive measures were surprising in view of the conceptual theoretical overlaps in terminology and constructs (see Chapter 2, p.46). In addition, there were some indications that good metacognitive skills did influence workplace success in the previous two Studies, this will also be discussed in more detail in the next Chapter (Chapter 6, p.185).

**Executive functioning and workplace success**

There has been consensus in the literature that good executive functioning skills improve people’s academic success and performance in the workplace: better cognitive flexibility aids
decision-making, leadership, creativity and entrepreneurship, leading to greater feelings of job satisfaction and self-efficacy (Bailey, 2007; Kanfer & Ackerman, 2005). However, the findings in the current Study do not fully support this. The lack of relationships identified for the dyslexic group may be indicative that dyslexic people make use of a different range of cognitive strategies that this research has been unable to determine. However, the two groups (dyslexics and non-dyslexics) did show evidence of attaining the same levels of success, irrespective of any executive functioning differences. Further research, which explores strategy use, job-specific and environmental aspects, may reveal how the dyslexic group achieved this (this will be discussed further in the next Chapter).

**Conclusions**

In relation to the three research questions, the findings suggest that dyslexic people may differ from non-dyslexics in certain aspects of executive functioning skill. Overall, the dyslexic participants performed less well than their non-dyslexics peers on measures associated with the processes of working memory. However, this was not a general deficit in executive functioning. Furthermore, despite any executive functioning deficits, and the weaker literacy skills of the dyslexic group, they showed evidence of being as successful as they non-dyslexic peers in terms of job satisfaction and self-efficacy, academic qualifications and financial success. Hence, for these dyslexic participants, any deficits did not seem to influence their workplace success. There is little in these data to suggest how these dyslexics achieved this, but perhaps their occupations suited their background and skills, so they have been able to develop job expertise, a point that will be returned to in the final Discussion.
Chapter 6

6. General Discussion

6.1 Introduction

An underlying premise of this research was that metacognitive processing might be instrumental in the success of dyslexic adults. This idea developed from the researcher’s own experiences of working with dyslexic children and adults as a teacher and tutor over many years. In addition to helping those with dyslexia develop their literacy skills, much of the work with adults has also focused on improving planning and organisational skills, as well as strategy development. This focus has been in response to the adults’ own reports of the difficulties they experience in training and the workplace. Recommendations for interventions made in diagnostic and workplace assessment reports have also stipulated the need for interventions that support planning and organisational skills due to potential deficits in memory and executive functions. The assessment of memory skill has been central to the diagnostic process, but rarely has there been systematic evaluations of executive processes, which raises the question of whether evidence can be found indicating that dyslexic people have more difficulty than non-dyslexic people with executive functions.

Research suggests that metacognition may improve the performance of dyslexic people in a range of contexts (Gerber, 2012; Meltzer, 2014; Trainin & Swanson, 2005). However, there has also been evidence which suggests that metacognition does not develop automatically in dyslexic people (Butler, 1995). As discussed in this Thesis, there is evidence to suggest that the development of metacognition may improve performance in academic and workplace settings generally. The question arises, therefore, as to whether metacognitive skills are weaker in dyslexic people and, if they are, does this influence the ability of the dyslexic individual to become successful.

Many dyslexic people develop their literacy skills to a competent level so, as the common understanding of the syndrome is that it only affects skills such as reading and spelling, poor performance at work may be construed as incompetence or inability. This may be due to the lack of research on the effects of dyslexia in the workplace, and is compounded by the variability in work-related achievements attained by dyslexic people, some are successful, some are not. The challenges facing people in the world of work are continually changing, there being increased demands on goal setting, multi-tasking, decision making, meeting
targets and deadlines and working in time pressured environments. This potentially puts dyslexic people at risk if they have executive functioning deficits.

On this basis the three research questions stated in Chapter 1 were formulated. These were:

1. Is there evidence that dyslexic people differ from non-dyslexic people in metacognitive skill and executive functioning skill?
2. Is metacognitive processing related to workplace success? Is there any evidence for any such relationships to vary across dyslexic and non-dyslexic people?
3. Do executive function processes influence workplace success? Is there evidence that such influences vary across dyslexic and non-dyslexic people?

Three studies were designed to provide answers to these questions. Participants were a group of dyslexic adults drawn from a variety of occupations and a control group who were matched on age and occupation. The first study established measures of workplace success: personal success criteria of job satisfaction and self-efficacy, and societal success criteria including academic qualifications and financial status. The findings of Study One determined that both groups were experiencing equivalent levels of workplace success. It also explored planning, metacognitive skill and cognitive failure, the last being considered a measure of executive attention/function. Study Two investigated the role of metacognition, confidence and reasoning, as well as actual task performance in relation to workplace success. In the final study, Study Three, executive functioning components of shifting, inhibition and updating were explored through one-to-one psycho-educational assessments. This study also included measures of fluid intelligence and semantic recall; though there were no statistically significant differences between the groups on these two measures. Levels of literacy attainment and literacy-related skills (such as rapid naming) were obtained and indicated that those in the dyslexic group were significantly weaker in these areas than those in the non-dyslexic group. All of these data were also analysed in relation to workplace success.

6.2 Executive functioning, working memory and dyslexia

Across all three studies, there was some evidence to indicate that the dyslexic people differ from non-dyslexic people in some aspects of executive functioning. This is partially consistent with previous research suggesting that dyslexic participants experienced greater problems with certain attention and memory tasks than their non-dyslexic peers (McNamara
& Wong, 2003; Smith-Spark et al. 2003, 2004). However, the data in the current Thesis indicate that differences between dyslexic and non-dyslexic participants were most consistently found with measures of updating. The argument throughout this Thesis has been there is a greater overlap between updating functions and working memory, than between shifting or inhibition and working memory these findings suggested that dyslexic people may have deficits in those aspects of executive functioning that require working memory.

However, this interpretation was not entirely consistent with all of the data, indicating that further research is needed. For example, the deficits in the updating component does not explain why no difference was found between the groups on the RNG updating measure (though see discussions in Towse, 1998). This interpretation was also somewhat inconsistent with the finding of the differences between dyslexics and non-dyslexics on the forward spatial span task. In most models of working memory, a simple retention task, such as recalling the order of spatial locations, would be considered to be to the functioning of short-term memory or an analogous slave system operating within working memory. Only when there is a requirement for more complex processing of material (in this case reversing the order of recall) should the processes of the general working memory system be used. In Study 3 of this Thesis, the dyslexic participants appeared to struggle with maintaining simple spatial information, possibly in addition to problems with being able to manipulate it as effectively as the non-dyslexic participants. Whether this was due to an insufficiency in working memory capacity, competing demands of storage and processing, or a deficit in the executive system (Baddeley 2012; Cowan, 2008; Engel et al. 2002) remains to be determined: currently, the available research is unable to distinguish between potential explanations.

The current Thesis data have provided some further evidence of deficits in relation to working memory processes. The role of working memory in dyslexia has received increasing research interest, though the exact reason for potential deficits has been debated. Some have argued that phonological processing deficits, which have been associated with dyslexia, impact on working memory processes, particularly verbal working memory (Berninger et al., 2007; Démonet et al., 2004; Jeffries & Everatt, 2004). Similarly, Swanson (2015) has provided evidence to suggest that dyslexic people have deficits in verbal short-term memory, including tasks requiring phonological coding and rapid naming. He has also claimed that complex working memory tasks (which would include the listening span task used in the current research), which would require the holding on to information in the face of
distraction, should be somewhat independent of short-term verbal working memory. Swanson (2015) concluded “that the limitations in the executive components of working memory can operate independently of those deficits in phonological processing” (p. 189). Kane and Engle (2002) have also maintained that verbal short-term memory and working memory tasks should be considered as inherently different. They draw a distinction between lower and higher-level cognition and that individual differences in working memory capacity refers to the individual’s capability for executive attention. They do not consider it to be a limited resource model, they suggest that no measure of working memory can exclude an executive attention component. Hence, their conception of working memory is related to executive control and attention “maintaining goal relevant information in a highly accessible state and in conditions free of interference and competition” (p. 149). Likewise, Swanson (2015) contends “attention problems (in dyslexic children) are related to their capacity to maintain and hold relevant information in the face of interference or distraction” (p. 187).

In contrast to the findings with the updating tasks, there was little evidence of differences between dyslexic and non-dyslexic participants in the shifting measures. The only one of the four measures used that showed a significant difference between the groups was the Plus-Minus measure. The temporal cost of shifting was far greater in the dyslexic group after the influence of processing speed had been eliminated by using ratio as the final measure, consistent with the findings of Smith-Spark et al. (2016). There are several interpretations for this difference. The Plus-Minus measure was the only task to require a speeded written response, it was a pencil and paper task, for example, which may be impacted by the dyslexic participants’ continued difficulties with certain areas of literacy. Alternatively, this measure also required relatively quick mental arithmetic calculations; and mental calculations have been suggested as an area of weakness among dyslexic individuals (see Chinn, 2009). However, these specific influences on this measure need not be related to executive functioning. Therefore, it cannot be conclusively argued that the current data provides evidence for weaknesses among dyslexic adults in terms of executive shifting processes.

Likewise, there were few group differences found on the executive inhibition measures. The only executive inhibition measure that showed a statistically significant group difference was the Random Number Generation Inhibition component. This finding was in contrast with lack of effect on the Updating component of the same task. Differences between the Random Number Generation components was not unexpected, and would be consistent with arguments for the independence between these factors as proposed by Miyake et al. (2000).
Clearly, the Random Number Generation task is a novel, multifaceted test that depends on a range of processes/abilities (Miyake et al., 2000; Towse & Neil, 1998). As such, the current findings were consistent with arguments for this task requiring complex executive processing (Baddeley, 1998). The task can be argued to tap several cognitive processes, and impairments in any one element may impact on performance (Towse, 1998). However, currently there has been little research involving this task with those with dyslexia, and future research may provide better understanding of the differences and similarities in performance between dyslexic and non-dyslexic participants identified in the current Thesis. What these findings do confirm is that even within the same task, measures considered to tap executive processing do not show consistent deficits among the dyslexic participants. Again, these findings do not support a general executive functioning deficit being related to dyslexia in adults.

The last measure related to executive processing that was used in the current Thesis work was the Cognitive Failures Questionnaire. This questionnaire has been considered to measure the ability to focus and maintain attention on day to day tasks, as well as the ability to remember information and how to perform routine tasks: it is a measure of self-reported failures in perception, memory and motor function. The findings of Study 1 suggested that this was an area of deficit for the dyslexic participants. Smith-Spark et al. (2004; 2016) also found that their dyslexic adults reported more failures than reported by non-dyslexic peers. The reason for such results requires further data, but given the findings described above, that the dyslexic participants show more consistent evidence of difficulties in tasks requiring updating, processes related to working memory, then the increased number of self-reported cognitive failures may be related to such updating/memory rather than executive processes related to inhibition or shifting. These data, therefore, may provide a direction to investigate further the self-reported cognitive failures of dyslexic people. They also suggest the potential importance of additional research as a way of considering the real-life practical implications of difficulties experienced by adult dyslexics.

Therefore, overall, while there were indications in the present research for some areas of deficit related to executive functioning, consistent with previous research, the current Thesis findings do not provide sufficient evidence to conclude that dyslexic people have a general executive functioning deficit. It potentially provides some support for working memory, which may impact on other executive processes (Friedman & Miyake, 2012; McCabe et al 2010). Furthermore, the deficits outlined above could account for the reported difficulties
dyslexic people with multi-tasking and memory lapses. Further research, therefore, is necessary to investigate these specific effects, as well as the variations across studies, to determine areas of weakness related to adult dyslexia.

6.3 Metacognitive processing and dyslexia

The other major area of processing that the current Thesis considered was that of metacognition. The results indicated a statistically significant group difference on one of metacognitive components: the dyslexic participants’ responses on the Knowledge of cognition scale suggested lower levels of self-knowledge compared to the non-dyslexic participants. Schraw and Denison (1994) have argued that Knowledge of cognition was self-awareness of one’s declarative, procedural and conditional knowledge, or knowledge of skills, tasks and strategies, and as well as knowledge of how and when to deploy them. It has also been argued that this type of knowledge develops over time; although it precedes the Regulation of cognition component (Schraw & Denison, 1994; Sperling et al, 2004). Possible reasons for the identified difference between the dyslexic and non-dyslexic participants were discussed previously, in Chapter 4 p.133: for example, metacognitive skill may have developed out of an experience of positive learning situations (see also Bergey et al., 2017; Butler, 1998) and dyslexic people potentially fewer such experiences. However, such explanations were not consistent with the lack of difference between the groups in terms of the Regulation of cognition scale. Regulation of cognition includes aspects of planning and monitoring skills, and differences between the groups were unexpected based on previous research (Brosnan et al., 2002; Smith-Sparks et al., 2016), as well as the anecdotally reported problems with planning and organisation that dyslexic people experience (De Beers, 2014; Bartlett & Moody, 2010). These findings suggested that dyslexic people do not have an intrinsic problem with planning or monitoring. The Regulation of cognition scale has also been associated with goalsetting, identifying errors and reflection on performance. However, Schultz and Roßnagel (2010) have argued that these skills can be implicitly learned in the workplace. Work goals or targets are often set for individuals (Munby et al., 2003), and there was evidence that the dyslexic participants had their own career goals. Hence, it might have been that the dyslexic participants had developed their Regulation of cognition skills via experiences in the workplace. Why this did not show the same influence on Knowledge of cognition remains to be explained, although arguably planning can be a learned skill acquired through strategy development. Further work is needed here also, perhaps in terms of comparisons of dyslexic adults in workplace versus educational contexts, to clarify the reasons for the differences identified in the current Thesis.
Given that Regulation of cognition has been considered as related to planning skills, then the findings on this scale were consistent with the findings of the planning scale introduced in Study 1. Both planning scales showed non-significant differences in the self-reports of the dyslexic versus non-dyslexic participants. This lack of effect, though, differed from the findings produced in the self-reported planning behaviour of the participants when asked to solve a verbal reasoning task: the dyslexic group reported planning significantly less than the non-dyslexic group on this verbal reasoning task. One potential reason for this was that this task required verbal processing, which the dyslexic participants may feel less confident about and interpret this as poor planning behaviour. This focus on the verbal aspects of the task would be consistent with the finding that there was no differences between groups in self-reported planning behaviour on the non-verbal task. Hence, when considering such metacognitive factors, the type of examples or tasks used in self-reports may need to be carefully considered when involving dyslexic adults. In the literature, planning has generally been defined in terms goal setting, with little specification of the task, whereas finding a plan to determine a solution or perform a task, arguably, involves a different set of cognitive skills related to task analysis. Therefore, while there was no consistent evidence of poor planning skills in this group of dyslexic adults, as discussed in the previous paragraph, it would be interesting if further research could determine if these people had perhaps learned to compensate as part of their work experiences, and whether these experiences lead to differences in self-reports rather than any underlying difficulties.

In relation to the first research question of this current Thesis research, the findings indicated that there were no obvious dyslexia-specific deficits in planning or cognitive control, which argues against a general deficit in metacognition experienced by these dyslexic individuals. This may be because dyslexic people do not have intrinsic problems with metacognition or alternatively they have developed strategies related to experiences in the workplace. Either way, as with the findings for executive functioning, the current data suggested that poor metacognitive skill is not necessarily a general problem for adults with dyslexia.

6.4 Issues of speed of processing and verbal fluency

There were two other areas of cognitive processing where significant differences between the dyslexic and the non-dyslexic participants were identified. These were in aspects of speed of processing and verbal fluency. Slower processing speeds, in comparison to the non-dyslexic
participants, were a factor in the performance of the dyslexic participants across a range of measures in the current work, and speed of processing has often been measured in research though, potentially, without sufficient recognition of its involvement in the performance of many tasks (see Salthouse, 1996). It was of interest in the research reported here as it has been argued to be a fundamental part of the cognitive system (Kail & Salthouse, 1994), and essential to the efficient processing of information (Kail, 1991). Speeded (or automatic) processing of basic aspects of information leaves more resources available for thinking about, or fully comprehending, material (Flannigan & Harrison, 2005; Salthouse, 2006): for example, in reading, automatic processing of individual words should allow more resources to be made available for the comprehension of text. Given that skills such as text comprehension will involve executive and/or working memory processes, then speeded processing of basic material may impact on the efficiency of these executive and/or working memory processes. In the present research, processing speed was considered as the ability to appraise and perform cognitive tasks quickly (Flannigan & Harrison, 2005), and a variety of speeded tasks were included in a battery of measures incorporated into Study 3. An interesting feature of the current Thesis work was that, in the executive functioning measures, when the effect of processing speed was minimised (e.g., by taking a ratio measure of performance that controlled for processing speeds), there was little difference between the groups. This may be consistent with an interpretation that slower processing speeds experienced by the dyslexic participants may impact on executive functioning; therefore, future research should also consider this potential influence when designing measures to contrast the performance of dyslexic and non-dyslexic participants. However, it should also be noted that there were measures used in this current Thesis that did not require speeded processing, but which still showed differences between the two groups of participants. Hence, a speed of processing explanation cannot fully account for differences between the groups, but should be considered in future research involving dyslexic adults.

Verbal fluency was also an area of significant difference between groups: the control group typically outperforming the dyslexics. A possible explanation previously proposed in the literature is that dyslexic people have trouble with verbal processing (Brosnan, 2002; Smith). Smith Sparks et al, (2017) explored relationship between design, semantic and phonemic fluency tasks. Their findings indicated that dyslexia predicted deficits, but only in phonemic fluency. They acknowledged that phonological processing difficulties were related to phonemic fluency deficits and concluded that ‘executive control’ may also have a role in performance as the participants were less able to switch between categories. Snowling (2014)
has argued that a phonological processing problem is “not sufficient to cause dyslexia; the likelihood of diagnosis is increased in the context of broader oral language difficulties or possible where there are co-occurring impairments such as attentional processes” (p. 47). However, a simple verbal processing deficit explanation does not fit with all the findings in this Thesis either. The dyslexic participants were also weaker on the spatial span measures. If the findings were only due to verbal processing deficits, then performance on the spatial span measures should be equivalent across the groups. It may be that these spatial span results could be explained if a proportion of dyslexics also showed difficulties with visual-spatial processes (Bacon et al., 2013), but further research exploring visual versus verbal difficulties would be necessary to test this possibility; and a simple visual deficit cannot explain the dyslexic participants equivalent performance on the non-verbal (matrix) reasoning measure. Therefore, further research contrasting different types of stimuli and different types of tasks (memory versus reasoning) may need to be considered further.

6.5 Models of executive processing, metacognition and working memory

The research performed as part of this Thesis was based on Miyake et al.’s (2000) conceptualisation of three components of executive function, and the Baddeley (2002, 2011) model of working memory. The lack of consistency in the data obtained across the three studies performed does not fully support either of these theoretical conceptions of executive processing. This may be a function of the fact that the majority of the participants in the research were dyslexic, which may lead to conclusions that would not be generalizable to the non-dyslexic population for which the original theories were developed. However, the data from the control participants were also not entirely consistent with predictions derived from these models and further research would seem to be necessary to determine why findings would vary across different populations. Clearly, the actual task demands can influence findings. For example, Towse (1998) found that there were significant differences in the performance of participants on the same RNG task when utilising different response modes: keyboard press versus oral response. There is also the difficulty of task impurity. Most of the tasks used to assess executive functioning are complex and require multiple basic and more complex processes (Miyake & Friedman, 2012). However, the current research employed a range of response formats and test measures, including some of those used in studies from which the main theories used in this research were developed. Therefore, again, it seems unlikely that this would present a full explanation of the inconsistencies identified in
the current data. Hence, the conclusion of the current research is that these models require further elaboration and modification.

This is not a new argument. For example, Salthouse (2006) has argued that the construct of executive functioning “lacks discriminant validity and that executive functions is broader and less coherent than a psychometrically based cognitive ability construct” (p. 50). Diamond (2013) has argued for a broader perspective on executive functions, which included higher-level problem-solving, emotional control and self-regulation. However, while it provides a coherent picture of a complicated area, the difficulty with this model is that all of these separate components were considered to inter-connect, which makes predictions based on this model difficult. Similarly, Brown (2013) suggested that the various components of executive functioning all work together in various combinations (see also Lezak et al. 2012).

Furthermore, these models have often included larger ranges of processes than the original conceptualisation of executive functioning would accept (e.g., Brown includes speed of processing), making it even harder to derive clear predictions and test the models.

Nevertheless, the frameworks potentially aid clarification of cognitive systems (Baddeley & Hitch, 1974; Cowan; 2008; Diamond, 2013; Miyake, 2000). These can provide structures and bases for research, and operational models that can be tested. They may also help to explain difficulties experienced by dyslexic individuals and suggest rationales for strategy use (Hock, 2012) in coaching: for example, the importance of planning, activating prior knowledge and focussing attention (Baddeley 2012; Cowan 2008).

The inconsistency of the findings reported in this Thesis, however, suggests that these models need to be further developed and revised (see also Diamond, 2103; Salthouse, 2012). Therefore, the Diamond model presented in Chapter 2 (p.33) has been adapted below to provide further potential areas of research, and to focus ideas on those related to adult dyslexia considered in this Thesis (see Figure 6.1). Given the potential for updating processes related to working memory to be a more consistent areas of difficulty for dyslexic adults, this component has been moved to a more central place, primarily in order to suggest that further research should concentrate within this area. Inhibitory control is now placed above shifting and working memory in support of the overarching theory of Kane & Engle (2002) and McCabe et al. (2010); and higher level executive processes are included but separated from inhibitory control, working memory/update and shifting. Again, further research clarifying the potential interactions between these different elements would be useful. The few elements that have been explored in the research performed as part of this Thesis are asterisked. The arrows display some of the interactions of the cognitive processes.
In addition, the model has been revised to specifically include language processing as a related aspect of executive functioning, and to acknowledge the potential influence of speed of processing. While the latter is not an executive function, it is inherent in many executive functioning processes and, potentially, should be considered in research with dyslexic people or when collecting data on fluency (see discussions earlier in this Chapter, p.186). Lesak, Howieson, Bigler, and Tranel, D.(2012) and Jurado & Rosselli (2007) have suggested that verbal fluency is a measure of executive function. Furthermore, Fisk and Sharp (2004) identified verbal fluency as a fourth component of the Miyake model, arguing that tasks requiring verbal fluency make demands on higher-order cognitive abilities and overlap with components of maintaining and updating information as well as suppressing irrelevant responses, shifting between categories and the maintenance of attention. Vygotsky (1962) proposed that thought and complex cognitive processes were associated with inner speech, the internalisation and verbalisation of cognitive...
Figure 6.1 an adapted model of executive function – adapted from Diamond (2013) processes. He argued that language was a primary instrument for conceptualisation and thinking and has a symbiotic relationship with executive functions. Diamond (2014) and Gordon-Perschey (2014) argue that language and verbalisation are essential to learning and reasoning but there has been less focus on the potential relationships between language, reasoning and executive functions (although see Acheson & MacDonald, 2009), even though such relationships may aid explaining the models, and may be a specific area of research with individuals with dyslexia.

6.6 Metacognition, executive functioning and workplace success

The main aim of the research conducted as part of this Thesis was to investigate aspects of cognitive functioning (specifically executive functioning and metacognition) that might influence workplace success in dyslexic people. An overview of the relationship findings are provided in Figures 6.2 and 6.3; though see the descriptions of results across the three studies as these figures need to be interpreted with caution due to differences in sample sizes and the potential for chance effects occurring when performing large numbers of correlational analyses. Such overviews, though, can make clearer patterns of consistencies within the findings.

As the figures make clear, the most consistent relationships were identified between the personal workplace success criteria and measures of self-reported metacognitive processing; i.e., planning, knowledge and regulation of cognition. This pattern of relationships seemed to be fairly consistent across both groups of participants and was in line with the career success literature (Bandura & Locke 2003; Bono & Judge, 2003): for example, the role of planning and goalsetting in relation to workplace success has been documented (Locke & Latham, 2002).

As previously discussed in this Thesis, Knowledge of cognition has been seen as integral to self-efficacy. For example, one of the principles in Bandura’s (1986) social cognitive theory of self-efficacy was mastery (that is, self-knowledge of personal performance), so the relationship between Knowledge of cognition and both self-efficacy and job satisfaction was predictable based on this theoretical perspective.
However, Figures 6.2 and 6.3 also show clearly the relatively small number of relationships between the societal measures of success and the other measures in the study. The lack of relationships between the metacognitive measures and academic qualifications, in particular,
contrasts with much research previously cited in this Thesis. Although much of the previous research was predictive of relationships, Sperling et al. (2004) have also referred to a lack of consensus about the relationship between metacognition and academic achievement. Furthermore, recent research by Chevalier et al. (2017) found few relationships between academic achievement and metacognitive processing, and Bergey et al. (2017) have concluded that many metacognitive inventories used in research do not accurately predict academic success.

Hence, in relation to the second research question, the findings argued for good metacognitive skill to be related to higher job satisfaction and better self-efficacy for dyslexic and non-dyslexic people alike. Likewise, and contrary to much research, neither group showed consistent relationships between the metacognitive scales used in the studies and the societal success criteria. As discussed in study 2, clearer clarification of the metacognitive processes being explored, particularly in relation to the context of their application (for example, in academic or workplace settings), would be advisable for future research (Dinsmore et al., 2008; Schunk, 2008). At present, the current data indicate that the aspects of metacognition studied in this Thesis were not a specific feature of workplace success for dyslexic adults over-and above that expected for the general population.

The findings are less conclusive in the executive functioning data. This may be considered surprising given the range of measures of executive functioning, and the relatively large number of dyslexic participants, included in the research. Indeed, the lack of consistent relationships between the executive processing measures and workplace success criteria (either societal or personal) could be argued to suggest (as for the metacognition conclusion) that the aspects of executive functioning studied in this Thesis were not a specific feature of workplace success for dyslexic adults over-and-above that expected for the general population.

The one area of consistency was the relationships between academic success and literacy skills. Although the levels of literacy between the two groups were significantly different, higher levels of literacy in each group were associated with higher levels of academic qualification. More surprising was that literacy was not related to the other workplace success criteria. This contrasts with much of the dyslexia research, which has argued that lower levels of literacy encroach on job satisfaction (De Beers et al, 2014). Additional research has suggested that the struggle to acquire literacy can have a negative impact on
self-esteem and/or self-efficacy (Klassen, 2011; McNulty, 2003; Nalvaney et al., 2011). Given that the dyslexic participants had gained equivalent academic qualifications, it may be that they had developed literacy skills to a competent level, which was appropriate for their workplace environment; or it may be that they utilised appropriate support, such as assistive technology, to enable them to deal with the literacy demands of their jobs. However, whatever the reason, the current findings suggested that weaker reading and spelling skills (as well as slower processing speeds) were not necessarily a barrier to achieving success in the workplace comparable with their non-dyslexic peers. Such findings should be seen as a positive outcome for individuals with dyslexia-related difficulties.

Overall, despite the range of possible explanations for success in the workplace posed by the current research, none have shown to be specific to this group of dyslexic adults. The question remains, then, whether there are specific factors enabling these dyslexic adults to achieve success or whether the same factors that influence all individuals are experienced by adults with dyslexia. For example, dyslexic and non-dyslexic participants self-reported similar levels of planning, and planning has been recognised as a precursor of success. Therefore, both groups of participants could show parity of achievement due to the same underlying factors. Equivalent levels of workplace success in this research, however, could be attributed to self-selection processes: it may be that only those who perceived themselves to be successful volunteered for such research. This does not explain what underpinned competent performance in the workplace; it just suggests that those who have developed competent performance were more likely to participate. Related to the idea of self-selection is the possibility discussed previously that job selection is important: that is, those individuals who are successful in their work select jobs that fit with their skills. Gerber and his associates (1992, 1994, 2002, 2012, 2013) have attempted to provide explanations for success in the workplace by dyslexic adults, and they have now refined their models to include a factor referred to as ‘finding a niche’. This factor can be associated with developing expertise.

According to Sternberg (2005) there are a number of factors that lead to expertise. These included knowledge, both declarative and procedural, of the area within which an individual can be considered an expert. However, he also discussed the idea of experience; the expert being able to draw on their personal resources. A third element was deliberate practice, reinforcement and over learning. This would also relate to reflection and metacognitive skill. Basically, the more knowledge and experience gained, the better able the individual should
be to analyse tasks, develop strategies, monitor effectiveness, evaluate performance, refine skills and attribute their performance to their own efforts (Zimmerman, 2006). In the executive functioning literature, the role of domain knowledge and experience plays an important part in improved performance. In a study exploring relationships between recall, domain knowledge and working memory, Hambrick and Engle (2002) determined that the level of domain knowledge accounted for 55% of variance in a composite measure of memory performance. These data suggested that the level of expertise was the primary influence on recall. Hambrick and Engle concluded that the acquisition of knowledge increases working memory capacity, providing a framework for more efficient encoding, which facilitates retrieval and enables increased focus of attention. Baddeley (2003) argued the degree of semantic knowledge on a specific subject was a major factor in the performance of working memory. Kail and Salthouse (1994) reported that, in a study of experienced typists, processing speed did play an important part in age-related decline of performance, but that experience and knowledge compensated for this loss of speed. It has also been argued that developing expertise can increase cognitive flexibility and efficiency when dealing with novel situations and improve deductive reasoning (Horn & Blankson, 2005; Sternberg, 2005). It may also play a part in increased automaticity of processing, and building multiple representations of knowledge enabling increased transfer of skills and knowledge (Norman, 2005). Salthouse (2012) takes a similar view in arguing that increased accumulated knowledge allows for increased competency due to less novel problem-solving requirements and a higher reliance on retrieval of earlier solutions.

All the elements mentioned above are the underlying principles of many specialist literacy programmes for dyslexic children that have the aim of developing literacy expertise. With regard to the development of reading skills, Fink (1999) in a constructivist study reported that the successful dyslexic adult participants did not develop the mastery of basic skills but used higher-level cognition skills and practiced on discipline-specific texts to develop familiarity with the words and concepts which led to improved comprehension and fluency. The knowledge gained, and practice-developed expertise and confidence in reading ability, was then transferable to broader more general reading texts; see also Kintsch, Patel and Ericsson (1999). Therefore, as people gain experience or expertise in job-specific tasks, and with the language used as part of the workplace (i.e., professional and technical jargon), it would be conceivable that they can rely on work-specific strategies that might mediate (compensate for) dyslexia-related difficulties. Hence, expertise or job-specific strategies, may allow dyslexic people to achieve equivalent success to their peers. Therefore, additional future
research that assesses job-specific expertise and strategies may improve our understanding of how some dyslexic adults have become successful in their work, whereas others have not. Such research may also help explain why some dyslexic adults have been reported to experience continued problems related to their dyslexia, whereas for others there may be little evidence of dyslexia negatively impacting on workplace success.

In summary, the dyslexic participants included in the current Thesis research were as successful as their non-dyslexic peers despite some evidence of poor performance in executive processing tasks. Additionally, measures of metacognition did not account sufficiently for any variations in workplace success across the cohort of dyslexic adults – and where relationships were identified, these were consistent with data from a non-dyslexic sample. Therefore, other aspects related to workplace performance may have to be considered in future research (see examples in Gerber et al., 1992; Madaus, 2010). Assessment of factors such as ‘finding a goodness of fit’ or ‘finding a niche’ may inform explanations of performance (Schneider et al., 2016) and the role of expertise (Sternberg, 2004; Zimmerman, 2006) may be an additional source of explanatory modelling.

6.7 Limitations and Future research

One of the potential limitations to the interpretation of findings obtained through the current Thesis research was the difference in sample sizes used across groups and between studies. Future research that addresses this potential concern would be welcome, maybe with a focus on different employment contexts; and potentially contrasting employment versus adult education contexts. There has been a paucity of research regarding dyslexia in the workplace, therefore further data on which to develop explanations (and models) would be useful. While comparisons can be drawn with studies on adult students and children in school, the workplace is a context of learning with specific environmental influences.

A further limitation (which could also be seen as a positive finding in the current research) was that those in the dyslexic sample seemed to show comparable evidence of success to their non-dyslexic peers; and similar levels of job satisfaction and self-efficacy. Although positive, this means that the sample may have been restricted in its influences on success. A restriction in range on the success criteria, therefore, might have reduced the potential to identify relationships with underlying cognitive processes. Therefore, research involving dyslexic people who are less successful, or who find work more challenging and are denied
promotion, might give greater insight into what cognitive processes support dyslexic people to succeed. Again, contrasts across different types of employment, and contrasts with those with lower levels of job experience may be useful. The latter would allow a comparison of different levels of experience or expertise.

Intervention studies targeted at improving job performance in those with low levels of work success might also provide improved explanations of the factors that influence personal and societal success criteria. Training in job-specific metacognitive processing and the development of expertise may provide more evidence for the factors that lead to improved success and should inform coaching programmes. Although this Thesis has not found evidence of dyslexic participants showing deficits in planning, it is an area that is said to be fundamental to performance, and specific training for those experiencing low levels of job satisfaction and or self-efficacy should also be useful in the development of explanatory models. A training/intervention study would (if appropriately conducted) provide evidence for potential causal relationships between underlying cognitive strategies and success criteria.

Under the terms of Equality Act 2010, employers have been obliged to make ‘reasonable’ adjustments at recruitment and in the workplace to enable those with disabilities to perform effectively. To ensure that adjustments are reasonable, they should be based on documented individual needs, which are usually outlined in diagnostic reports and/or workplace assessments. The most common (perhaps the most important) adjustment is time. Shaywitz (2003) wrote that “dyslexia robs a person of time: accommodations return it” (p. 314). The research reported as part of this Thesis also provided additional evidence that tasks which require speeded processing are performed significantly slower by dyslexic adults. Extra time in assessment settings, and potentially in the workplace generally, is provided as an appropriate accommodation for many. However, further research that manipulates time limitations may provide additional data on which to assess the influence of time or speeded processing. Such findings may lead to a greater acknowledgement that dyslexic people may require extra time to complete any language-based task, and more understanding that poor word fluency in situations such as interviews and meetings should not be seen as a reflection of a lack of competence.

Dyslexic adults also often benefit from support and advice from professionals. There has been little outcome research into, or evaluation of the effectiveness, of workplace coaching. One such study of this was conducted by Doyle & McDowall (2015). Their findings
indicated that, for both managers and employees, organisational skills including planning, and memory strategies, should be part of coaching programmes. The current research finding was consistent with this as planning/metacognitive skill was related to improved job satisfaction and self-efficacy, potentially less cognitive failure and improved accuracy on problem-solving. Hock (2009) and Swanson (2013) advised that key elements of an intervention programme were the acknowledgement of individual learning differences and experience, explicit (job or task specific) instruction and focused practice which led to familiarity. Increased automatic recall and the use of verbalisation as a strategy, as well as training in the transfer of such skills (Scruggs et al., 2012) have also been identified as important in training. However, investigations of these aspects and their specific benefits for dyslexic adults would also be welcome. It may be that certain elements are more important than others when supporting dyslexic adults in the workplace.

The literature on expertise maintains an individual’s successful experiences should be built on. Individual reflection and attribution of how the skills they have utilised should be refined and generalised. The impact of dyslexia, and subsequent levels of success, may be determined to some extent by such experiences but also by environmental factors. These experiences and environmental factors may vary in relation to individual cognitive factors. Therefore, individualised rather than generic solutions may be more effective. Again, research contrasting individualised versus generic intervention programmes would be very useful both to inform theory but also appropriate practice. In addition, the importance of the environment and the social ecologies (Schnieders et al., 2016) to the career success of dyslexic people argues for good career guidance and career planning.

6.8 Conclusions

This research investigated executive functioning deficits that might account for the broader difficulties reported by dyslexic adults and influence their workplace success. It also aimed to explore any cognitive compensatory mechanisms (such as those related to metacognition) that might contribute to the success of dyslexic adults. The results were mixed and raised as many questions as answers. The data suggested that dyslexic people do perform less well than non-dyslexics in certain aspects of executive function, particularly those which may be related to processes associated with working memory. However, these deficits were not entirely consistent across measures of the same construct, and variations in measures of executive functioning did not explain differences in the success criteria. Additionally, self-
reports on metacognition scales were related to measures of workplace success in terms of personal success criteria, but not societal success criteria. These relationships were similar across dyslexic and non-dyslexic samples, which suggested that influences of metacognition were not specific to dyslexia. Therefore, further research was suggested to provide additional data on which to develop explanations of workplace success (and difficulties) experienced by dyslexic adults. The role of environmental influences in individual development, and the influence of job-specific expertise were considered. Extra time to develop expertise was suggested as a likely area of further intervention-related work; and considerations of the factors, skills and strategies that increase expertise were also discussed. The dyslexic participants included in the research were comparatively successful. They indicated good levels of job satisfaction and self-efficacy; and reported similar levels on all of the success criteria used to their non-dyslexic peers, despite continuing literacy weaknesses. These data argued for the importance of being in the right job, particularly where there was a fit with the skills of the dyslexic individual. However, further research will be needed to better specify the factors that influence workplace success among dyslexic adults.
References


Equality Act 2010. Her Majesty’s Stationery Office (HMSO)


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Chapter 3 Appendices

Study 1

3.1 Exploring the factors that contribute to the success of dyslexic people

Information sheet

Thank you for your interest in this research. Here is some information about what I am trying to achieve.

Dyslexia is complex, it affects everybody differently and the impact on the individual’s performance varies greatly – some dyslexic people overcome their difficulties and achieve a great deal – others are less successful; for some people it is a disability, for others it is a difference.

Although there is a growing awareness of dyslexia and an increasing amount of research into the causes, dyslexia in adulthood is much misunderstood. It is still largely seen as a reading or spelling problem, these are the two most common characteristics and so most of the research up till now has tended to focus on literacy skills. There are many dyslexic people, with and without good literacy skills, who have become successful. The aim of this study is to try and find out what might be the reasons for this success. This study has been reviewed and given favourable ethical opinion.

This questionnaire is the first part of a study to try and establish a measure of success and explore the factors involved in achievement. It is hoped that the research will ultimately lead to developing people’s understanding of dyslexia and a rationale for a tool that help dyslexic people improve their performance.

The questionnaire should take about 15 minutes to complete but you may take longer if you like. If you need any help in completing it, please ask. You can contact me by email c.leather@surrey.ac.uk or by phone 07779 588 265. If you start to complete the questionnaire and then change your mind, you can withdraw at any time without having to give a reason.

Any information obtained in connection with this research project and which could be identified with you will be kept strictly confidential. However, representatives from the research educational institution may inspect research records anonymously to assess the results of this research. The information in this study may also be published in educational journals or presented at educational meetings, but your identity will be kept strictly confidential.

Questions about the research rights or any concerns or complaints about any aspect of the way you have been dealt with may be directed to Dr Henriette Hogh (h.hogh@surrey.ac.uk) or Carol Leather (c.leather@surrey.ac.uk) at Surrey University.
Exploring the factors that contribute to the success of dyslexic people

Consent Form

• I, the undersigned, voluntarily agree to take part in the study on:

Exploring the factors that contribute to the success of dyslexic people

• I have read and understood the Information Sheet provided. I have been given a full explanation by the investigators of the nature, purpose, location and likely duration of the study, and of what I will be expected to do.

• I have been given the opportunity to ask questions on all aspects of the study and have understood the advice and information given as a result.

• I agree to comply with any instruction given to me during the study and to co-operate fully with the investigators.

• I understand that I am free to withdraw from the study at any time without needing to justify my decision and without prejudice.

• I consent to my personal data, as outlined in the accompanying information sheet, being used for the research project detailed in the information sheet, and agree that data collected may be shared with other researchers or interested parties. I understand that all personal data relating to volunteers is held and processed in the strictest confidence, and in accordance with the Data Protection Act (1998).

• I confirm that I have read and understood the above and freely consent to participating in this study. I have been given adequate time to consider my participation and agree to comply with the instructions and restrictions of the study.

Name of volunteer (BLOCK CAPITALS)

........................................................

Signed

........................................................

Name of researcher/person taking consent (BLOCK CAPITALS)

........................................................
Success and dyslexia questionnaire

I am undertaking some research into the factors that contribute to the success of dyslexic people. I would be extremely grateful if you could complete this questionnaire. It should only take 15 or so minutes but you may take as long as you like.

Please can you hand it in before you leave or post it to me in the envelope provided, or email it to me at c.leather@surrey.ac.uk.

1. Background information

a) What is your age? (please tick the box)  18 -24  
   25 -34  □  35 – 44 □  45- 54 □  55-64 □  65 -74 □ 75+ □

b) Gender?……………………………………..         Male □  Female □

c) Is English your first language?         Yes □  No □

d) When were you assessed as being dyslexic? ………Primary school □ Secondary school □
   □ College □  University □  At work □  Other □

e) Do you have any additional hidden disabilities? ………Dyspraxia □
   ADD □  Dyscalculia □  Other □̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊̊...
3. Educational Achievements

a. Do you have any academic qualifications?  no □ yes □

If yes are they?  CSE’s  GCSE’s  (O Levels) yes □ no □

A–Levels / Non-University Higher Education yes □ no □

Undergraduate BA, BSc  ……………… yes □ no □

Postgraduate MA, MSc or MBA / PhD or Doctorate  yes □ no □

b. In which broad category would you put your degree?  e.g humanities, sciences, computing, accounting, law, medicine ……………………………

c. Do you have any professional or vocational qualifications or training?

yes □  no □ Please state…………………………………………………

d. Other qualifications?  yes □ no □ Please state…………………………

4. Career Status

a. Are you employed at present?  yes □ no □

If not employed – how long have you been out of work? ……………………….

Please give reasons ………………………………………………………………………

If you are employed what is your job title? ………………………………………

b. Is it a good job for you? Please rate it on a scale 1-5 (tick box).

<table>
<thead>
<tr>
<th>1= very good</th>
<th>2= good</th>
<th>3= neither good nor bad</th>
<th>4= bad</th>
<th>5= no, very bad</th>
</tr>
</thead>
</table>

Please give your reasons ……………………………………………………………

c. How long have you been in a job? Under 1 year □ 2-3 yrs □

4-5 yrs □ 5-7 yrs □ 8-10 yrs □ 11-15 yrs □ + 15 yrs □

d. Have you ever been promoted? yes □ no □ ……………………………

e. Are you successful at work? Please rate it on a scale of 1-5 (tick box).

<table>
<thead>
<tr>
<th>1= very successful</th>
<th>2= quite successful</th>
<th>3= some of the time</th>
<th>4= no, not really</th>
<th>5= no, not at all</th>
</tr>
</thead>
</table>

Please state when and why you feel most successful………………

f. When do you feel least successful……………………………………

Why………………………………………………………………………………

g. Do you have a career goal in mind? Please rate it (tick box)
Please state ..........................................................

**h.** Given your age and experience do you consider you are on track to achieve your career goal? (tick box)

<table>
<thead>
<tr>
<th>1 = yes</th>
<th>2 = mostly</th>
<th>3 = in some ways</th>
<th>4 = not really</th>
<th>5 = no not at all</th>
</tr>
</thead>
</table>

**i.** What do you consider to constitute a good job........................................

**5. Financial status**

Please tick the box that best describes your annual income

- Up to £10,000 □
- £10,000 - £20,000 □
- £20,000 - £30,000 □
- £30,000 - £50,000 □
- £50,000 - £75,000 □
- £75,000 - £100,000 □
- £100,000 - £150,000 □
- £150,000 - £200,000 □
- £200,000 + □

**6. Personal success**

**a.** In what ways do you feel successful at a personal level? ..................

............................................................................................................................

**b.** When do you feel least successful..........................

............................................................................................................................

**c.** What is it about you personally that has contributed to your present achievements either at work or at home..........................................

............................................................................................................................

**d.** Do you consider that the way you ‘think’ has contributed to your performance yes □

no □

don’t know □

Comments.................................................................

**e.** What do you consider to be your greatest strength.................................

**f.** What is the biggest barrier to you achieving more..............................

**g.** Are you good at setting goals? Please rate on a scale of 1-5 (tick box)

<table>
<thead>
<tr>
<th>1 = always</th>
<th>2 = often</th>
<th>3 = sometimes</th>
<th>4 = rarely</th>
<th>5 = never</th>
</tr>
</thead>
</table>

Comments ...............................................................
h. What external factors do you think have played a part in your achievements?

Comments …………………………………………………………………………………

Other people □ Parents □ Friends □
Education □ Luck □

Please could you spend a few minutes filling in the scales below. Thank you

**Job Satisfaction**  Please can you tick the appropriate number for each question

1= Strongly Agree  2= Agree  3= Neutral  4= Disagree  5= Strongly Disagree

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<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. My job gives me a feeling of accomplishment.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>2. My job allows me to learn new skills.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>3. I am satisfied with my job.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>4. My work is valued by my employer/supervisor.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5. My work is rewarded by my employer/supervisor.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>6. There is a match between my skills/abilities and my job.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>7. My job provides opportunities for professional development.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>8. My job provides an appropriate amount of independence.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>9. My colleagues are supportive of my professional work.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>10. My colleagues and I work well together.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

**Self Efficacy**

1= Strongly Agree  2= Agree  3= Neutral  4= Disagree  5= Strongly Disagree

<p>| | | | | |</p>
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<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>1. I use creative ways to perform my job.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>2. I take the initiative for carrying out an important project.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>3. I exercise leadership in my job.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>4. I make good use of my strengths and abilities.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5. I interact with my co workers.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
6. I communicate clearly with my supervisors.  
7. I communicate clearly with my colleagues.  
8. I plan how to meet the demands of my job.  
10. I develop new skills needed for doing my job well.  
11. I productively use my time on the job.  
12. I adapt to the demands of new responsibilities in my job.  
13. I manage workload and time pressures.  
14. I apply the skills I have learned in job situations.  
15. I work effectively with co-workers.  
16. I deal with the challenges related to my job.

<table>
<thead>
<tr>
<th>Planning</th>
<th>Please can you tick the appropriate number in for each question</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I set myself specific goals</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>2. I organise my time</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>3. I ask myself questions before I begin a task</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>4. I analyse what I have to do</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>5. I estimate how long it will take</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>6. I think of several ways to do something before I start</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>7. I check how I am getting on</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>8. I change my plan if it is not going well</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>9. I stop and seek advice if it is not going well</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>10. I reflect on how well the task has been completed</td>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Memory skills</th>
<th>Please can you tick the appropriate number for each question</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I set myself specific goals</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>2. I organise my time</td>
<td>1 2 3 4 5</td>
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<tr>
<td>3. I ask myself questions before I begin a task</td>
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<td>4. I analyse what I have to do</td>
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</tr>
<tr>
<td>9. I stop and seek advice if it is not going well</td>
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<tr>
<td>10. I reflect on how well the task has been completed</td>
<td>1 2 3 4 5</td>
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<tr>
<td></td>
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<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>1. Do you read something and find you have not been thinking about it and must read it again?</td>
<td>1</td>
</tr>
<tr>
<td>2. Do you find you forget why you went from one part of the house to other?</td>
<td>1</td>
</tr>
<tr>
<td>3. Do you fail to notice signposts on the road?</td>
<td>1</td>
</tr>
<tr>
<td>4. Do you find you confuse right and left when giving directions?</td>
<td>1</td>
</tr>
<tr>
<td>5. Do you bump into people?</td>
<td>1</td>
</tr>
<tr>
<td>6. Do you find you forget whether you’ve turned off a light or fire or locked the door?</td>
<td>1</td>
</tr>
<tr>
<td>7. Do you fail to listen to people’s names when you are meeting them?</td>
<td>1</td>
</tr>
<tr>
<td>8. Do you say something then realise afterwards that it might be taken as insulting?</td>
<td>1</td>
</tr>
<tr>
<td>9. Do you fail to hear people speaking to you when you are doing something else?</td>
<td>1</td>
</tr>
<tr>
<td>10. Do you lose your temper and regret it?</td>
<td>1</td>
</tr>
<tr>
<td>11. Do you leave important letters unanswered for days?</td>
<td>1</td>
</tr>
<tr>
<td>12. Do you find you forget which way to turn on a road you know well but rarely use?</td>
<td>1</td>
</tr>
<tr>
<td>13. Do you fail to see what you want in a supermarket (although it’s there)?</td>
<td>1</td>
</tr>
<tr>
<td>14. Do you find yourself suddenly wondering whether you’ve used a word correctly?</td>
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<tr>
<td>2. Do you have trouble making up your mind?</td>
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</tr>
<tr>
<td>3. Do you forget appointments?</td>
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<tr>
<td>4. Do you forget where you put something like a newspaper or a book</td>
<td>1</td>
</tr>
<tr>
<td>5. Do you find you accidentally throw away the thing you want and keep what you meant to throw away – as in the example of throwing away the matchbox and putting the used match in your pocket?</td>
<td>1</td>
</tr>
<tr>
<td>6. Do you daydream when you ought to be listening to something?</td>
<td>1</td>
</tr>
<tr>
<td>7. Do you find you forget people’s names?</td>
<td>1</td>
</tr>
<tr>
<td>8. Do you start doing one thing at home and get distracted into doing something else (unintentionally)?</td>
<td>1</td>
</tr>
<tr>
<td>9. Do you find you can’t quite remember something though its ‘on the tip of your tongue’</td>
<td>1</td>
</tr>
</tbody>
</table>
10. Do you forget what you came to the shops to buy?  

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
</table>

41  Do you drop things?  

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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</table>

11. Do you find you can’t think of anything to say?  

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
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<th>4</th>
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</table>

Thank you so much for completing this questionnaire. I hope you found it interesting.

This is the first stage of the research. If you would like to participate in the later stages which should take place autumn 2010 please can you send me an email to c.leather@surrey.ac.uk

Carol Leather  1-7 Woburn Walk , LONDON WC1H OJJ  Many thanks
Appendix 3.2  Factor structure on personal success criteria

<table>
<thead>
<tr>
<th>Component</th>
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</tbody>
</table>

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

The factor analysis extracted 3 factors that closely related to the scales on the questionnaire suggesting internal consistency and validity of the scales.

Factor 1  Self efficacy All the items loaded only on to this factor; furthermore all items are those of the original scale in the questionnaire apart from ‘I organise my time’ which was originally in the planning scale. The Eigenvalues are 13.42. The highest loading items were ‘I manage my time well’ and ‘I deal with challenges’ (both .819). The lowest loading items were ‘I make good use of my strengths’.456 and ‘I organise my time’.459

Factor 2  Job Satisfaction All the items loaded quite highly onto the factor, the range being from .840-.572. The item with the highest loading ‘My job gives me a feeling of satisfaction’. I work well with my colleagues was the lowest loaded item.

Factor 3  Planning It is comprised of 8 of the items on the planning scale that was devised for the purpose of this questionnaire so it appears to have reliability. The item ‘I think of several ways to do something before I begin’ was the item loading most heavily on this factor, 0.83 .The loadings on the next two items , ‘I ask myself questions before I begin a task’ 0.79; ‘ I check how I am getting on’ 0.75 are also quite similar and suggesting a close relationship with the factor.
Chapter 4 Appendices

Study 2

4.1. Dyslexia and thinking skills questionnaire

This questionnaire is exploring the role of metacognition in the success of dyslexic people. I would be extremely grateful if you could complete this questionnaire. It should take around 15 minutes to complete.

Please can you post it to me at IDC 1-7 Woburn Walk, London WC1H OJJ (I will provide a stamped addressed envelope if you wish) or email it to me at c.leather@surrey.ac.uk

1. Background information

   g) What is your age? (please tick the box) 18 -24 □ 25 -34 □ 35 – 44 □ 45 - 54 □ 55-64 □ 65 -74 □ 75+ □

   b) Gender? Male □ Female □

2. Personal thinking skills

Please circle either yes or no or sometimes as appropriate

Do you know how you think/learn best? Yes No

Comment ………………………

Do you solve problems best when you have time to ponder? Yes No

Comment ………………………………………………………

Are you more creative if you can

- bounce ideas off other people Yes No Sometimes
- be spontaneous Yes No Sometimes
- draw diagrams Yes No Sometimes

Comment ………………………………………………………
When there is a positive or good outcome, do you put this down to: Please tick relevant boxes

<table>
<thead>
<tr>
<th>Luck</th>
<th>Your input</th>
<th>Other people</th>
<th>Circumstance</th>
</tr>
</thead>
</table>

3. **Daily activities**

a) When you are carrying out daily activities do you plan (for example do you plan your shopping trips)?

<table>
<thead>
<tr>
<th>Not at all</th>
<th>A little bit</th>
<th>Quite a bit</th>
<th>In some detail</th>
</tr>
</thead>
</table>

b) Do you plan when cooking a meal

<table>
<thead>
<tr>
<th>Not at all</th>
<th>A little bit</th>
<th>Quite a bit</th>
<th>In some detail</th>
</tr>
</thead>
</table>

c) Do you plan your holidays

<table>
<thead>
<tr>
<th>Not at all</th>
<th>A little bit</th>
<th>Quite a bit</th>
<th>In some detail</th>
</tr>
</thead>
</table>

d) **Generally** when things go wrong, do you attribute this to

<table>
<thead>
<tr>
<th>Your input</th>
<th>Circumstance</th>
<th>Other people</th>
<th>Luck</th>
</tr>
</thead>
</table>

4. **Hobbies**

a) Do you play sports at any level?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
<th>Sometimes</th>
</tr>
</thead>
</table>

If yes, what sports do you play?

…………………………………………………………………………………………………………………………………………………………………………………………

b) At what level would you place yourself?

<table>
<thead>
<tr>
<th>Professional</th>
<th>Semi professional</th>
<th>Good amateur</th>
<th>Amateur</th>
<th>Just for fun</th>
</tr>
</thead>
</table>

Comment

…………………………………………………………………………………………………………………………………………………………………………………………

…………………………………………………………………………………………………………………………………………………………………………………………
c) Prior to playing, do you plan how you are going to play?

<table>
<thead>
<tr>
<th>In detail</th>
<th>Quite a bit</th>
<th>A little bit</th>
<th>Not at all</th>
</tr>
</thead>
</table>

d) If you are playing well, do you change the way you play?

<table>
<thead>
<tr>
<th>Always</th>
<th>Mostly</th>
<th>Sometimes</th>
<th>Occasionally</th>
<th>Never</th>
</tr>
</thead>
</table>

e) If you are playing badly, do you change the way you play?

<table>
<thead>
<tr>
<th>Always</th>
<th>Mostly</th>
<th>Sometimes</th>
<th>Occasionally</th>
<th>Never</th>
</tr>
</thead>
</table>

5. **Reading**

a) Do you enjoy reading?

Please can you tick the appropriate number 1= very much to 5 = not at all

| 1 | 2 | 3 | 4 | 5 |

b) Is reading hard work for you?

Please rate how hard reading is for you 1 = very easy to 5 = very hard

| 1 | 2 | 3 | 4 | 5 |

c) How much do you read? Please tick the ones that apply

<table>
<thead>
<tr>
<th>A great deal yes / no</th>
<th>Only at work Yes / No</th>
<th>Only for pleasure Yes / No</th>
<th>Only when I have to Yes / No</th>
<th>Not at all Yes / No</th>
</tr>
</thead>
</table>

d) When you are reading do you try to read all the words?

<table>
<thead>
<tr>
<th>Always</th>
<th>Mostly</th>
<th>Sometimes</th>
<th>Occasionally</th>
<th>Never</th>
</tr>
</thead>
</table>

e) What do you read? 1= daily 2= weekly 3 =sometimes 4= rarely 5=never

Please circle the relevant box

<table>
<thead>
<tr>
<th>1. Work documents</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Books -- Fiction</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>3. Books – Non-fiction</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>4. Newspapers</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5. Magazines</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
6. Searching the Internet

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
</table>

7. Twitter or texts

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
</table>

f) If you are reading a long document do you start at the beginning and read the whole way through

<table>
<thead>
<tr>
<th>Always</th>
<th>Mostly</th>
<th>Sometimes</th>
<th>Occasionally</th>
<th>Never</th>
</tr>
</thead>
</table>

i) Do you re-read the text as you are reading?

<table>
<thead>
<tr>
<th>Always</th>
<th>Mostly</th>
<th>Sometimes</th>
<th>Occasionally</th>
<th>Never</th>
</tr>
</thead>
</table>

j) Do you check your understanding?

<table>
<thead>
<tr>
<th>Always</th>
<th>Mostly</th>
<th>Sometimes</th>
<th>Occasionally</th>
<th>Never</th>
</tr>
</thead>
</table>

k) Do you ask yourself questions about why you are reading something?

<table>
<thead>
<tr>
<th>Always</th>
<th>Mostly</th>
<th>Sometimes</th>
<th>Occasionally</th>
<th>Never</th>
</tr>
</thead>
</table>

5. Solving puzzles   Visual Puzzles

a) Please glance at the box below for 5-10 seconds. **Do not** try to solve this puzzle.

![Visual Puzzle](image)

Please answer the questions now [still – do not try and solve the puzzle]

b) How confident are you in being able to find a solution to this type of puzzle?

<table>
<thead>
<tr>
<th>Very Confident</th>
<th>Quite Confident</th>
<th>May be</th>
<th>Quite Unsure</th>
<th>Very Unsure</th>
<th>Give up</th>
</tr>
</thead>
</table>

c) How long do you think it will take you to solve this puzzle - please circle the most likely time.
Now -- please do this puzzle below -- please put a ring around the numbered shape that best fits in the box above-- please record the time it takes you to complete.

d) Did you have a plan when trying to find a solution?

<table>
<thead>
<tr>
<th>Yes</th>
<th>Partly</th>
<th>No</th>
</tr>
</thead>
</table>

e) Did you come up with an answer? Please put answer in the box

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

f) How long did you take to do the puzzle?

<table>
<thead>
<tr>
<th>15 sec</th>
<th>30 sec</th>
<th>1 min</th>
<th>1:30min</th>
<th>2 min</th>
<th>Longer</th>
</tr>
</thead>
</table>

g) How confident are you that your answer is correct?

<table>
<thead>
<tr>
<th>Very Confident</th>
<th>Quite Confident</th>
<th>Maybe</th>
<th>Quite Unsure</th>
<th>Very Unsure</th>
<th>Give up</th>
</tr>
</thead>
</table>

6. Verbal Puzzles

a) Please read the blue sentences below. Do **not** try to solve this puzzle.
Socks

If you have black socks and brown socks in your drawer mixed in a ratio of 4 black to 5 brown socks, how many socks will you have to take out to make sure of having a pair of the same colour?

b) How confident are you in being able to find a solution?

<table>
<thead>
<tr>
<th>Very Confident</th>
<th>Quite Confident</th>
<th>May be</th>
<th>Quite Unsure</th>
<th>Very Unsure</th>
</tr>
</thead>
</table>

Please read the blue sentences below, this is a similar puzzle to the one just shown. Please try and solve it and record the time it takes you to do this.

Water Lilies

Water lilies double in area every 24 hours. At the start of the summer, there is one water lily on a lake. It takes 60 days for the lake to be covered with water lilies. On what day is the lake half-covered?

d) Did you come up with an answer? Please enter your answer in the box below

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

e) Did you have a plan when trying to find a solution?

<table>
<thead>
<tr>
<th>Yes</th>
<th>Partly</th>
<th>No</th>
</tr>
</thead>
</table>

f) How confident are you that your answer is correct?

<table>
<thead>
<tr>
<th>Very Confident</th>
<th>Quite Confident</th>
<th>May be</th>
<th>Quite Unsure</th>
<th>Very Unsure</th>
<th>Give up</th>
</tr>
</thead>
</table>

g) How long did you take?

<table>
<thead>
<tr>
<th>15 sec</th>
<th>30 sec</th>
<th>1min</th>
<th>1:30min</th>
<th>2 min</th>
<th>Longer</th>
</tr>
</thead>
</table>

Final section!

In this last section there are two scales to complete.

They should not take very long – they are just asking for some finer details for me to analyse. Your help is greatly appreciated.

Please can you tick the appropriate number for each question
<p>| 1. I ask myself periodically if I am meeting my goals | 1 2 3 4 5 |
| 2. I consider several alternatives to a problem before I answer | 1 2 3 4 5 |
| 3. I try to use strategies that have worked in the past | 1 2 3 4 5 |
| 4. I pace myself while learning in order to have enough time | 1 2 3 4 5 |
| 5. I understand my intellectual strengths and weaknesses | 1 2 3 4 5 |
| 6. I think about what I really need to learn before I begin a task | 1 2 3 4 5 |
| 7. I know how well I did once I finish a test | 1 2 3 4 5 |
| 8. I set specific goals before I begin a task | 1 2 3 4 5 |
| 9. I slow down when I encounter important information | 1 2 3 4 5 |
| 10. I know what kind of information is most important to learn | 1 2 3 4 5 |
| 11. I ask myself if I have considered all options when solving a problem | 1 2 3 4 5 |
| 12. I am good at organizing information | 1 2 3 4 5 |
| 13. I consciously focus my attention on important information | 1 2 3 4 5 |
| 14. I have a specific purpose for each strategy I use | 1 2 3 4 5 |
| 15. I learn best when I know something about the topic | 1 2 3 4 5 |
| 16. I know what the teacher expects me to learn | 1 2 3 4 5 |
| 17. I am good at remembering information | 1 2 3 4 5 |
| 18. I use different learning strategies depending on the situation | 1 2 3 4 5 |
| 19. I ask myself if there was an easier way to do things after I have finished a task | 1 2 3 4 5 |
| 20. I have control over how well I learn | 1 2 3 4 5 |
| 21. I periodically review to help me understand important relationships | 1 2 3 4 5 |
| 22. I ask myself questions about the material before I begin | 1 2 3 4 5 |
| 23. I think of several ways to solve a problem and chose the best one | 1 2 3 4 5 |
| 24. I summarize what I have learned after I finish | 1 2 3 4 5 |
| 25. I ask others for help when I don’t understand something | 1 2 3 4 5 |
| 26. I can motivate myself to learn when I need to | 1 2 3 4 5 |</p>
<table>
<thead>
<tr>
<th>Number</th>
<th>Statement</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>27</td>
<td>I am aware of what strategies I use when I study</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>28</td>
<td>I find myself analyzing the usefulness of strategies while I study</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>29</td>
<td>I use my intellectual strengths to compensate for my weaknesses</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>30</td>
<td>I focus on the meaning and significance of new information</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>31</td>
<td>I create my own examples to make information more meaningful</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>32</td>
<td>I am a good judge of how well I understand something</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>33</td>
<td>I find myself using helpful learning strategies automatically</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>34</td>
<td>I find myself pausing regularly to check my comprehension</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>35</td>
<td>I know when each strategy I use will be most effective</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>36</td>
<td>I ask myself how well I accomplished my goals once I’m finished</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>37</td>
<td>I draw pictures or diagrams to help me understand while learning</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>38</td>
<td>I ask myself if I have considered all options after I solve a problem</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>39</td>
<td>I try to translate new information into my own words</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>40</td>
<td>I change strategies when I fail to understand</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>41</td>
<td>I use the organizational structure of the text to help me learn</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>42</td>
<td>I read instructions carefully before I begin a task</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>43</td>
<td>I ask myself if what I’m reading is related to what I already know</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>44</td>
<td>I re-evaluate my assumptions when I get confused</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>45</td>
<td>I organise my time to best accomplish my goals</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>46</td>
<td>I learn more when I am interested in the topic</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>47</td>
<td>I try to break studying down into smaller steps</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>48</td>
<td>I focus on overall meaning rather than specifics</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>49</td>
<td>I ask myself questions about how well I am doing while I am learning something new</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>50</td>
<td>I ask myself if I learned as much as I could have once I finished a task</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>51</td>
<td>I stop and go back over new information that is not clear</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>52</td>
<td>I stop and reread when I get confused</td>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>
Please could you spend only a few more minutes filling in the scales below.

Please can you tick the appropriate number for each question
1= Strongly Agree 2= Agree 3= Neutral 4= Disagree 5= Strongly Disagree

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>My memory is above average</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>To solve a problem I rely on reasoning abilities.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Compared to other intellectual abilities (i.e., attention, reasoning) my memory is good.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>I enjoy being involved in activities that require some sort of reasoning.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>I can remember more material than the average person.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>I feel confident when solving problems that require reasoning skills</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>I’m satisfied with my memory</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>In an exam situation I get answers right mostly by reasoning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>I describe myself as a person with reasoning abilities that are above average</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>I rely on my memory to get me through exams</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>I am happy with my reasoning abilities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>I enjoy engaging in activities that require me to remember things</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>I can reason better than the average person</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>For exam purposes I memorize material easily</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Compared to my other cognitive abilities my reasoning is sound</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>I have good memory</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Thank you so much for completing this questionnaire. I hope you found it interesting.

There is one more stage to this research, which will involve a one to one meeting with myself. The purpose of the last stage is to look in more detail at the way dyslexic people think and solve problems. If you would like to participate in this later stage which should take place Autumn 2011 please can you can you send me an email to c.leather@surrey.ac.uk
### Chapter 5 Appendices

#### 5.1 Assessment Schedule

<table>
<thead>
<tr>
<th>ID</th>
<th>Initials</th>
<th>Age</th>
<th>Gender</th>
<th>Stage 1 ID</th>
<th>Stage 2 ID</th>
<th>Date of Stage 3</th>
<th>Stage 3 ID</th>
</tr>
</thead>
</table>

Tests given in the following order:

1. Brosnan – immediate recall random

2. Trails

3. WRAT Reading

4. GEFT

5. Plus minus

6. CTOPP rapid naming
   - Letters / Digits

7. WCST

8. Brosnan – 40 mins structured

9. Listening span

10. WRAT Spelling

11. CTOPP rapid naming
    - Objects

12. Random no generation

13. Spatial span

<table>
<thead>
<tr>
<th>Test Description</th>
<th>1st</th>
<th>2nd</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brosnan – immediate recall random</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trails</td>
<td>1st</td>
<td>2nd</td>
<td></td>
</tr>
<tr>
<td>WRAT Reading</td>
<td>Raw score</td>
<td>Scaled score</td>
<td></td>
</tr>
<tr>
<td>GEFT</td>
<td>1st</td>
<td>2nd</td>
<td>Total</td>
</tr>
<tr>
<td>Plus minus</td>
<td>+</td>
<td>-</td>
<td>±</td>
</tr>
<tr>
<td>CTOPP rapid naming</td>
<td>Letters</td>
<td>Digits</td>
<td></td>
</tr>
<tr>
<td>WCST</td>
<td>RS</td>
<td>Correct</td>
<td>Errors</td>
</tr>
<tr>
<td>Brosnan – 40 mins structured</td>
<td></td>
<td></td>
<td>Total</td>
</tr>
<tr>
<td>Listening span</td>
<td>RS</td>
<td>Level</td>
<td></td>
</tr>
<tr>
<td>WRAT Spelling</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CTOPP rapid naming</td>
<td>RS</td>
<td>SS</td>
<td></td>
</tr>
<tr>
<td>Random no generation</td>
<td>Time</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>Spatial span</td>
<td>Forward</td>
<td>Backwards</td>
<td>Total RS</td>
</tr>
<tr>
<td>Test Type</td>
<td>Example 1</td>
<td>Example 2</td>
<td>Example 3</td>
</tr>
<tr>
<td>-----------</td>
<td>-----------</td>
<td>-----------</td>
<td>-----------</td>
</tr>
<tr>
<td>TOWRE</td>
<td>Sight</td>
<td>Non words</td>
<td>Sight</td>
</tr>
<tr>
<td>Stroop</td>
<td>1st</td>
<td>2nd</td>
<td></td>
</tr>
<tr>
<td>Matrices</td>
<td>RS</td>
<td>SS</td>
<td></td>
</tr>
<tr>
<td>Dual word generation / Maze completion</td>
<td>VFI</td>
<td>MI</td>
<td>VF/R</td>
</tr>
<tr>
<td>Spadafore</td>
<td>Speed</td>
<td>Oral reading</td>
<td>Silent reading</td>
</tr>
</tbody>
</table>

### 5.2.1 Examples of Test items

<table>
<thead>
<tr>
<th>The Listening Span test</th>
<th>True // False</th>
<th>TBR</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>3x2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 There are 365 days in a year</td>
<td>T</td>
<td>Year</td>
<td>736</td>
</tr>
<tr>
<td>2 Arms have knees</td>
<td>F</td>
<td>Knees</td>
<td>90</td>
</tr>
<tr>
<td>1 The stars are best seen at night</td>
<td>T</td>
<td>Night</td>
<td>265</td>
</tr>
<tr>
<td>2 There are 7 players in a football team</td>
<td>F</td>
<td>Team</td>
<td>186</td>
</tr>
<tr>
<td>1 We hear things through our eyes</td>
<td>F</td>
<td>Eyes</td>
<td>297</td>
</tr>
<tr>
<td>2 When you are very cold you shake</td>
<td>T</td>
<td>Shake</td>
<td>93</td>
</tr>
<tr>
<td>1 The flying Scotsman is a plane</td>
<td>F</td>
<td>Plane</td>
<td>45</td>
</tr>
<tr>
<td>2 There are seven days in a week</td>
<td>T</td>
<td>Week</td>
<td>155</td>
</tr>
<tr>
<td>3 A dog is an animal a trout is a fish</td>
<td>T</td>
<td>Fish</td>
<td>103</td>
</tr>
<tr>
<td></td>
<td>People are often frightened of spiders because of their hairy legs</td>
<td>T</td>
<td>Legs</td>
</tr>
<tr>
<td>---</td>
<td>------------------------------------------------------------------</td>
<td>----</td>
<td>------</td>
</tr>
<tr>
<td>2</td>
<td>Astronomy is the study of the stars</td>
<td>T</td>
<td>Stars</td>
</tr>
<tr>
<td>3</td>
<td>The most commonly used phone now is the mobile phone</td>
<td>T</td>
<td>Phone</td>
</tr>
<tr>
<td></td>
<td>People can wear strange hats on their head</td>
<td>T</td>
<td>Head</td>
</tr>
<tr>
<td>2</td>
<td>Cherries are coloured red and bananas are usually blue</td>
<td>F</td>
<td>Blue</td>
</tr>
<tr>
<td>3</td>
<td>In the spring birds sing and the flowers start to grow in the floor</td>
<td>F</td>
<td>Floor</td>
</tr>
</tbody>
</table>

### 3x4

|   | In 1998 Adele quit the Spice Girls pop group                    | F  | Group | 601 |
| 2 | Apples, pears and tomatoes are all a fruit                      | T  | Fruit | 51  |
| 3 | The word ‘nasal’ is usually used in relation to talking about the hand | F  | Hand  | 188 |
| 4 | Antarctica is very cold and it is at the north-pole             | F  | Pole  | 26  |

|   | Rosemary is a herb and a girl’s name                            | T  | Name  | 33  |
| 2 | Harrods is a world famous shop                                  | T  | Shop  | 102 |
| 3 | The human body contains 10 pints of blood                       | F  | Blood | 101 |
| 4 | Sir Walter Raleigh became famous for sailing the sea            | T  | Sea   | 130 |
5.2.2. Dual Task Test of Verbal Fluency

Word frequencies taken from Oxford English Dictionary ( )

<table>
<thead>
<tr>
<th>1st task Base line measure</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(words beginning with the letter S -for 20 seconds)</td>
<td>(words beginning with the letter M for 20 seconds)</td>
<td>(words beginning with the letter D for 20 seconds)</td>
<td>(words beginning with the letter H for 20 seconds)</td>
<td>Words beginning with the letter G for 20 seconds)</td>
</tr>
<tr>
<td>TOTAL:</td>
<td>TOTAL:</td>
<td>TOTAL:</td>
<td>TOTAL:</td>
<td>TOTAL:</td>
</tr>
<tr>
<td>(words beginning with the letter N for 30 seconds)</td>
<td>(words beginning with the letter L for 30 seconds)</td>
<td>(words beginning with the letter W for 20 seconds)</td>
<td>(words beginning with the letter E for 20 seconds)</td>
<td></td>
</tr>
<tr>
<td>TOTAL:</td>
<td>TOTAL:</td>
<td>TOTAL:</td>
<td>TOTAL:</td>
<td>Total Number</td>
</tr>
</tbody>
</table>
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