RUNNING HEAD: Multiple Errands Test

Development and Validation of a Modified Multiple Errands Test for Adults with Intellectual Disabilities

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Abstract

Background: The aims of the current study were to adapt a version of the Multiple Errands Test (MET) for people with intellectual disabilities (IDs) and assess its ecological and construct validity.

Material and Methods: Using a correlational design, 40 participants with IDs were invited to complete a battery of neuropsychological assessments, including the modified Multiple Errands Test for Intellectual Disabilities (mMET-IDs).

Results: Task completion on the mMET-IDs correlated significantly the Tower of London Test and the Six Parts Test. These findings suggest that the mMET-IDs has construct validity. , However, the findings also showed that the relationship between the mMET-IDs and the Six Parts Test could be accounted for by Verbal IQ and receptive vocabulary. Also, the mMET-IDs failed to correlate with the DEX-IR and its subscales.

Conclusions: The mMET-IDs can be successfully used with people with IDs, but further work is needed to improve ecological validity.

Ecological Assessment of the Supervisory Attentional System in People with Intellectual Disabilities

Oscar-Berman and Marinković (2007) defined executive function as "human qualities, including self awareness, that allow us to be independent individuals with purpose and foresight about what we do and how we behave" (p. 246). Various theoretical models have been developed to conceptualise and measure this construct. These include goal neglect theory (Duncan, 1986, 1995; Duncan, Burgess, & Emslie, 1995; Duncan, Emslie, Williams, Johnson, & Freer, 1996; Duncan, Johnson, Swales, & Freer, 1997; Duncan et al., 2008), the central executive (Baddeley, 1986, 1996, 2001; Baddeley, Della Sala, Gray, Papagno, & Spinnler, 1997), and the Supervisory Attentional System (SAS; Burgess & Shallice, 1996a; Burgess & Shallice, 1996b; Norman & Shallice, 1986; Shallice 1982, 2000; Shallice & Burgees, 1991; Shallice & Burgess, 1996), to name a few.

The SAS offers perhaps the most detailed specification of the cognitive processes described as executive functions. At the simplest level, the SAS comprises two main components: the contention scheduling system (CSS) and the supervisory attentional system. The CSS governs the practice of routine behaviours by using incoming perceptual information to select the most appropriate schema (or organised plan) to suit a situation. These schemas are typically well rehearsed and organised and can be deployed in routine situations with little conscious effort (e.g., driving the familiar route to one's workplace). As these schemas generally run automatically, the CSS acts to select, prioritise and implement the correct schema(s), based on environmental demands. To prevent irrelevant schemas being activated in inappropriate circumstances (e.g., accidentally driving the familiar route to one's workplace on a weekend when one actually intended to go to the supermarket), the SAS intervenes to bias the activation of schemas so that they are appropriate to the situation. Thus, the SAS contains "the general programming or planning systems that can operate on schemas in every domain" (Shallice, 1982, p. 201), before finally monitoring and evaluating how effectively they are operating.

The SAS (as a complete theory of executive function) has been employed as a useful model to formulate certain cognitive impairments and related functional difficulties observed in people with brain injuries (Oddy & Worthington, 2009), dementia (Perry & Hodges, 1999) and schizophrenia (Wykes & Reeder, 2005). There is little research, however, examining the SAS model with people with intellectual disabilities (IDs). This is surprising because theoretical models of executive function may have much to offer in formulating the cognitive and adaptive behaviour difficulties faced by people with IDs. For example, significant deficits in an individual's adaptive behaviour are an essential criterion in the diagnosis of IDs. Adaptive behaviour has been defined as "the collection of conceptual, social, and practical skills that have been learned and are performed by people in their everyday lives" (Tasse et al., 2013, p. 291) and it has been argued that many of the adaptive behaviours needed for functional independence (e.g., shopping, cooking etc) are dependent

on executive functions (Baum et al., 2008). Therefore, the SAS might be a useful model for formulating and habilitating adaptive behaviour deficits in people with IDs.

Unfortunately, using the SAS as an underlying model to test hypotheses about adaptive behaviour deficits in people with IDs is difficult as the majority of standard measures of executive function tend to be too complex or rely too heavily on verbal skills (Masson, Dagnan, & Evans, 2010). Nevertheless, recent research has attempted to adapt and evaluate certain measures of executive function in people with IDs (e.g., Adams & Oliver, 2010; Ball, Holland, Treppner, Watson, & Huppert, 2008; Dymond, Bailey, Willner, & Parry, 2010; Lanfranchi, Baddeley, Gathercole, & Vianello, 2011; Willner, Bailey, Parry, & Dymond, 2010), and of these, the Tower of London Test (TOLT; Shallice, 1982) is one specific measure of the SAS that has appeared in all of the above studies.

The TOLT includes two rectangular boards supporting three equidistantly placed pegs of ascending heights. The test starts with the examiner placing three coloured discs onto the participant's board in a specified starting position. The examiner then arranges three discs onto the pegs of their board and the participant is required to replicate the examiners arrangement whilst obeying a set of rules (e.g., not exceeding the specified number of moves to reach the goal state, moving only one disc at a time etc). As the task progresses so do the number of moves required to replicate the examiners arrangement, hence increasing the task's difficulty. Shallice (1982) suggested that as successful performance on TOLT does not require the use of any special purpose schemas from the CSS (as for most undertaking the assessment it will be a completely novel task), the TOLT relies exclusively on the SAS (to the exclusion of the CSS). Accordingly, those with an intact SAS would perform much better on the TOLT compared to those without, where it would be expected that distractibility and perseveration would occur (Shallice, 1982).

In one study focusing exclusively on the adaptation and validity of the TOLT in people with IDs, Masson et al. (2010) found a clear hierarchical structure where 43 participants with IDs were able to solve the first TOLT problem level but only 9 (20.9%) were able to solve the sixth and final level. Masson et al. (2010) also reported that the TOLT and its subscales had significant negative correlations, between $r = -.37$ and $r = -.57$, with the Dysexecutive Questionnaire Independent Rater Version (DEX-IR; Burgess, Alderman, Wilson, Evans, & Emslie, 1996) and significant positive correlations with the Adaptive Behaviour Scale – Residential and Community: Second Edition (ABS-RC 2; Nihira et al., 1993) and its subscales, between $r = .44$ and $r = .50$, all $p = < .002$. Together, these findings indicate that the TOLT is sensitive to executive function difficulties in participants with IDs, and that performance on the TOLT in individuals with IDs is associated with 'real world' functions thought to be dependent on executive skills.

Correlating neuropsychological assessments with informant questionnaires of everyday functioning is generally becoming the adopted way of assessing the ecological validity of a measure (Chaytor, Schmitter-Edgecombe & Burr, 2006). Indeed, the ecological validity of neuropsychological assessments is becoming an increasingly important concern for researchers and clinicians (Burgess & Robertson, 2002; Burgess et al., 2006) as measures

low in ecological validity limit the ability a clinician has to translate assessment scores into a formulation which can be used to guide interventions for everyday cognitive and adaptive behaviour difficulties.

There are several measures of executive function which claim to have ecological validity. For example, several studies have shown that the Behavioural Assessment of the Dysexecutive Syndrome (BADS; Wilson, Alderman, Burgess, Emslie, & Evans, 1996), and the child version (BADS-C; Emslie, Wilson, Burden, Nimmo-Smith, & Wilson, 2003), correlate well with informant questionnaires sampling aspects of everyday functioning (Norris & Tate, 2000; Wilson, Evans, Emslie, Alderman, & Burgess, 1998) in individuals without IDs, , however, there is evidence to question the validity of the children's version of the BADS when used with people with IDs (Willner et al., 2010). While the TOLT is the only known assessment of executive function that has been found to be accessible for people with IDs and correlates well with measures of everyday functioning, it has been criticised for being different from real life tasks, such as planning a trip away, or a meal for friends (Burgess & Robertson, 2002; Burgess et al., 2006). This draws the relationships between "laboratory" based neuropsychological assessments and situations encountered in real life into question.

One such measure of the SAS that was specifically designed to bridge the gap between laboratory-based assessment and real life is the Multiple Errands Test, which has yet to be investigated for use with people who have IDs. The MET was originally developed by Shallice and Burgess (1991) to capture the everyday task impairments of people with acquired brain injuries who were able to perform adequately on most standardised neuropsychological assessments, despite family members reporting significant impairments in their general activities of daily living. In response to this, Shallice and Burgess (1991) developed a measure that could be undertaken within a real life shopping centre to assess the examinee's ability to function outside of structured office based settings. Participants were given a list of tasks to undertake whilst following a series of rules. The tasks included instructions, such as, buy a loaf of bread and find the price of a pound of tomatoes. There were rules, such as, not to enter a shop other than to buy something, and take as little time as possible. Whilst the tasks were relatively simple, the rules were designed to increase demands on planning, multitasking, and prospective memory (Alderman, Burgess, Knight, & Henman, 2003; Burgess & Alderman, 2004). Shallice and Burgess (1991) described successful performance on the MET to be dependent on the ability of the SAS to: (a) identify a goal, (b) create a plan, (c) create a "marker" to help the plan be realised effectively at a later time, (d) trigger the "marker" when necessary, and (e) monitor and evaluate the process to assist the creation of sub-goals and/or modify of the plan if necessary. Despite reasonable performance on many neuropsychological assessments, Shallice and Burgess (1991) reported that three participants with frontal lobe damage performed much more poorly on the MET relative to a non-injured comparison group. The MET, therefore, appeared to be sensitive to impairments of the SAS within everyday scenarios, which were otherwise overlooked by structured "laboratory" based neuropsychological assessments.

Research investigating the MET has shown that it can successfully discriminate between neurological samples (e.g., brain injury and post stroke participants) and neurologically healthy people, and it has been administered in a range of ecological environments including shopping centres, hospital grounds, hospital wards, university departments, and virtual environments (Alderman et al. 2003; Burgess, Alderman, Volle, Benoit, & Gilbert, 2009; Dawson, Anderson, Burgess, Cooper, Krpan, & Stuss, 2009; Goldstein, Bernard, Fenwick, Burgess, & McNeil, 1993; Knight, Alderman, & Burgess, 2002; McGeorge et al. 2001; Rand, Basha-Abu, Rukan, Weiss, & Katz, 2009; Rand, Weiss, & Katz, 2009; Tranel, Hathaway-Nepple & Anderson, 2007). The MET, therefore, has the potential to provide a quantitative and seemingly ecologically valid measure of executive function, as well as give the examiner an impression of the individual's ability to deploy executive skills in everyday life.

Considering the literature, it would, therefore, appear that the MET may have some advantages over traditional assessments of executive function that have been recently developed with people with IDs. To investigate this, a sample of people with IDs were recruited and completed a version of the MET that had been adapted, creating the modified MET – Intellectual Disabilities (mMET-IDs). Participants were also invited to complete several traditional measures of the SAS, which were compared to performance on the MET-IDs in order to consider its validity. The specific aims of this study were to: (a) examine the strength of the relationship between the mMET-IDs and other measures of the SAS to assess the construct validity of the mMET-IDs, and (b) to examine the strength of the relationship between performance on the mMET-IDs and observer ratings of executive (dys)function to assess the ecological validity of the MET-IDs.

Methods

Participants

Forty participants with IDs, M_{age} = 45, SD = 9.27, M_{IQ} = 58, SD = 4.54, 63.5% women, were recruited from day centres in the East of England. Full Scale IQ was estimated using the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999) and receptive vocabulary was measured using the British Picture Vocabulary Scale – Third Edition (BPVS-III; Dunn, Dunn, Styles, & Sewell, 2009). Reading (phonological awareness), word recognition and word decoding skills were assessed using the Word Reading subtest (WR) of the Wechsler Individual Attainment Test – Second Edition (WIAT-II$_{UK}$; Wechsler, 2005).

Participants were recruited from four different day centres. For the 40 participants, four (10%) were from day centre A, 16 (40%) were from day centre B, 13 (32.5%) were from day centre C and seven (17.5%) were from day centre D. Performance by participants across the day centres did not vary as there was no significant difference between day centres on mMET-IDs task attempts, $\chi^2(3)$ = 1.88, p = .62, task completions, $\chi^2(3)$ = 2.36, p = .52, and rule breaks, $\chi^2(3)$ = .22, p = .98.

Design and Procedure

Using a correlational design, and after gaining informed consent, each participant was asked to complete the WASI, BPVS and the subtests from the WIAT-II$_{UK}$. A time was then arranged to meet with the participant again within the following week, where the remaining measures were administered, including the mMET-IDs. Staff members at the participant's day centre were asked to complete the Dysexecutive Questionnaire Independent Rater Form (DEX-IR) for each participant, once the person with IDs had given consent for this to happen. All of the testing took place within the day-centres for people with IDs. A favourable ethical opinion was granted for this study by a National Health Service (NHS) Research Ethics Committee.

Measures. *Modified Multiple Errands Test - Intellectual Disabilities (MET-IDs).* A version of the MET for people with IDs was developed, but modelled as closely as possible to the Knight et al. (2002) version, although simplified in a number of ways. First, the task was undertaken in the participant's day centre as this was the most pragmatic environment. Second, the text instructions were enlarged, simplified and spread across an A3 clipboard with pictures added to supplement the written material. Third, to assist those with reading difficulties, a Mantra Lingua RecorderPEN2 was used to vocalise the written instructions; the participant could move a pen over small labels placed next to text on the mMET-IDs exercise sheet, and the pen would read out the text. Fourth, the number of tasks were reduced from ten to five, and the number of rules were reduced from nine to six. Finally, participants were guided through two practice tasks prior to the full administration of the mMET-ID to help them understand the task. During this time, the tasks/rules were explained to the participant and they were given a watch (if they did not already have one) to help with one of the tasks.

Once started, the examiner followed the participant around the day centre at a distance of approximately two metres until the participant informed the examiner that they had finished. Participants carried the mMET-IDs instructions and the RecorderPEN2 with them whilst they were carrying out the task. A standard prompt was introduced when a participant asked a question or tried to speak to the examiner. This was "remember, I'm not allowed to give you any help but you must do all the tasks and not break any of these rules". The practice items, tasks and rules, as presented to participants, is found in Table 1(a) and 1(b).

Recording of mMET-IDs performance was conducted as per Knight et al. (2002) where the examiner wrote down all aspects of the participants' performance as they engaged in the task. This written summary of performance was then scored. In developing a scoring system, three scales were used. These were (a) task attempts (where a task is attempted but not completed satisfactorily), (b) task completions (where a task is attempted and completed satisfactorily), and (c) rule breaks. Both task attempts and completions were scored out of six, with one point being awarded for each of the six tasks. Rule breaks were also recorded and scored out of six where a point was awarded if a rule was broken. A similar scale was employed by Dawson et al. (2009) on an adapted version of the MET. Higher task attempts and task completions equate to better executive function

whereas higher rule breaks equate to worse executive function. The complete scoring rules are found in Table 2.   Inter-rater reliability for the scoring was determined by coding twenty five percent of the MET-IDs scripts with a second rater. The resulting intraclass correlation coefficient (ICC) for task attempts was, *ICC* (10) = .89, for task completions, *ICC* (10) = .99, and for rule breaks, *ICC* (10) = .84.

Six Parts Test. The Six Parts Test (SPT) is a subtest from the Behaviour Assessment of Dysexecutive Syndrome - Children (BADS-C). It is a simplified version of the Six Elements Tests (SET) from the adult BADS. Whilst the SET is undertaken in an office setting, it is designed to "tap a subset of the same cognitive components" (Burgess, 2000, p. 281) that are required in the mMET-IDs. Specifically, the SPT has been described as a measure of "Planning, task scheduling and performance monitoring" (Baron, 2006, p. 540).

The SPT contains three tasks, each with two parts (six parts in total) and participants must attempt at least something from each of the six parts within a five minute time limit. However, a rule prevents the participant from completing two parts from the same task consecutively. For example, the participant cannot go directly from task A part 1, to task A part 2. They must attempt one of the parts from task B or C beforehand. The SPT was administered as per the BADS-C manual, but modified to allow the participant to read out the answers to tasks where writing was involved. The rule sheet was also enlarged and supplemented with pictures to assist those with reading difficulties. The maximum score available on the SPT is 16. Lower scores relate to poorer executive function.

Tower of London Test.

The TOLT is described above. Scoring according to Masson et al. (2010) was adopted where a total score of 18 could be obtained and subscale scores of number of problems solved correctly at first attempt and highest level of problem achieved were also recorded.

Dysexecutive Questionnaire. Burgess et al. (1996) developed the Dysexecutive Questionnaire (DEX) as a means of assessing a range of symptoms associated with dysexecutive syndrome. The DEX contains 20 items each responded to on a five point Likert type scale (ranging from *never* to *very often*), asking about the degree to which an individual conforms to each item. The independent rater form (DEX-IR) was used here and completed by a member of staff at the participant's day centre. The DEX-IR has a maximum score of 80, with higher scores equating to more executive dysfunction.

Results

The descriptive statistics for the mMET-IDs scales, along with the other measures, are presented in Table 3.   To explore the relationship between measures, a correlation matrix between the mMET-IDs subscales, SPT, TOLT, DEX-IR, VIQ, PIQ, FSIQ, BPVS and WR scores is presented in Table 4. High DEX-IR scores and MET-IDs rule breaks equate to worse executive function whereas high mMET-IDs task attempts, mMET-IDs task completions, TOLT and SPT scores equate to better executive function.

Construct Validity

mMET-IDs and the Six Parts Test. As shown in Table 4, only mMET-IDs task completions correlated significantly with the SPT, $r(40) = .27$, $p = .048$. Verbal IQ and receptive vocabulary significantly correlated with both task completions and the SPT. When Verbal IQ and receptive vocabulary were controlled, the relationship between mMET-IDs task completions and the SPT was no longer significant, $r_s(40) = .13$, $p = .211$.

MET- IDs and the Tower of London Test. There was a significant positive relationship between task completions and the TOLT, $r(40) = .37$, $p = .01$ (Table 4). Whilst, BPVS score, $r(40) = .22$, $p = .087$ and verbal IQ, $r(40) = -.12$, $p = .24$, did not correlate significantly with TOLT total score, an additional analysis was conducted to assess the influence of these variables, along with the Word Reading score on the relationship between mMET-IDs task completions and the TOLT. When these variables were simultaneously controlled, there was no change to the relationship between mMET-IDs task completions and TOLT total score , $r_s(40) = .38$, $p = .01$.

Exploring the relationship between the mMET-IDs and the subscales of the TOLT revealed that mMET-IDs task completions correlated significantly with TOLT highest problem level achieved, $r(40) = .33$, $p = .019$, and TOLT correct first attempt, $r(40) = .39$, $p = .006$. When BPVS, Word Reading and verbal IQ scores were simultaneously controlled, these correlations remained significant. MET-IDs task completions correlated significantly with TOLT highest problem level achieved, $r(40) = .35$, $p = .017$, and TOLT correct first attempts, $r(40) = .42$, $p = .005$.

Ecological Validity

MET-IDs and the Dysexecutive Questionnaire. The correlations between the DEX-IR total score, the subscales, and measures of executive function were all small and non-significant (Table 4).

Internal Consistency

Internal consistency was calculated for each of the mMET-IDs subscales. The Cronbach's alpha coefficient was .84 for task attempts and .61 for task completions. For rule breaks, however, Cronbach's alpha coefficient was -.58.

Discussion

The specific aims of this study were to: (a) examine the strength of the relationship between the mMET-IDs and other measures of the SAS to assess the construct validity of the mMET-IDs, and (b) to examine the strength of the relationship between performance on the mMET-IDs and observer ratings of executive (dys)function to assess the ecological validity of the MET-IDs.

Considering the first aim, the results indicated that there were significant correlations between mMET-IDs task completions and the SPT and TOLT. Whilst these correlations were only small to medium in strength, it is important to interpret these findings within the context of the wider research literature. Indeed, Burgess and Robertson (2002) outline how correlations between performance on different executive tasks in both

neurological and healthy samples are typically low (e.g., Duncan et al., 1997; Emslie et al., 2003; Myakie et al., 2000; Norris & Tate, 2000; Robbins, 1998). The strength of the correlations observed here may not, therefore, be out of context with those observed in other populations and offer some evidence for the construct validity of the mMET-IDs. When receptive vocabulary and general verbal abilities were controlled, the correlation between mMET-IDs task completions and the SPT disappeared. The findings indicated that receptive vocabulary and verbal abilities had a strong influence on the relationship between the mMET-IDs and the SPT. Whilst it has been noted that it would be very difficult to design a measure of executive function that does not tap areas such as language (Baddeley et al., 1997), it raises questions about the specific contribution that functions of the SAS had on the participants mMET-IDs and SPT performance, over and above the contribution of verbal abilities. This finding could be explained by considering the role of the phonological loop on both mMET-IDs and SPT performance. The phonological loop is a cognitive structure capable of storing and rehearsing auditory-verbal information which is suggested as having evolved to facilitate the acquisition of language (Baddeley, 2003; Baddeley, Chincotta, & Adlam, 2001). Baddeley et al. (2001) found that when visual prompts were removed from an executive task, participants compensated for this by rehearsing the prompts on their phonological loop, thus facilitating performance. In a further task, when visual prompts were again removed and the participants were prevented from using their phonological loop (by, for example, asking them to verbally recite a series of months), performance was impaired. Baddeley et al. (2001) suggested that this is evidence for the verbal control of action, or as Baddeley (2003, p. 199) explains "when driving along an unfamiliar route under stressful weather conditions, sub-vocally maintaining the number and direction of the next turn can be a simple but very effective strategy." Thus, as the mMET-IDs and the SPT both rely on holding tasks and rules in mind whilst performing them, those participants who were able to complete tasks on the mMET-IDs and the SPT may have been subvocally rehearsing each task in mind to help their performance. The role of verbal abilities on mMET-IDs and SPT performance may, therefore, be accounted for via the participant's use of their phonological loop to complete the task.

This interpretation is partly limited by the fact that the participants had the instructions written in front of them and were able to use the RecorderPEN2 to vocalise them. Participants who had reading problems, however, may have relied more heavily on the RecorderPEN2, which would itself necessitate use of the phonological loop to hold the task in mind whilst performing it. This does not eradicate the role of the SAS in mMET-ID performance all together. Indeed, the SAS is a more detailed specification of the central executive (Wilson et al. 1998) which, according to the working memory model, controls the processing of information in the phonological loop (Baddeley, 1996).

In contrast, correlating mMET-IDs task completions and the TOLT, while controlling for receptive vocabulary, reading ability, and general verbal abilities, did not influence the strength of the relationship. This is encouraging as the TOLT is possibly one of the most widely used measures of executive function in people with IDs suggesting that it is a highly

accessible measure for this population (Adams & Oliver, 2010; Ball et al., 2008; Masson et al., 2010; Willner et al., 2010) and offers some useful theoretical implications. For example, in considering the more recent specifications of the SAS (Shallice, 2002; Shallice & Burgess 1996), its component processes have been fractionated into eight functions including spontaneous schema generation (implicitly knowing what to do), goal setting, adoption of processing mode (problem solving), episodic memory retrieval (drawing upon memory from past experiences), delayed intention marker realisation (remembering to do something in the future), working memory, monitoring and rejection of schema (Burgess & Alderman, 2004). Drawing upon this model, it is possible to see how the ability to initiate tasks on the mMET-IDs could be attributed to the spontaneous schema generation (being able to implicitly develop a plan to achieve the set task), goal setting (being able to adequately set oneself the goal of achieving a set task), adoption of processing mode (being able to problem solve any difficulties that may arise) and delayed intention marker realisation (being able to remember to go back to tasks that cannot be completed straight away). Accordingly, it is useful to understand how abilities in these areas would correlate with performance on the TOLT.

Aside from being a measure of "planning" (Shallice, 1982) the TOLT has also been conceptualised as a measure of goal-conflict resolution (Morris, Miotto, Feigenbaum, Bullock, & Polkey, 1997). This may relate to the mMET-IDs and the SAS in a number of ways. For example, on the TOLT the participant has to consider a number of moves that will bring their disc arrangement closer to the required end state. Calculating all possible sequences to move from the starting arrangement to the end-statewould place too high a cognitive load on working memory, therefore, a more efficient strategy is to engage in a number of problem solving processes. Simon (1975) describes one of the most efficient strategies as being to divide the task into smaller subgoals and progressively move through the subgoals accordingly. Goal-subgoal conflict occurs when one has to make a move that, whilst needed to bring the discs to the required end state, necessitates that the participant makes a move that appears to take them away from the end goal state. Several examples of such moves are present on the TOLT used in this study (see Masson et al., 2010).

Accordingly, successful performance on the TOLT could be explained via abilities in spontaneous schema generation (being able to implicitly develop a plan to make a correct move in the face of goal-subgoal conflict), goal setting (being able to develop effective sub-goals to bring them closer to the desired end state in the face of goal-subgoal conflict) and adoption of processing mode (being able to problem solve any difficulties that may arise the face of goal-subgoal conflict).

Thus, with the exception of delayed intention marker realisation, there is a correspondence in the spontaneous schema generation, goal setting, and adoption of processing mode functions of the SAS that could plausibly explain the relationship between these two measures. It is these components of the SAS that could potentially be functioning well in those able to complete tasks on the MET-ID and perform successfully on the TOLT.

The theoretical implications of the findings lead onto a number of potential clinical implications. Based on the SAS model, Shallice and Burgess (1996) suggest that if spontaneous schema generation fails to occur, the adoption of processing mode function (e.g., problem solving) can be used to devise an appropriate plan. Thus, deficits in schema generation, goal setting, and problem solving would lend themselves to interventions that explicitly address problem solving deficits. Such interventions include Goal Management Training (Levine et al., 2000) or Problem Solving Therapy (PST; D'Zurilla & Nezu, 2007). Problem Solving Therapy (D'Zurilla & Nezu, 2007) attempts to address four major problem solving skills including: (a) problem definition and formulation, (b) generation of alternative solutions, (c) decision making and (d) solution implementation and verification. Interventions based on problem solving therapy have been shown to be effective at improving executive function in participants with brain injuries (von Cramon, Matthes-von Cramon, & Mai, 1991) and, based on evidence that the application of problem solving therapy to difficulties faced in the social domain have been effective in people with IDs (Lindsay, et al., 2011; Loumidis & Hill, 1997), it is conceivable that such a therapy may be successfully adapted for executive deficits in people with IDs.

Turning to the second aim, which was to examine the strength of the relationship between performance on the mMET-IDs and observer ratings of executive (dys)function to assess the ecological validity, the MET-IDs did not correlate significantly with the DEX-IR. At face value, this may suggest that the mMET-IDs may lack ecological validity. This finding is out of context with research in both IDs and non-IDs samples where the DEX-IR has been shown to correlate with measures of executive function (Chan, 2001; Dawson et al., 2009; Emsile et al., 2003; Knight et al., 2002; Masson et al., 2010). There is, however, also evidence where the DEX-IR has not consistently correlated well with measures of executive function (Norris & Tate, 2000), and it is very difficult to ascertain whether people completing the DEX-IR are doing it with the same degree of awareness and understanding of the person they are rating (Chaytor, Schmitter-Edgecombe & Burr, 2006) or the familiarity the respondent has with the cognitive and behavioural symptoms of executive dysfunction (Bennett et al., 2005). It is possible that the results reported may have arisen because staff members did not know the participants or the symptoms of executive dysfunction well enough to make valid ratings.

As a measure, the mMET-ID, as developed here, has a number of strengths. Firstly, the mMET-IDs was applied across a range of different real world environments and there proved to be no differences in mMET-ID scores across the four different day centres, suggesting that the measure can be successfully used within day-centres for people with IDs. Secondly, in many cases, the use of recorder pen to vocalise the written instructions of the mMET-IDs also helped to circumvent the difficulties faced by many of those who were unable to read the mMET-IDs instructions. Whilst, the mMET-IDs still needs further development, this study has demonstrated that executive function can be assessed outside the traditional office settings and thus afford a richer formulation of how an individual's executive function may play out in their everyday life.

A number of difficulties, however, were also noted with the mMET-IDs. Firstly, the internal consistency of the rule breaks measure was poor. This is unfortunate as the rule breaks scale has been shown to correlate with various measures of executive function (Alderman et al., 2003; Knight et al., 2002) as well as being predicative of specific dysexecutive symptoms (Alderman et al., 2003). Indeed, the difficulties in the internal consistency of this measure can be explained by some of the rules being consistently broken frequently (e.g., "Don't speak to Tom unless it's to tell him you have finished"), whereas other rules were rarely broken at all (e.g., "Don't leave the day centre"). It is likely to be very difficult for people with IDs to avoid speaking to the researcher when they are following them around the day centre. Having to be mindful of six rules may have loaded too heavily on the participants working memory demands so they found it difficult to check them whilst completing the tasks. Such practice (doing tasks whilst checking rules) may itself present a "dual task" scenario (Baddeley et al., 1997, Della Sala et al., 2010) or tap "switching" or "set shifting" skills that may load onto executive abilities and be problematic for people with IDs (Ball et al. 2008; Danielson et al., 2010; Kittler et al., 2008; Lanfranchi et al., 2011). This suggests that rule breaks can be a highly clinically useful scale and it is unfortunate that an acceptable degree of performance was not captured here. Thus, the rules of the mMET-IDs need further adaptation in a future study to make rule breaks a more clinically useful scale.

Within any future study, it would also be useful to include other measures of executive function to allow further exploration of the specific executive components of the mMET-IDs. More importantly, future research should address issues of ecological validity. For example, by using observer ratings specifically designed for people with IDs such as the Adaptive Behaviour Scale – Residential and Community: Second Edition (ABS-RC 2; Nihira et al., 1993) and careful selection of informants who have a good knowledge of and familiarity with the participant. Furthermore, future research might focus on developing a version of the mMET-IDs that can be carried out within the examinee's home, as it is likely that many potential participants (whether attending a day service or not) would live in a residential setting in which they could be assessed.

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Table 1 (a)

The Multiple Errands Task – Intellectual Disabilities (MET-IDs): Practice Tasks, and Tasks as given to the participants with accompanying symbols.
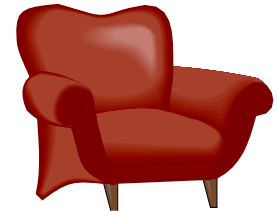
Practice tasks

Do the green tasks:

Find a chair and sit on it

Find a window and touch it

Tasks

Do the green tasks:

Find a book and give it to Tom.

Ask for a piece of paper from reception and put it on a chair.

Find an empty cup and give it to Tom

Clap your hands together 3 minutes after you start

Find a pencil and put it on a table

TELL TOM WHEN YOU HAVE FINISHED

Table 1 (b)

The Multiple Errands Task – Intellectual Disabilities (MET-IDs): Rules as given to the participants with accompanying symbols.

Rules

Follow the red rules:

Do <u>ALL</u> **the tasks in** <u>ANY</u> **order**
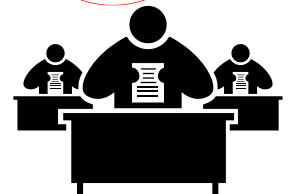
<u>DON'T</u> **speak to Tom unless it's to tell him when you've finished.**

<u>DON'T</u> **walk inside the** <u>RECEPTION</u>

<u>DON'T</u> **walk inside any** <u>STAFF OFFICES</u>

<u>DON'T</u> **go back into a room you've already been in**

<u>DON'T</u> **leave the** <u>DAY CENTRE</u>

Table 2

Multiple Errands Task – Intellectual Disabilities (MET – IDs) Score Sheet

MET-IDs Scoring Sheet

Participant ID: Date of testing: Rater:

Effort category	Example	Yes?
Task attempts *-Where a task is attempted but not completed satisfactorily.* *- If the task is also completed satisfactorily then a point is still awarded for the attempt.* *- Award one point per task attempt.*	• Found a book (award point even if participant finds alternate relevant item e.g., magazine, leaflet, brochure, newspaper etc). • Asked for a piece of paper from reception (award point even if participant fails to put item on chair). • Found an empty cup (award point even if participant finds a cup but fails to give it to examiner, if the cup has liquid in or if alternate relevant item e.g., glass). • Clapped hands together (award point even if clap is too early [<two minutes] or too late [>four minutes]). • Found a pencil (award point even if participant uses a pen/marker or gets pencil but fails to put it on a table). • Told examiner when finished (award point even if participant indicates they have finished without prompting but fails to explicitly say "finished").	
Total task attempts		

Error category	Example	Yes?
Rule breaks *-Where a specific rule was broken.* *- Award one point per rule break.*	• Failed to **attempt** all six tasks (award if total task attempts score is five or less) • Spoke to examiner other than to say when they had finished (includes reading out tasks) • Entered reception • Entered staff office (not reception) • Re-entered **side room** (re-entering communal pathways/access points (e.g., hall/foyer and/or recreation area) is OK. • Exited day centre	
Total Rule Breaks		

Effort category	Example	Yes?
Task completions *-Where a task is attempted and completed satisfactorily.* *- Award one point per task completion.*	• Found book **and** gave it to examiner (not completed satisfactorily if item was not a book e.g., item was a magazine or brochure or does not give it to examiner) • Got a piece of paper from reception **and** put it on a chair (not completed satisfactorily if paper was not put on a chair or put a table/floor etc) • Found an empty cup **and** gave it to examiner (not completed satisfactorily if cup is not given to examiner, has liquid in it or relevant item given is not a cup e.g., a glass). • Clapped hands three minutes after starting (not completed satisfactorily if participant claps hand too early [<two minutes] or too late [>four minutes]). • Found a pencil **and** put it on a table (not completed satisfactorily if participant uses a pen/marker rather than a pencil or puts it somewhere other than a table). • Told examiner when finished (not completed satisfactorily if states something like "I'm ready to go back to the room now" rather than specifically using the word "finished").	
Total task completions		

Table 3

Descriptive statistics for the measures

Measure	Maximum score	No at minimum (%)	No at maximum (%)	Range of scores	Mean (SD)	Median
Task attempts	6	4 (10)	10 (25)	0 – 6	3.9 (2.1)	5
Rule breaks	6	0 (0)	0 (0)	1 – 4	2.2 (0.8)	2
Task completions	6	4 (10)	0 (0)	0 – 5	2.7 (1.5)	3
SPT	16	0 (0)	0 (0)	1 – 13	6.3 (3.0)	6
TOLT	18	0 (0)	0 (0)	2 – 17	10.5 (4.8)	10.5
DEX-IR	80	0 (0)	0 (0)	6 – 67	30.6 (14.5)	29
WASI	130	0 (0)	0 (0)	52 – 70	58 (4.54)	56.5
BPVS-III	169	0 (0)	0 (0)	19 – 159	102 (31.2)	99.5
WR	131	0 (0)	0 (0)	3 – 124	59.8 (36.0)	54.5

Note. BPVS-III = British Picture Vocabulary Scale – Third Edition Raw Score; DEX-IR = Dysexecutive Questionnaire Independent Rater total score; SPT = Six Parts Test total score; TOLT = Tower of London Test total score; WASI = Wechsler Abbreviated Scale of Intelligence Full Scale IQ; WR = Wechsler Individual Attainment Test – Second Edition Word Reading subtest total score.

Table 4

Spearman's rho correlations between the mMET-IDs and neuropsychological measures.

Measure	1	2	3	4	5	6	7	8	9	10
1. Task attempts	-									
2. Rule breaks	.44**	-								
3. Task completions	.73**	.43**	-							
4. SPT	.21	-.15	.27*	-						
5. TOLT	.22	-.03	.37**	.08	-					
6. DEX-IR	.05	.04	.12	.14	-.02	-				
7. VIQ	.33*	.24	.35*	.29*	-.12	-.10	-			
8. PIQ	.00	-.02	.07	.09	.38**	-.31*	.21	-		
9. FSIQ	.19	.06	.24	.28*	.34*	-.34*	.48**	.89**	-	
10. BPVS-III	.39**	.10	.43**	.26*	.22	-.14	.45**	.36*	.47**	-
11. WR	.35*	.09	.26	.23	-.05	-.29*	.58**	.31*	.49**	.35*

Note. BPVS-III = British Picture Vocabulary – Third Edition Raw Score; DEX-IR = Dysexecutive Questionnaire Independent Rater total score; FSIQ = Wechsler Abbreviated Scale of Intelligence Full Scale IQ; PIQ = Wechsler Abbreviated Scale of Intelligence Performance IQ; SPT = Six Parts Test total score; TOLT = Tower of London Test total score; VIQ = Wechsler Abbreviated Scale of Intelligence Verbal IQ; WR = Wechsler Individual Attainment Test – Second Edition Word Reading subtest total score. Significance values are one tailed.

* $p < .05$

** $p < .01$