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The association between repetitive behaviours, impulsivity and hyperactivity in people with intellectual disability.

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Abstract

Background. There is a need for assessments of psychological difference and disorder in people who have more severe intellectual disability. Hyperactivity and impulsivity are two behavioural domains of importance as they are correlated with self-injury and aggression and this alludes to a shared cognitive correlate of compromised behavioural inhibition. Additionally, compromised behavioural inhibition is demonstrably related to repetitive behaviour and the latter might be expected to be associated with impulsivity and hyperactivity.

Methods. The Activity Questionnaire (TAQ) was developed for this study. Three subscales with high levels of face validity were supported by factor analysis of the scoring of 755 intellectually disabled participants on the TAQ items. These subscales mapped onto the constructs of Overactivity, Impulsivity and Impulsive Speech. Test-retest, inter-rater reliability and internal consistency were robust. TAQ scores and scores on the Repetitive Behaviour Questionnaire (RBQ) were collected for a sample of 136 participants with varying degrees of intellectual disability.

Results. Scores on the TAQ at subscale and full scale level were not related to level of adaptive functioning. There were significant positive associations between overactivity (TAQ) and stereotyped behaviour (RBQ), impulsivity (TAQ) and restricted preferences (RBQ), and impulsive speech (TAQ) and repetitive speech (RBQ).

Conclusions. The TAQ is a reliable assessment of hyperactivity and impulsivity for people with intellectual disability with robust factor structure. Validity requires evaluation. The relationship between impulsivity and restricted preferences may result from a common cognitive impairment in inhibition which may underpin these two classes of behaviour.

Introduction

The assessment of cognitive, emotional and behavioural difference and disorder in people with intellectual disability presents a significant challenge to researchers and clinicians (see Ross and Oliver, 2003; Hogg and Langa, 2005). Self-report is frequently compromised in people with more severe intellectual disability and normative data for informant based measures for typically developing individuals is likely to differ from those that might be generated for people with intellectual disabilities. The range of possible levels of intellectual disability is a further complication as assessment items may not be applicable for those with a more severe intellectual disability because of lack of opportunity (e.g. initiating activities) or performance requirements (e.g. speech). Finally, the behavioural manifestation of cognitive and emotional difference and disorder in people with severe intellectual disability might be different in form to that seen in more able or typically developing people.

It is important that assessments of separable psychological phenomena are developed to cater for the full range of intellectual disability to prevent exclusion of those with more severe disabilities who are, arguably, at greater risk for psychological distress (Dykens, 2000, Berry and Gaedt, 1995 and Borthwick-Duffy and Eyman, 1990, Emerson and Hatton, 2007). With careful scale development it should be possible to operationalise and quantify separate constructs thought to comprise a single disorder (e.g. the triad of impairments in autism spectrum disorder) and examine the relationship between these constructs within and between, for example, groups of people with intellectual disability of different aetiology (Moss et al, in press; Moss et al., in review). Additionally, these assessments will provide a useful assessment of outcome for interventions when combined with statistical techniques for single case designs such as the reliable change index (Christensen and Mendoza, 1986).

Two behavioural constructs of importance for clinicians and researchers are hyperactivity and impulsivity. Along with inattention these phenomena comprise the diagnosis of ADHD (American Psychiatric Association, 1994). A valid and reliable informant based behavioural assessment of these areas would be of value for a number of pragmatic reasons. An informant based measure would provide objective

assessment of impulsivity when contemporary neuropsychological assessments are not possible and aid evaluation of the outcome of interventions. It would also be possible to examine the validity of diagnosis in those who are more severely disabled and objectively assess constructs such as overactivity as a possible behavioural indicator of pain and discomfort (Luzanni et al, 2003).

In addition to these more applied issues there are two emerging areas of research within the intellectual disability field that are of importance to understanding the cognitive and, potentially, biological correlates of hyperactivity and impulsivity. First, there is growing evidence that specific syndromes are associated with overactivity and/or impulsivity (e.g. Fragile X, Angelman, Cri du Chat and Smith-Magenis syndromes (Bregman et al., 1988, Clarke and Marston, 2000; Cornish and Bramble, 2002; Dykens and Smith, 1998). Comparisons across these groups are warranted as behavioural differences between syndromes allude to biological differences and because dissociation of overactivity from impulsivity, suggested in some descriptions, might have important implications for theoretical models of ADHD.

Second, contemporary theories of ADHD and repetitive behaviours each impute compromised executive function in cognitive accounts of behavioural phenomenology. Barkley (1997, 1999) identifies deficits in cognitive and behavioural inhibition as central to hyperactivity and impulsivity with evidence from neuropsychological studies using, for example, stop signal and delay gratification tasks (Oosterlan et al., 1998; Schweitzer and Sulzer-Azaroff, 1995). Turner (1999) has proposed that repetitive behaviours and restricted interests arise due to impaired generativity and compromised response inhibition. If these theories are correct then it might be expected that hyperactivity, impulsivity and repetitive behaviours should co-occur as they share cognitive underpinnings. Any tests of this hypothesis would need to ensure that measures clearly define the constructs under examination to avoid confounding the correlation and would most easily be conducted within a sample of people with an intellectual disability as repetitive behaviours are more likely to be present. The clinical importance of this association is that hyperactivity and compulsions are related to self-injury in people with intellectual disability and may be associated with increased severity (Bodfish and Lewis, 2002; Bodfish et al., 1995; Sloneem et al., in review; Petty and Oliver, 2005). This suggests that behaviour

dysregulation by, for example, compromised behavioural inhibition may be an important determinant of severity of self-injury.

There is a broad range of relevant scales of hyperactivity currently employed in research with people with intellectual disabilities. Existing scales reported to be normed on a population of people with intellectual disabilities include The Aberrant Behavior Checklist (ABC; Aman and Singh, 1986), the Reiss Scales (Reiss, 1987) and The Developmental Behavior Checklist (DBC; Einfeld and Tonge, 1992). The ABC and DBC assess different sets of behaviours and constructs relevant to the assessment of ADHD that are derived from factor analysis and so may not include all relevant behaviours and may exclude others. Reliability and validity of a number of ADHD rating scales used with intellectually disabled children have been assessed (Miller, Fee and Netterville, 2004 and Miller, Fee and Jones, 2004) but it should be noted that individuals with severe and profound levels of intellectual disability were excluded. Exclusion of people with severe and profound intellectual disability and the need for an assessment with items that map onto the constructs of hyperactivity and impulsivity indicates that the development of an appropriate and robust measure for use with this population would be useful.

The first aim of this study is to develop and evaluate the psychometric properties of an informant-based questionnaire measure of hyperactivity and impulsivity for use in relation to people with all levels of intellectual disability. Items will be based on existing measures, selected because of their reference to the six hyperactivity and three impulsivity criteria for Attention Deficit Hyperactivity Disorder in DSM-IV (American Psychiatric Association, 1994). The second aim is to evaluate the association between repetitive behaviour and hyperactivity and impulsivity to test the prediction that these phenomena should co-occur given that each is associated with impaired executive dysfunction.

Methods

Measures

To fulfil the first aim of the study we developed an informant based assessment of overactivity and impulsivity and evaluated the psychometric properties.

Development of the Activity Questionnaire (TAQ, Burbidge and Oliver, 2008)

The TAQ is an information-based questionnaire comprising eighteen items with a five-point Likert –style response format ranging from 0 (never/almost never) to 5 (always/almost all of the time). To develop the scale, items from the Aberrant Behavior Checklist (Aman and Singh, 1986), ADHD Rating Scale IV (Dupaul, Power, Anastopoulos and Reid, 1998), Child Behavior Checklist (Achenbach, 1991), Conners’ Rating Scales (Conners, 1994), Revised Behaviour Problem Checklist (Quay and Peterson, 1983), and the Strengths and Difficulties Questionnaire (Goodman, 1999) were initially selected based on their reference to the nine inattention, six hyperactivity and three impulsivity criteria for ADHD in DSM-IV (American Psychiatric Association, 1994). However, items relating to inattention were excluded as the focus on academia rendered them inappropriate for participants with severe and profound intellectual disabilities. The remaining items were condensed to a concise format covering all nine DSM-IV hyperactivity and impulsivity criteria. Where necessary, modifications were made to terminology to maximise applicability to a population encompassing individual characteristics of immobility and limited or no verbal ability. Adaptations involved a) inclusion of terms related to a variety of positions of the individual: ‘lying down’ as well as seated, b) removal of terms related to academia: leaves seat ‘in classroom’ and inclusion of more general items: “prefers to be moving around or becomes frustrated if left in ‘one position’ for too long” c) rewording of items to prevent reliance on verbal ability (where possible): “disturbs others because they have difficulty waiting for things or waiting their turn” rather than “interrupts or intrudes on others e.g. butts into conversations or games”. The items included in the final version of the TAQ are shown in Table 1.

+++++++ Insert Table 1 here ++++++

Despite adaptations to questions, two items were considered to be heavily reliant on mobility: item 11 “Does the person’s behaviour seem difficult to manage/contain whilst out and about (e.g. in town, in supermarkets etc.)?” and item 12 “Do you feel

that you need to ‘keep an eye’ on the person at all times?” Three items are reliant on the person being verbal (Item 10 “Does the person often talk excessively?”, item 14 “Does the person blurt out answers before questions have been completed?” and item 15 “Does the person start to respond to instructions before they have been fully given or without seeming to understand them?”). Thus, in the empirical evaluation of the factor structure of the TAQ reported below, analysis was conducted separately for participants who were mobile and verbal, or immobile, or non-verbal.

Factor analysis

Given that the TAQ was developed based on items from existing measures relating to hyperactivity and impulsivity, empirical demonstration of TAQ factors mapping onto these theoretical constructs would support the validity of the measure. In addition to this, empirical evaluation of the factor structure of the TAQ will assist in the development of subscales to assess different aspects of activity.

To empirically evaluate factor structure of the TAQ, 2218 potential participants were approached, as part of a larger study (see citations withheld for blind review), through six syndrome support groups: Cri du Chat Syndrome (CdC), Cornelia de Lange Syndrome (CdLS), Angelman Syndrome (AS), Prader Willi Syndrome (PWS), Fragile X Syndrome (FXS) and Lowe Syndrome (LS). A group of participants with heterogeneous cause of intellectual disability (HID) were recruited via day placements for children and adults with intellectual disabilities and from participants in a previous study of the behavioural phenotype of Cornelia de Lange syndrome (citations withheld for blind review). In total, 816 (37% response rate) questionnaires were returned. Respondents with children under 4 years old were excluded as the TAQ items were considered inappropriate for these individuals. Respondents who returned questionnaires with substantial missing data were also excluded. As a result, the total sample comprised 755 participants, 62 (8.2%) CdC, 107 (14.2%) CdLS, 103 (13.6%) AS, 181 (24.0%) PWS, 187 (24.8) FXS, 56 (7.4%) LS and 59 (7.8%) HID. Sixty-six percent of participants were male and the age ranged from 4 to 51 years (mean age=16.5, SD=9.86). Four hundred and ninety three participants were verbal and mobile, 24 were verbal but not mobile, 156 were mobile but not verbal, and 82 were immobile and non-verbal.

Factor Structure

The mobile, verbal participants obtained TAQ total scale scores ranging from 0 to 72 (mean = 31.60, SD = 18.01), the immobile, verbal participants obtained total scores ranging from 11 to 58 (mean = 26.93 and SD = 12.42), the mobile, non-verbal participants obtained total scores ranging from 1 to 60 (mean = 36.35 and SD = 13.42), and the immobile, non-verbal participants obtained total scores ranging from 4 to 51 (mean = 25.98 and SD = 12.11). Factor analysis using the Maximum Likelihood Method and a Direct Oblimin rotation¹ was carried out on three samples of participants (using SPSS 16.0 for Windows software package); mobile, verbal (n=493), and mobile, non-verbal (n=156) participants comprised the first two samples. Immobile, verbal and immobile, non-verbal participants were combined into a single sample (n=106) in order to create a sample of comparable size. All TAQ items for which participants could obtain a score were entered into the analyses. Thus, all items were entered into the analysis for the sample of mobile, verbal participants, all items except 10, 14 and 15 were entered into the analysis for the sample of mobile, non-verbal participants, and all items except 10, 11, 12, 14 and 15 were entered into the analysis for the sample of immobile (verbal or non-verbal) participants. Factors extracted were those associated with eigenvalues greater than one (Kaiser, 1960) that also satisfied the criteria of a scree test (Cattell, 1966). Factor loadings between 0.3 and 0.5 would generally be considered statistically significant ($p < .01$) with the present sample sizes and 0.4 is often taken as the cut-off for the point at which the amount of variance ($> 16\%$) in a factor accounted for by a variable is considered important (Field, 2000). Thus, in the analysis below we consider all factor loadings greater than 0.3 as being potentially important.

The results of these analyses are shown in Table 2. As can be seen in Table 2, two factors clearly emerged across all three samples and a third factor emerged for the sample of verbal, mobile participants. The third factor emerging from the verbal, mobile sample involves items 10, 14 and 15, which relate to talking excessively, blurting out answers and responding to instructions before they have been fully given.

¹ Factor analysis using Pearson's correlation coefficients was employed despite some suggestions that polychoric correlations are more appropriate for use with ordinal data (e.g. Tello, Moscoso, Garcia & Abad, 2010) in order to ensure that the present results are in line with previously published factor analyses of similar questionnaire measures (e.g. Deb, Dhaliwal, & Roy, 2009; Westerlund, Holberg, Naswall & Fernell, 2008).

These items were not included in the factor analyses with the other two samples as non-verbal participants could not obtain a score on these items. Thus, this factor can be described as an ‘Impulsive Speech’ factor and can be scored for verbal participants².

+++++++ Insert Table 2 here ++++++

Across all three samples, items 1 to 9 inclusive clearly load predominantly onto one factor, while items 12, 16, 17 and 18 clearly load predominantly onto a second factor. Items 1 to 9 include behaviours such as fidgeting, difficulty holding still and a preference for moving around, which all fit in well with the theoretical construct of over-activity. Items 12, 16, 17 and 18 include behaviours such as finding it difficult to wait and wanting things immediately, which fit in well with the theoretical construct of impulsivity. Thus, each of the samples examined resulted in two factors which strongly map onto the constructs of over-activity and impulsivity, supporting the validity of the TAQ.

In the development of subscales for the TAQ, the results of the factor analysis acted as a guide to separate the items into impulsive speech, over-activity and impulsivity subscales. Item 13 ‘seem to act/do things without stopping to think’ loaded predominately onto the impulsivity factor in the (largest) verbal, mobile sample. In the other two (smaller) samples, there was little difference between the loadings of this item onto the hyperactivity or the impulsivity factors. However, given the strong face validity of this item in mapping onto the impulsivity construct, the decision was made to include it in the impulsivity subscale. Item 11 ‘behaviour seems difficult to manage/contain whilst out and about’ loaded fairly strongly onto both over-activity and impulsivity factors in the verbal, mobile sample but loaded predominately onto the over-activity factor in the non-verbal, mobile sample. Given the less clear face validity of the mapping of this item onto either the over-activity or the impulsivity subscale, the decision was made to exclude this item from both subscales.

² In order to provide further confirmation of the ‘Impulsive Speech’ factor, a factor analysis using the Maximum Likelihood Method and a Direct Oblimin rotation was carried out on all verbal participants (n=517). These participants could be mobile or immobile so all TAQ items except 11 and 12 were entered into the analysis. An equivalent three factor solution as is shown for the verbal, mobile sample was obtained, with the third factor comprising items 10, 14 and 15.

Subscale Structure and Scoring

Thus, three subscales were derived from the TAQ; the impulsive speech (items 10, 14 & 15), the over-activity (items 1 to 9) and the impulsivity (items 12, 13, 16, 17 & 18) subscales. Given the primary aim of the TAQ of providing a measure of over-activity and impulsivity that is clinically useful, subscale scores were derived simply by summing individuals' scores on all of the items pertaining to each subscale. As noted above, non-verbal participants were unable to score on the impulsive speech subscale, the total possible TAQ score for non-verbal participants was adapted accordingly (total score=60 versus 72). Immobile participants were only able to score on four of the five items on the Impulsivity subscale (i.e. not item 12) so in order that their scores were comparable to mobile participants, scores were pro-rated. This procedure involved multiplying the Impulsivity subscale score for immobile participants by 1.25 (as calculated by dividing the total number of items on this subscale (5) by the number of items on which immobile participants can score (4)). As immobile participants could not score on item 11, the total possible TAQ score for these participants was adapted accordingly (total score=68 versus 72).

Internal Consistency

Internal Consistency was evaluated at full scale and subscale level for the mobile, verbal; mobile, non-verbal; and immobile (verbal or non-verbal) participants separately. Table 3 summarises internal consistency at full scale and subscale level across the three groups, showing the 95% confidence intervals of the Alpha coefficients.

+++++++ Insert Table 3 here ++++++

All subscales were positively correlated with each other to a moderate degree: Overactivity and Impulsivity ($r(755) = .59, p < .001$), Overactivity and Impulsive Speech ($r(517) = .50, p < .001$) and Impulsivity and Impulsive Speech ($r(517) = .50, p < .001$). This suggests that subscales may appraise related but different constructs. It remains possible that the apparent relationship between the subscales has arisen purely from relationships between each subscale and a common (undefined and

unmeasured) underlying construct. However, the important point here is that, the (only) moderate correlations between the subscales support the suggestion that they measure distinct constructs.

Inter-rater and Test-retest Reliability

Reliability data were collected for 125 people with severe and profound intellectual disabilities in addition to the samples described above. Twenty-two participants were recruited through syndrome support groups (10 CdC and 12 CdLS) and consisted of eight (36.4%) males and fourteen (63.6%) females with an age range of 6-48 years (mean 16.5, SD 10.3). The remaining 103 participants were recruited from four residential schools/colleges for people with intellectual disabilities. This group consisted of 73 (70.9%) males and 22 (21.4%) females (8 missing) with an age range of 10-28 years (mean 17.6, SD 3.7). Across the 125 participants there were: 81 (64.8%) males, 36 (28.8%) females (8 missing data), 58 (46.4%) verbal participants, 59 (47.2%) non-verbal participants (8 missing data), 102 (81.6%) mobile participants and 15 (12%) immobile participants (8 missing data). The mean scores on the TAQ were 30 for nonverbal individuals (N = 54, range 0-60, SD 14) and 32 for verbal individuals (N = 48, range 3-62, SD 16). Mean scores were 14 (N = 106, range 0-36, SD 9) on the Overactivity subscale, 15 (N = 105, range 0-24, SD 7) on the Impulsivity subscale and 4 (N = 49, range 0-12, SD 3) on the Impulsive Speech subscale.

For the purpose of assessing inter-rater reliability each questionnaire was completed independently by two parents/carers of the participants, within a seven-day window (N=125). The TAQ was administered to the same informants on two occasions, two weeks apart to assess test-retest reliability (N=103). Item level inter-rater reliability ranges from .31-.75 (mean .56) and test-retest reliability ranges from .60-.90 (mean .75). Whilst inter-rater reliability is low for a number of items, the level is comparable to other widely used measures, such as the Aberrant Behavior Checklist (Aman and Singh, 1986). Inter-rater and test-retest reliability data were calculated at subscale and total score level. Table 4 shows a summary of these indices, which demonstrate that all correlations are at .70 or above and provide evidence that at subscale and full-scale level, both inter-rater and test-retest reliability of the TAQ are robust.

+++++++ Insert Table 4 here ++++++

The association between repetitive behaviours, impulsivity and overactivity.

To fulfil the second aim of the study we examined the association between repetitive behaviours, impulsivity and hyperactivity within a sample of people of intellectual disability of mixed aetiology.

Procedure

The Wessex Scale, the Repetitive Behaviour Questionnaire (RBQ) and The Activity Questionnaire (TAQ) were completed by carers of participants.

Measures

The Wessex Scale (Kushlick, Blunden and Cox, 1973)

The Wessex Scale is an informant questionnaire designed to assess social and physical abilities in children and adults with intellectual disabilities. Subscales include continence, mobility, self help skills, speech and literacy and information on vision and hearing is also included. The Wessex Scale has good inter-rater reliability at subscale level for both children and adults (Kushlick, Blunden and Cox, 1973; Palmer and Jenkins (1982). Based on their scoring on the self help subscale participants can be classified on a three-point scale (able, partially able, not able) indicating their level of adaptive functioning.

The Repetitive Behaviour Questionnaire (RBQ; Moss & Oliver, 2008)

The RBQ is an informant questionnaire for use in relation to verbal and non-verbal children and adults with intellectual disabilities. The RBQ is a measure of specific , operationally defined types of repetitive behaviour and consists of nineteen items are grouped into five subscales: stereotyped behaviour, compulsive behaviour, insistence on sameness, restricted preferences and repetitive use of language. Informants rate the occurrence of behaviour on a five-point Likert scale from 'never occurring' to 'occurring more than once a day' based on observations over the last month. The RBQ has good overall reliability, with mean inter-rater and test-retest reliability co-

efficients of .80 and .88 on the Compulsive Behaviour subscale and .71 and .87 on the Stereotyped Behaviour subscale. Convergent validity between the RBQ and scores on the Repetitive Behaviour subscale of the Autism Screening Questionnaire (Berument, Rutter, Lord, Pickles & Bailey, 1999) is also good. The RBQ has different scoring protocols for verbal and non-verbal participants as verbal ability is necessary for scoring on some of the items.

Participants

142 participants were recruited from two residential schools and one college for people with intellectual disability and from a database of individuals with intellectual disability of heterogeneous cause who had participated in previous research projects and had given their permission to be contacted again. Information regarding chronological age was available for 134 participants. Participants ranged in age from 6 to 38 years (mean 17.87 years). 70.4% of participants were male (gender information was unavailable for 1.4% (n=2) of participants), 52.8% were verbal (more than 30 words/signs in vocabulary) and 85.2% were mobile (able to walk unaided). Wessex data were available for 60 participants. On the self help subscale of the Wessex, 26.7% were classified as 'able', 36.7% were classified as 'partly able' and 36.7% were classified as 'not able'.

Results

Background information on scores on the RBQ and TAQ and the effects of level of adaptive functioning, gender and age

Table 5 presents the mean, range and standard deviation of scores on each subscale and total scale of the RBQ and TAQ. Scores on each subscale of each measure evidence a wide range. The range of TAQ total and subscale scores indicates that the measure is able to appraise overactivity and impulsivity across a continuum including very high and very low scores, this provides support for the clinical utility of the measure.

+++++++ Insert Table 5 here ++++++

In order to examine the relationship between participants' level of adaptive functioning and their scoring on the RBQ and TAQ, a series of one-way ANOVAs was conducted within the subset of participants ($n=60$) for whom Wessex data was available³. The level of adaptive functioning measured on the Wessex self help subscale (able, partially able, not able) was treated as the between subjects factor and scores on the five RBQ and three TAQ subscales, and the RBQ and TAQ full scales were treated as the dependent variables. A Bonferroni correction was applied in order to adjust for the ten separate one-way ANOVAs that were conducted and $p < .005$ was treated as significant. Separate analyses within verbal and non-verbal participant groups could not be conducted due to the resulting small number of participants at each level of adaptive functioning. Thus, verbal and non-verbal participants were included in the same analyses and the non-verbal RBQ scoring protocol was applied. Only the main effect of level of adaptive functioning on repetitive speech was significant ($F(2,59)=11.05, p < .001$) with a higher level of adaptive functioning being associated with increased repetitive speech. Only the effects of level of adaptive functioning on compulsive behaviour and obsessive behaviour were significant even to an uncorrected level ($F(2,59)=3.64, p = .032$; $F(2,59)=4.29, p = .018$), with increased adaptive functioning being associated with increased obsessions and compulsions.

Independent samples t-tests were conducted to assess the effect of gender on subscale and total scores for the RBQ and TAQ. However, there were no significant effects of gender on any of the subscale or full scale scores even at an uncorrected alpha level. Age was only moderately but significantly positively correlated with the repetitive speech subscale of the RBQ ($r(134)=.24, p = .005$), but did not show notable relationships with any other RBQ or TAQ subscale or full scale scores.

The relationships between repetitive behaviour overactivity and impulsivity

To fulfil the second aim the study we conducted Pearson correlations to assess the relationships between the constructs measured by the TAQ and RBQ subscales (see Table 6). Significant positive correlations were demonstrated between scores on the Overactivity subscale of the TAQ and the Stereotypy and Restricted Preferences

³ These analyses were also conducted using non-parametric Kruskal Wallis tests, which produced exactly the same pattern of results.

subscales of the RBQ, between the Impulsivity subscale of the TAQ and the same RBQ subscales. There were also significant positive correlations between scores on the Impulsive Speech subscale of the TAQ and the Restricted Preferences, Insistence on the Sameness and the Repetitive Speech subscales of the RBQ. Pearson's partial correlation coefficients were calculated for these relationships with scores on every other RBQ and TAQ subscale being partialled out of the analysis in turn (see Table 6).

As can be seen from Table 6, the relationship between TAQ Overactivity and RBQ stereotypy remained similar in strength (moderately high) regardless of which other TAQ and RBQ variables were partialled out of the analysis. However, the relationship between TAQ impulsivity and RBQ stereotypy (although similar in strength when other RBQ variables were partialled out of the analysis) was substantially reduced when other TAQ variables were partialled out of the analysis. There was no notable relationship between TAQ impulsive speech and RBQ stereotypy. This suggests that the relationship between RBQ stereotypy and the TAQ is driven by a positive association between overactivity (TAQ) and stereotypical behaviour (RBQ).

The relationship between TAQ Impulsive Speech and RBQ Repetitive Speech remained similar in strength (moderately high) regardless of which other TAQ and RBQ variables were partialled out of the analysis. Given the weak relationships between RBQ Repetitive Speech and the other TAQ subscales, it appears that this relationship reflects a specific association between impulsive speech (TAQ) and repetitive speech (RBQ). The relationship between TAQ Impulsive Speech and RBQ Insistence on Sameness was substantially reduced when some of the other RBQ variables were partialled out of the analysis or when TAQ Impulsivity was partialled out. Thus, it is likely that this relationship is driven by interactions between the TAQ versus RBQ subscale relationships and the associations between different RBQ or TAQ subscales.

The relationship between TAQ Impulsivity and RBQ Restricted Preferences remained similar in strength (moderate) when other RBQ variables were partialled out of the analysis and when TAQ Overactivity was partialled out of the analysis. However the

relationship between TAQ Overactivity and RBQ Restricted Preferences was reduced to a non-significant level when a number of other RBQ and TAQ variables were partialled out of the analysis, for example, RBQ Repetitive Speech or TAQ Impulsivity. Similarly, the relationship between TAQ Impulsive Speech and RBQ Restricted Preferences was substantially reduced when RBQ Repetitive Speech or TAQ Impulsivity were partialled out of the analysis. Thus it appears that the relationship the RBQ Restricted Preferences and the TAQ may be driven by other specific associations between RBQ and TAQ variables.

+++++++ Insert Table 6 here ++++++

Discussion

The first aim of this study was to develop an informant-based questionnaire measure of hyperactivity and impulsivity for use in relation to people with all people with intellectual disabilities. Analysis of the psychometric properties of the TAQ demonstrates a robust factor structure, including factors which map onto the target constructs of hyperactivity and impulsivity, across mobile, immobile, verbal and non-verbal participants. This factor structure was used to support the composition of statistically robust subscales associated with high face validity for measuring the constructs of overactivity, impulsivity and impulsive speech. The resultant measure was associated with good internal consistency at full scale and subscale level across mobile, immobile, verbal and non-verbal participants. Inter-rater and test-retest reliability at subscale and full-scale level are robust, with all correlations at or above .70 and .87 respectively.

At full-scale level, internal consistency of the TAQ is comparable to the parent completed Werry-Weiss-Peters Activity Rating Scale (WWPARS, Routh et al., 1974) and the parent and teacher completed Swanson, Nolan and Pelham (SNAP) Checklist (Pelham and Murphy, 1981). At subscale level the TAQ is comparable to the Conners Teacher Rating Scale (CTRS-39, Conners, 1989), the parent and teacher completed Attention Deficit/Hyperactivity Disorder Test (ADHDT, APA, 1994) and the teacher

completed Aberrant Behavior Checklist-Community scale (ABC-C, Marshburn and Aman, 1992), with stronger internal consistency than the Conners Parent Rating Scale (CPRS-48, Conners, 1989) and the ADD-H Comprehensive Teacher's Rating Scale (ACTeRS, Ullman et al., 1991). Test-retest reliability of the TAQ at full-scale level is comparable to the teacher completed SNAP and is stronger than for the parent and teaching assistant completed SNAP and the parent completed WWPARS. At subscale level, the TAQ is comparable to the teacher completed ABC-C and teaching assistant completed CTRS-39 although the teacher completed CTRS-39 is marginally stronger than the TAQ.

The TAQ has comparable test-retest reliability to the teaching assistant completed ABC-C, the CPRS-48, the parent, teacher and teaching assistant completed ADHDT and teacher and teaching assistant completed ACTeRS. The SNAP was only reported to have significant inter-rater reliability correlations for parent-teacher comparisons (at full-scale level) and this appeared to be considerably lower than for the TAQ (no data are available for the WWPARS). For teacher-teaching assistant comparisons, inter-rater reliability data were reported for a number of subscales within the rating scales. The ABC-C demonstrated adequate to good inter-rater reliability on all factors with the coefficient for hyperactivity (.80) being stronger than for the TAQ overactivity subscale (.70). The CTRS-39 and ADHDT inter-rater reliability coefficients for hyperactivity (.49 and .50 respectively) are lower than for the TAQ.

Scores on the TAQ do not appear to be related to individuals' levels of adaptive functioning. This suggests that the measure is indeed suitable for use with individuals with a range of degrees of intellectual disability and that the behaviours assessed at item level do not represent behaviours that would only be shown by individuals within a specific ability range.

Although psychometric properties of the TAQ are good, it must be noted that the sample sizes (particularly of verbal, immobile participants) employed for the development of the measure reported here were relatively small compared to those commonly used to obtain robust normal data for the standardisation of questionnaire measures. Future development of the TAQ should aim to expand on this initial data set. It must also be noted that the Wessex scales provide a very crude measure of

level of adaptive functioning, which in this study was taken as an indicator of level of intellectual ability. For the generation of normative data for the TAQ a more sensitive assessment of intellectual ability would be required, for example, standardised direct assessments like the Bayley Scales of Infant Development or standardised informant report interviews of adaptive functioning like the Vineland Adaptive Behaviour Scales.

An additional limitation to the present findings is that no validity data were obtained, these data will be essential for the future development of the measure. Finally, there has been substantial progress in the development of more objective measures of ADHD including continuous-performance tests and systematic behavioural observations (Barkley, 1999). Increasingly, these tests are being standardised and have the advantage over rating scales as they do not rely on informants. These assessments might be adapted for people with intellectual disability and used to appraise the validity of the TAQ. In summary, examination of the psychometric properties of the TAQ informant-based questionnaire indicates a robust measure of hyperactivity, impulsivity and impulsive speech for use in relation to people with intellectual disabilities.

The second aim of this study was to evaluate the relationship between repetitive behaviours, hyperactivity and impulsivity using measures that clearly differentiated between these constructs. There were a number of associations between scores on TAQ subscales and scores on subscales of the Repetitive Behaviour Questionnaire (the robust measure employed to assess repetitive behaviour). However, using a series of partial correlation analyses, it was demonstrated that three specific associations appeared to be driving the reported relationships. There were significant positive associations between overactivity (TAQ) and stereotypical behaviour (RBQ), between impulsivity (TAQ) and restricted preferences (RBQ), and between impulsive speech (TAQ) and repetitive speech (RBQ).

The relationship between overactivity and stereotypical behaviour suggests that hyperactive individuals may be more likely to show stereotypical behaviour and that the two behaviours may be driven by a common underlying mechanism. Dysfunction in subcortical structures (e.g. the subthalamic nucleus) and abnormalities in dopamine

transmission have both been linked to abnormal movement behaviours including hyperactivity and stereotypical behaviour (Karachi et al., 2009; Nwaneshiudu & Unterwald, 2009). Thus, one suggestion may be that individuals showing stereotypical behaviour show a particular neurochemical or neuronal abnormality which may also promote hyperactivity. Given the nature of the behaviours measured by TAQ and RBQ subscales of overactivity and stereotypical behaviour, it must be noted that it is possible that the same behavioural phenomena shown by the participants contributed to scores on both scales, although this seems unlikely given the clear descriptions of items in each scale.

The relationship between impulsive speech and repetitive speech may reflect some overlap between the behaviours being measured by the corresponding TAQ and RBQ subscales. However, as in the case of overactivity and stereotypical behaviour, the impulsive and repetitive speech subscales comprise items with clear descriptions of different behaviours. It is possible therefore, that the relationship between impulsive speech and repetitive speech reflects a broader relationship between impulsivity and repetitive behaviour, which is also reflected by the specific relationship between impulsivity and restricted preferences.

The relationship between impulsivity and restricted preferences is less likely to be affected by overlap of the behaviours described on the two measures as the items on these two subscales are clearly dissimilar. It has been argued that impulsivity may be underpinned by compromised behavioural inhibition and deficits in inhibition have been linked to some types of repetitive behaviour including restricted preferences (Barkley, 1999; Turner, 1999). Thus it is possible that individuals showing high levels of impulsivity show a compromised capacity for inhibition, which in turn underpins the restricted preferences shown by these individuals.

Compromised inhibition can manifest behaviourally as an impaired capacity to prevent or curtail a prepotent response. It therefore follows that some forms of ritualistic behaviours or restricted interests might be construed as unrestricted responses to stimuli that have previously been rewarded. These behaviours may differ from compulsive behaviours as they are not necessarily preceded by related thoughts or anxiety (see Baron-Cohen, 1985). The relationship between impulsivity and

restricted preferences (and perhaps to some extent, that between impulsive speech and repetitive speech) is therefore important in alluding to a possible cognitive mechanism underpinning some forms of repetitive behaviour and adds to the growing literature linking executive functioning to repetitive behaviour (e.g. Lopez, Lincoln, Ozonoff & Lai, 2005). Future research should evaluate the relationship between compromised behavioural inhibition and restricted preferences using neuropsychological and behavioural tests.

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TAQ Item	
1wriggle or squirm about when seated or lying
2fidget... play with hands and/or feetseated or lying down?
3	....find it difficult holding still?
4	....find it difficult to remain in their seat even when expected?
5	....prefer to be moving around Frustrated if left in one position?
6	When involved in a leisure activity make a lot of noise?
7	When ... involved in an activity boisterous and/or rough?
8	... act as if they are “driven by a motor” ?
9	....need very little rest to recharge their battery?
10	....talk excessively?
11	....behaviour seem difficult to manage/contain whilst out and about?
12	....need to “keep an eye” on the person at all times?
13	....seem to act/do things without stopping to think ... ?
14	....blurt out answers before questions have been completed?
15	....respond to instructions before they have been fully given ...?
16	....want things immediately?
17	....find it difficult to wait?
18	....disturb others difficulty waiting for things or ... their turn?

Table 1. Items of the TAQ

	Mobile, verbal (n=493)			Mobile, non-verbal (n=156)		Immobile, verbal OR non- verbal (n=106)	
	Factor 1	Factor 2	Factor 3	Factor 1	Factor 2	Factor 1	Factor 2
1	0.81	0.01	-0.03	0.88	0.07	0.70	-0.22
2	0.60	0.03	0.08	0.64	0.00	0.61	-0.08
3	0.85	0.01	0.00	0.71	-0.01	0.63	-0.03
4	0.87	-0.05	-0.08	0.79	0.01	0.58	0.13
5	0.85	-0.08	-0.16	0.76	0.02	0.58	0.08
6	0.59	-0.02	0.17	0.63	0.12	0.35	0.07
7	0.56	-0.09	0.14	0.47	-0.10	0.50	0.23
8	0.82	0.00	0.01	0.85	0.00	0.76	0.09
9	0.77	0.06	0.06	0.51	-0.14	0.69	-0.07
10*	0.17	-0.12	0.39	-	-	-	-
11*	0.41	-0.42	0.00	0.50	-0.13	-	-
12*	0.15	-0.51	0.02	0.18	-0.47	-	-
13	0.25	-0.44	0.15	0.32	-0.29	0.47	0.35
14*	-0.07	0.02	0.95	-	-	-	-
15*	0.04	-0.06	0.75	-	-	-	-
16	-0.10	-0.97	0.02	-0.01	-0.90	-0.06	0.96
17	-0.08	-1.01	-0.02	-0.09	-1.01	-0.04	1.00
18	0.04	-0.83	0.05	0.03	-0.80	0.20	0.71

* Items 10, 14 and 15 are not scored for non-verbal participants. Items 11 and 12 are not scored for immobile participants. Only 24 participants were verbal but immobile thus these participants were combined with those who were immobile and non-verbal (n=82) to create a sample of participants who were immobile and could be either verbal or non-verbal. For this sample, neither verbal (10, 14 & 15) or mobile specific items (11 & 12) were scored.

Table 2. Factor loadings for items in the TAQ for i) mobile and verbal participants, ii) mobile and non-verbal participants and iii) immobile participants (verbal or non-verbal). The loadings with an absolute value greater than 0.3 are shown in bold.

Group	N	Full Scale	Overactivity	Impulsivity	Impulsive Speech
Mobile, verbal	493	.932-.947	.917-.936	.894-.920	.732-.803
Mobile, non- verbal	156	.882-.925	.867-.917	.828-.896	-
Immobile (verbal or non- verbal)	106	.833-.905	.793-.883	.766-.872	-

Table 3. 95% confidence intervals for the alpha coefficients for The Activity Questionnaire at Full- and Subscale level for mobile & verbal, mobile & non-verbal, and immobile (verbal or non-verbal) participants.

	N	M (SD)	Range	Inter-rater Reliability (N)	Test-retest Reliability (N)
Overactivity	106	14.41 (8.82)	0-36	.70 (97)	.87 (81)
Impulsivity	105	14.92 (6.63)	0-24	.74 (100)	.88 (77)
Impulsive Speech	49	3.70 (3.22)	0-12	.72 (45)	.90 (36)
Total for Verbal	48	31.51 (15.81)	3-62	.74 (45)	.88 (42)
Total for Non Verbal	54	30.38 (14.02)	0-60	.78 (44)	.94 (34)

Table 4. Means, SDs, Range and inter-rater and test-retest reliability coefficients for The Activity Questionnaire (N varies across and within analyses due to missing data and verbal ability)

Measure	Subscale	Mean Score (SD) <i>Range</i>
Repetitive Behaviour Questionnaire	Stereotyped behaviour	6.50 (4.39) <i>0.0-12.0</i>
	Compulsive behaviour	6.47 (7.22) <i>0.0-32.0</i>
	Restricted preferences	3.22 (3.18) <i>0.0-11.0</i>
	Repetitive Speech	4.63 (4.03) <i>0.0-12.0</i>
	Insistence on Sameness	2.39 (2.66) <i>0.0-8.0</i>
	Total verbal	26.54 (14.85) <i>0.0-69.0</i>
	Total nonverbal	19.39 (13.29) <i>0.0-60.29</i>
	The Activity Questionnaire	Overactivity	13.07 (8.88) 0.0-36.0
Impulsivity		12.09 (5.97) <i>0.0-20.0</i>
Impulsive Speech		3.84 (3.18) <i>0.0-12.0</i>
Total verbal		29.17 (15.19) <i>3.0-62.0</i>
Total nonverbal		28.21 (14.03) <i>0.0-60.0</i>

Table 5: Mean scores (standard deviations) and ranges of the RBQ and TAQ subscales and total scores.

Relationship		Pearson's r partial correlation Coefficients with the variables at the head of each column partialled out of the relationships										
TAQ	RBQ	None	RBQ subscales	RBQ stereotypy	RBQ compulsive	RBQ restricted preferences	RBQ insistence on sameness	RBQ repetitive speech	TAQ subscales	TAQ overactivity	TAQ impulsivity	TAQ impulsive speech
Overactivity	Stereotypy	.45 **	.44 **	-	.43 **	.45 **	.45 **	.45 **	.559 **	-	.37 **	.58 **
	Compulsive	.15										
	Restricted Preferences	.20 *	.17 *	.21 *	.15	-	.20 *	.16	.09	-	.11	.14
	Insistence on sameness	.025										
Impulsivity	Repetitive speech	.12										
	Stereotypy	.29 **	.31 **	-	.27 **	.30 **	.30 **	.30 **	.071	.12	-	.21
	Compulsive	.15										
	Restricted Preferences	.23 **	.28 *	.36 **	.36 **	-	.35 **	.29 *	.19	.30 *	-	.22
Impulsive speech	Insistence on sameness	.15										
	Repetitive speech	.16										
	Stereotypy	-.04										
	Compulsive	.18										
Impulsive speech	Restricted Preferences	.37 **	.20	.39 **	.34 **	-	.32 **	.21	.19	.30 *	.21	-
	Insistence on sameness	.24 **	.10	.25 *	.18	.14	-	.16	.20 *	.25 *	.19	-
	Repetitive speech	.40 **	.28 *	.42 **	.37 **	.26 *	.36 **	-	.28 *	.32 **	.31 **	-

Table 6. Pearson correlation coefficients for the relationships between RBQ and TAQ subscale scores. Where there is at least a weak relationship between a TAQ and an RBQ subscale ($r \geq 0.2$) the strength of the relationship is also assessed with other RBQ and TAQ subscales partialled out of the analysis. Correlation coefficients significant to $p \leq .05$ at indicated with a single star, those significant to $p \leq .01$ are indicated with two stars.