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Establishing Normative Values for 18-35 Years Age in Neuropsychological Tests used with Head and Brain Injury Patients during Cognitive Rehabilitation: Benton Visual Retention Test and National Adult Reading Test

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Abstract

The Benton Visual Retention Test (BVRT) is a neuropsychological assessment of visuo-spatial and visuo-memory ability. Claims of high reliability and validity are based on solitary samples representative of a wide age range. This study validated theBVRTagainst the National Adult Reading Test (NART), a highly validated and reliable test of estimated pre-morbid IQ in an age-specific group of participants (18-35 years).

Using Between-subjects factorial design, fifty-three participants (24 female, 29 male) aged 18-35 years (inclusive) were administered the NART and 3 administrations of the BVRT.

Significant positive correlations were found betweenBVRTError scores and NART Error scores for administrations B and C of theBVRTwhich is when presented stimuli are followed by a short time delay before allowing respondents to recall. Significant negative correlations were found over these administrations forBVRTCorrect scores and NART Error scores. No significant relationship was found between depression and performance on theBVRT. However, a weak, non-significant relationship was found between anxiety andBVRTperformance.

The BVRTis a well-validated and highly reliable neuropsychological test of visuo-spatial and visuo-memory abilities. Findings provide new data for the 18-35 years age group as well as providing a cautionary note on the possible influence of anxiety on performance levels in light of the frequent occurrence of anxiety post-neurological injury.

Introduction

The Benton Visual Retention Test (BVRT) (Benton, 1955; Benton Sivan, 1992) is a neuropsychological test of non-verbal memory assessing visual perception, visual memory and visuo-constructive abilities. The test is frequently incorporated in neuropsychological assessment batteries (Thompson, et al., 2006) due to its sensitivity in detecting cerebral disease (Messinis, et al., 2009; Benton Sivan, 1992) and its ability to enable assessors to determine the specific acquired cognitive deficit (Thompson, et al., 2007), deciphering whether the deficit is perceptual, motor or memory in nature.

The BVRT comprises a series of geometric shapes, with each design comprising either one major figure or two major figures and one smaller peripheral figure. There are three separate forms, C, D and E that contain 10 designs (simple line drawings). Each of the forms is of approximately equivalent difficulty.

Administering theBVRTinvolves presenting the patient with a drawing of a geometric figure for a variable period of time and then removing the drawing from sight. After a variable delay period, dependent on the administration employed, the patient is then instructed to reproduce the geometric figure previously presented relying solely on their visual spatial memory. Administration A, the standard procedure of theBVRT, involves presenting the drawing for 10 seconds and then requesting immediate recall of the geometric shape. Administration B involves presenting the drawing for 5 seconds and then requesting immediate recall of the geometric shape and administration C involves directly copying the geometric shape. Administration D involves exposure to the drawing for 10 seconds and a delayed response time of 10 seconds. Patient's performances are evaluated based on the number of correct reproductions and the number of errors produced, with an all-or-none score credited (1 for correct or 0 for error). Vakil, et al. (1989) argue for the use of both error and correct scores when evaluating a patient's performance on theBVRTfollowing their research suggesting that error and correct scores are not related in those with right cerebral hemisphere damage.

Clinically practical benefits of theBVRTinclude a short-administration time (the approximate administration time is 5 – 10 minutes) and precise

scoring criteria. The normative data for the scoring criteria is based on large samples, however such samples consist of a wide variation of ages, ranging from 16- 65. Several studies have demonstrated a decline in performance on theBVRTwith increasing age (Arenberg, 1978; Poitrenaud & Clement, 1965; Benton, Eslinger & Damasio, 1981).

Inter-rater agreement on the scoring ofBVRThas been shown to be as high as .973 for correct scores and .974 for error scores in one study (Swan, Morrison & Eslinger, 1990). Previous research has also yielded high inter-rater agreement scores of .95 (Wahler, 1956). Alternate-form reliability is purported to be high, with studies reporting correlation coefficients between theBVRTthree forms of .79 to .84 (Benton Sivan, 1992). Internal consistency is reported to be as high as .911 when all 30 items (completed forms C, D and E) are administered (Steck, et al., 1990) and test-retest reliability is reported to be good (.85; Benton, 1974).

Thus theBVRToffers the clinician a highly reliable and valid neuropsychological assessment that enables them to detect the nature of any neuropsychological deficits present, as well as the ability to detect deceptive responses. There is vast research evidence purporting that theBVRTis sensitive to neuropsychological dysfunction, particularly parietal lobe dysfunction, following neurological insult (Golden, Espe-Pfeifer & Wachsler-Felder, 2000; Thompson, 2006).

Thompson, MacDonald and Coates (2001) demonstrated that theBVRTwas significantly able to detect changes in neuropsychological functioning such as visual memory and visuo-spatial abilities in those receiving Aricept, a psychopharmacological treatment for Senile Dementia of the Alzheimer's Type (SDAT).

Further, Almos, et al. (2010) suggest that theBVRTshows a strong correlation with different aspects of visual memory deficits that are common in schizophrenic patients revealing its clinical validity when assessing neuropsychological deficits associated with severe mental illness.

Considering this evidence and the fact that the test is recommended by the National Institute for Health and Clinical Excellence (NICE) guidelines (NICE, 2009; Golden, et al., 2000) for inclusion in neuropsychological assessment batteries owing to its high validity and reliability ratings, it would appear that the importance of validating theBVRTin relation to other validated and reliable assessments of neuropsychological functioning is of paramount importance.

Prior research has demonstrated that both error and correct scores of theBVRTwere more effective in eliciting a defective visual retention score on the Memory for Designs Test (MDT), a test that is also used to detect impaired visuo-spatial retention abilities (Marsh & Hirsch, 1982). The authors concluded that theBVRTshould be selected in evaluating patients with mild to moderate brain damage due to its heightened sensitivity.

Emdad, Söndergraad and Theorell (2005) reported a significant correlation between errors scores on theBVRT and performance on the Thurstone Picture Memory Test (TPMT). In a further study Emdad, et al. reported error scores on theBVRT predicted performance on the Block Design Test (BDT) and a regression model which controlled for co-linearity revealed performance on the Raven Standard Progressive Matrices (RSPM) was correlated withBVRT test performance in a group of PTSD patients (Emdad & Söndergaard, 2006).

Almost, et al. (2010) reviewed theBVRTperformances in relation to other validated tests of visuo-spatial abilities and reported significant correlations between performance on theBVRTand performance on the Spatial Recognition Memory (SRM) and the Rapid Visual Processing (RVP) subscales of the Cambridge Neuropsychological Test Automated Battery and the Digit Symbol Task.

Evidence purports that theBVRTcorrelates highly with demographic variables. Performance on theBVRTdemonstrates a moderate correlation of .7 with intelligence (Benton, 1974) and age (Arenberg, 1978; Benton, 1974). Such data was derived from large cohorts of healthy participants and whilst dated, more recent research yields similar findings. Youngjohn, larrabee and Crook (1993) conducted stepwise multiple regression analyses examining the relationship between age, educational attainment and performance on the BVRT in healthy individuals. The analysis revealed a significant positive relationship between BVRT performance and educational attainment and a significant negative association between BVRT performance and age suggesting the BVRT is an adequate predictor of intellectual ability. Utilising a cross-sectional design Coman, et al. (2002) found similar findings in those with no or low neuropsychological deficits. Further, Messinis, et al. (2009) purport that the BVRT is strongly associated with demographic variables such as educational level, IQ and age in healthy participants.

The normative data for scoring of the BVRT separate age groups into four categories (15-44, 45-59, 60-64, 65-69). However the test is evaluated extensively in adults 18-65 categorized as a solitary group, with studies failing to separate out participants according to their age group. There are also studies investigating

adults of older age (Coman, et al., 1999) and child and adolescence (Snow, 1998) performances on the BVRT, however the performance of adults of the age 18-35 on the BVRT has remained a vastly understudied area. This study seeks to validate the BVRT as a neuropsychological assessment against another highly validated and reliable neuropsychological assessment, the National Adult Reading Test (NART; Nelson, 1991) within this age group.

NART

The NART is an assessment of estimated pre-morbid intelligence quotient (IQ) that is frequently administered as part of a battery of neuropsychological assessments to indirectly predict a patient's level of functioning prior to neurological insult or the onset of organic dementia.

The test involves presenting the patient with a series of 50 word cards each inscribed with an irregularly spelled word and then asking the patient to read each word aloud (Figure 1). Assuming that the individual is familiar with the word, the accuracy of pronunciation is scored to predict the patients pre-morbid IQ. Owing to the irregularity of the spelling, intelligent guesswork will not suffice to produce the correct pronunciation, thus performance is resultant on prior knowledge as opposed to current cognitive capacity (Nelson & O'Connell, 1978). The evaluation of a participant's performance is based on their total error scores rather than the number of words they produced correctly.

The average administration time required to complete the NART is 10 minutes, adding to its pragmatic value. The NART is based on the premise that reading ability remains relatively intact in dementia patients (Nelson & McKenna, 1975). Indeed research has repeatedly demonstrated that the ability to pronounce irregular words is retained in those with mild to moderate dementia (Crawford, et al., 1988; Fromm et al., 1991; Sharpe & O'Carroll, 1991; Stebbins, et al., 1990) suggesting that it is a valid test of pre-morbid IQ. Further, Moss and Dowd (1991) presented a case report comparing the IQ score obtained in childhood of an acquired brain injured patient with the patient's current NART score. The NART was found to produce an accurate estimate of the patients pre-injury IQ and this finding, whilst restrictive due to the research design used, is encouraging for the application of the NART as a measure of pre-morbid IQ.

Research evidence frequently purports the NART yields high inter-rater reliability of at least .88 (Crawford, et al., 1989; Sharpe & Carroll, 1991), internal reliability of at least .90 (Crawford et al., 1988) and a test-retest reliability of .98 (Crawford, et al., 1989). Practice effects have been demonstrated although they appear to be of minimal clinical significance, demonstrating a decrease of only one NART error.

Such a measure of pre-morbid intelligence must correlate highly with measured IQ in a normally distributed population to ensure its validity. Two separate studies demonstrated that were no significant differences in NART performance between patients whom suffered a neurological insult and well-matched controls (Crawford, et al., 1988; Watt & O'Carroll, 1999). Brayne & Beardsall (1990) found that NART scores were normally distributed in a study of over 300 normal community-dwelling adults further suggesting its validity as a measurement of pre-morbid IQ.

The NART is capable of predicting a substantial proportion of IQ variance in the normal population, with a high correlation between reading ability and intelligence in a normal population being demonstrated by Crawford, et al. (1989). Further, NART scores are highly correlated (.73) with measures of general intellectual ability (Raguet, et al., 1996) and educational status (Maddrey, et al., 1996) in healthy individuals.

The NART has also been demonstrated as largely insensitive to psychiatric disorder (Crawford, 1989) demonstrating insensitivity to depressive episodes (Crawford, et al., 1987) and untreated acute schizophrenic episodes (O'Carroll, et al., 1992). However there is evidence that the NART is not insensitive to the effects of neurological disorders, with Morris, et al. (2005) demonstrating a significant correlation between severity of neurological injury and declining performance on the NART and O'Carroll, et al. (1992) demonstrating its insensitivity to Korsakoff's syndrome and moderate to late stage SDAT. Such evidence is disputed, with research suggesting that the NART may be less sensitive to neurological insult than many other cognitive measures of pre-morbid functioning (Berry, et al., 1994; Christensen, et al., 1991; Maddrey, et al., 1996), particularly, the best previously available word list, the Schonell GWRT (Hart, Smith & Swash, 1986; Nelson & O'Connell, 1978).

More recent research evidence also reflects such findings, with McGurn, et al. (2004) validating the NART as an accurate estimate of pre-morbid IQin mild to moderate dementia. Their highly controlled study compared NART scores in mild to moderately demented patients and non-demented demographically-matched controls. After controlling for actual pre-morbid IQ recorded in youth, a relationship was found between NART performance and childhood ability.

Thus the available evidence purports that the NART meets the necessary requirements of a pre-morbid

measure of IQ, an IQ that is difficult to obtain for multiple purposes.

HADS

Whilst the NART is purported to be insensitive to psychiatric illness, there is evidence to suggest that BVRT performance is affected by such illness. Emdad, Söndergraad and Theorell (2006) reported that those suffering from post-traumatic stress disorder (PTSD) experienced significantly poorer short-term memory and non-verbal memory on the BVRT compared to well-matched controls.

Benton (1955) identifies severely depressed patients as at risk of performing poorly on the BVRT; however, Rowley and Baer (1961) concluded that brain damage was more likely to be a causal factor of poor performance on the BVRT than emotional disturbance and its associated concentration and attention deficits in children and adolescence presenting with behavioural maladjustment or cerebral disease.

Potter, et al. (2009) found that depression, as measured by the Montgomery-Asberg Depression Rating Scale (MADRS; Montgomery & Asberg, 1979), did not predict an inferior neuropsychological performance on the BVRT.

Given the utility of the BVRT in inferring neuropsychological deficits and the frequent occurrence of affective and anxiety disorders succeeding the emergence of neuropsychological deficits (Mooney & Speed, 2001; van Reekum, Bolago & Finlayson, 1996), it is decisively important to investigate the BVRT's sensitivity to psychiatric illness to restrict the occurrence of misdiagnosis.

Thus a further aim of this study is to identify if there is a relationship between anxiety and depression scores, as measured by the Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983), and BVRT performance in this sample of participants. The HADS was designed to provide a simple, reliable assessment measure that is quick to implement in clinical practice to screen for the presence of depression and anxiety. A systematic review concluded that " … the HADS was found to perform well in assessing severity and 'caseness' of anxiety disorders and depression in both somatic and psychiatric cases and in primary care patients and the general population" (Bjelland, et al., 2002).

Further, research purports that the HADS depression subscale (HAD-D) has 90% sensitivity and 86% specificity for depression compared to the gold standard of a structured diagnostic interview (Wilkinson & Barczak, 1988; Zigmond & Snaith, 1983), thus research suggests it is a highly valid clinical tool for detecting depression and anxiety in the general population.

Materials and methods

Hypotheses: The present study is unique in that it examines the performance of young adults aged 18-35 years on the BVRT in relation to their performance on the NART. Further, this study aims to identify whether BVRT performance is affected by anxiety and depression scores, as measured by the HADS.

It is predicted that there will be a positive correlation between error scores on the NART and error scores on the BVRT and a negative correlation between error scores on the NART and correct scores on the BVRT. Further it is predicted that anxiety will be positively correlated with BVRT error scores and negatively correlated with BVRT correct scores. It is predicted that there will be no relationship between depression and BVRT performance.

Sample: The sample was of an opportunistic nature and consisted of 53 participants (24 female, 29 male) whom were aged 18-35 years (inclusive). This age range in particular was sampled due to the lack of research evidence specifically assessing such a group of individual's performance on the BVRT. Those recruited were volunteers, however their participation in this study was rewarded with course credits from Bournemouth University.

The inclusion criteria ensured that the participants were representative of a general healthy population and addressed the age range this study specifically sought to investigate. Participants were of mixed gender owing to the fact several studies have identified gender is not correlated with performance on the BVRT (Coman, et al., 2002; Messinis, et al., 2009; Youngjohn, et al., 1993).

Materials: BVRT:

The BVRT is a test of visuo-spatial and visuo-constructive memory and ability. Participants are asked to copy a series of geometric shapes following various presentation and delay periods.

NART:

The NART is a measure of pre-morbid intelligence. Participants are asked to read out loud a series of 50 words inscribed on a set of cue cards and are scored based on the pronunciation errors made.

HADS:

HADS is a self-screening questionnaire for anxiety and depression that is designed as a quick and effective tool for detecting such disorders in medical settings.

Procedure: On arrival participants were given a brief overview of the study and provided with a consent form to read and sign. They were also given an opportunity to have any questions they may have

answered. Participants were assured that all data would be confidential and they could withdraw themselves or their data from the study at any point during or after implementation of the tests.

The first test administered was the BVRT. Administrations A, C and D of the BVRT fifth edition were administered to all participants utilizing forms C, D and E. Participants were spatially placed so that no copying would ensue.

The second test administered was the NART, which was administered on an individual basis to restrict the influential presence and distraction of others. Participants were informed they would be scored based on their pronunciation of the words inscribed on the cue cards. Reassurance was given to participants about the possibility they may not be able to pronounce every word.

Finally, participants were asked to fill out the HADS questionnaire, which again was administered on an individual basis.

Afterwards participants were given a debrief of the aim of the study as well as contact details of the experimenter if they have further questions or would like to withdraw their data.

Results

A statistical analysis of the raw data using Spearman's r_s revealed a significant positive correlation between performance on the NART and error scores on administration B (r_s= .318, N= 53, p < .05, two-tailed) and administration C (r_s= .376, N= 53, p < .005, two-tailed) of the BVRT. A significant negative correlation was found between performance on the NART and correct scores on administration B (r_s= -.318, N= 53, p < 0.05, two-tailed) and administration C (r_s= -.325, N= 53, p < .05, two-tailed) of the BVRT. The statistical analysis revealed no significant correlation between NART performance and correct scores (r_s= -.125, N= 53, p= .371, two-tailed) or error scores (r_s= .113, N= 53, p= .420, two-tailed) on administration A of the BVRT, however the direction of the correlations, whilst the small, reflected the relationships found in administrations B and C (Figure 2).

A Spearmans Rank Order correlations revealed a moderate relationship between correct and error scores of administrations B (Figures 3 & 4) and C (Figures 5 & 6) of the BVRT and NART error scores and a weak non-significant relationship between correct and error scores of administration A of the BVRT and NART error scores.

Depression scores were not related to BVRT

performance, however anxiety scores, whilst not significant, revealed a small correlation with BVRT performance. Correct scores of administration A, B and C of the BVRT demonstrated small negative correlations with anxiety scores on the HADS, however these relationships were not significant (r_s = -.219, N= 53, p= .116, two tailed; r_s= -.165, N= 53, p= .239, two-tailed; r_s= -.169, N= 53, p= .226, two tailed, respectively). Error scores on administrations A, B and C of the BVRT demonstrated small positive correlations with anxiety scores on the HADS, but again these were not significant (r_s = .248, N = 53, p = .073, two tailed; r_s= .157, N= 53, p= .261, two-tailed; r_s= .196, N= 53, p= .160, two tailed, respectively). Figure 7 shows Spearman's rank order correlations for the anxiety scores as measured by the HADS and BVRT performance.

Discussion

The BVRT is a highly validated and reliable form of neuropsychological assessment. It is frequently administered as part of neuropsychological assessment batteries to detect specific neuropsychological dysfunction in relation to visuo-spatial memory and ability. The BVRT has been validated against other highly valid and reliable neuropsychological assessments of visuo-spatial ability such as the visuo-spatial subscales of the Cambridge Neuropsychological Test Automated Battery, the MDT, the BDT and the TMPT. However these studies have frequently assessed performance in a solitary sample representing a wide range of ages. This study sought to identify the relationship between performance on the BVRT of young adults aged 18-35 years and their performance on the NART, a well validated form of pre-morbid IQ assessment that is scored by errors produced.

The findings of this study demonstrate a moderate relationship between performance on the NART and performance on administration's B and C of the BVRT. Although administration A was not found to be significantly correlated with NART performance, a weak directional relationship reflective of administrations B and C relationship with the NART was demonstrated.

Administration B error scores of the BVRT were found to be significantly correlated in a positive direction with NART performance, whilst administration B correct scores of the BVRT were found to be significantly correlated in a negative direction with NART performance. This was also found to be the case for administration C of the BVRT, with error scores found

to be positively correlated with NART performance and correct scores negatively correlated with NART performance. These results were found to be significant at the .001 level and support the prediction that performance on the NART correlates with performance on the BVRT in the 18-35 age group.

The data revealing age-related changes in performance on the BVRT (Arenberg, 1982; Poitrenaud & Clément, 1965; Benton, et al., 1981) lends support to the notion that age separate normative data is required for each separate age category. The aim of this study was to extend the normative data already provided for the BVRT and contribute to the normative data for the younger adults' age range. An amalgamation of these results suggest that the BVRT is an adequate assessment of current neuropsychological functioning, although administration A only provides weak evidence for this. A larger sample may have yielded stronger correlations and significant results on administration A of the BVRT. This study examined the performance of only 53 participants, almost half of the recommended participants deemed acceptable for a correlation analysis (Brace, Kemp & Snelgar, 2006), thus it is possible that the reduced statistical power of this study restricted the possibility of achieving statistically significant results.

This may also be the case with regards to the relationship between anxiety and BVRT performance. Although no significant relationship was found between anxiety and BVRT performance the directional relationship with anxiety scores was as predicted with anxiety positively correlated with error scores on the BVRT and negatively correlated with correct scores on the BVRT. Such a relationship, although weak, replicates the directional findings of prior studies (Emdad, Söndergraad & Theorell, 2005; Emdad & Söndergraad, 2006).

This previous research has demonstrated that those suffering from an anxiety disorder such as PTSD perform poorly on the BVRT compared to matched controls (Emdad, Söndergraad & Theorell, 2005). These authors propose two explanations for the deficits in BVRT performance in PTSD samples. They suggest either a focal deficit related to the impact of PTSD on hippocampus function or a more general dysfunction of cognitive and emotional processing pertaining to generalized anxiety symptoms. The latter of the explanations would certainly fit with the direction of the results of this study.

It is possible that the symptoms experienced in general by anxiety patients such as hyperventilation, increased vigilance, excessive sweating, flashbacks, feelings of panic and negative imagery may impair visual-spatial processing abilities resulting in decreased performance on visuo-spatial tasks. It is also possible that the administration of such tests as those involved in this study may invoke such symptoms resulting in higher degrees of anxiety being reported on the HADS. This may explain why no relationship was found between depression and BVRT performance, but a small relationship was found between anxiety and BVRT performance. Such results suggest that the clinician should be cautious of co-morbid psychiatric disorders, particularly any underlying anxiety disorder, when administering and scoring the BVRT.

This study also sought to identify whether performance on the BVRT was affected by depression scores as measured by the HADS. Reflective of Potter et al.'s research this study provides further evidence that BVRT performance is not influenced by a current episode of depression, finding no correlation between depression scores on the HADS and BVRT scores. This supports the prediction that there would be no relationship between depression and BVRT performance.

Benton (1955) suggested that determinants of defective performance on the BVRT, in addition to neurological insult, may include the participant's lack of adequate effort possibly owing to lack of motivation, lack of commitment or lack of interest, depressive mood or anxious state. Whilst it is possible that participant's performance was affected by lack of motivation and commitment to complete the test it is possible that such motivation and commitment may too be lacking in the clinical setting for many reasons. The lack of personal significance and monotonous nature of the BVRT may too result in lack of commitment to the test and the possible resulting deficits and mood disorders of a neurological insult may reduce motivational efforts. Future research utilizing the BVRT in clinical samples of brain-damaged patients should address such factors to ensure relevant clinical assumptions and diagnoses are derived from patients' performance.

Benton Sivan (1992) suggests that extended neuropsychological assessment batteries may invite confounding variables such as "non-neurologic factors of a physical, emotional, and motivational nature (particularly fatigue and sagging motivation but also distrust and hostility) that interact with the condition of the brain". Such factors are most likely to affect acutely brain dysfunctional patients. Owing to the frequent utility of the BVRT to assess neuropsychological dysfunction in everyday clinical practice, future research should seek to clarify the impact anxiety has on BVRT performance and seek to

clarify depressions relationship to the test.

These are important variables to consider when assessing performance on the BVRT due to their frequent occurrence following neurological insult (Mooney, 2001; van Reekum, 1996) and the co-morbid motivational deficits they share. Understanding the impact anxiety and depression have on BVRT performance is critical not only to ensure adequate neuropsychological assessment, but to the subsequent assessment of psychopathology, neuropsychological rehabilitation and the provision of adequate psychological services to patients and their families (Thurber, 1998).

This study did not address the type of errors produced by participants on the BVRT. The scoring of the types of error produced allows for quantitative and qualitative analysis of the participant's performance, thus failing to obtain this information restricted a more detailed analysis from being carried out. The six major types of error noted in the BVRT manual; omissions, distortions, perseverations, rotations, misplacements and size errors enable the clinician to decipher the nature of the cognitive deficit present. Future research may wish to investigate the relationship between NART errors and specific errors on the BVRT as well as explore the relationship between depression, anxiety and specific BVRT errors.

The BVRT scoring criteria divides age groups into specific categories (15-44, 45-59, 60-64, 65-69 years) yet research examining the BVRT frequently consists of a sample combined in a solitary category representing children and adolescence (4-18 years), adults of working age (18-65 years) or adults of older age (65+ years). Future research should consider separating their samples reflecting the age categorizations of the BVRT scoring criteria to assess the validity of the test in relation to age norms of other validated neuropsychological tests. Further, the BVRT scoring criteria for those above 70 does not exist. Research is required to validate and normalize the predicted correct and error scores of those above the age of 69 to reflect the increasing longevity of the older age population.

Further, in line with the theorem that short-term visual memory declines with age, one would expect future studies to demonstrate that BVRT performance declines with age. Prior studies certainly lend support to this notion (Arenberg, 1978; Poitrenaud & Clément, 1965; Benton, Eslinger & Damasio, 1981). Future studies examining BVRT performance in specific samples should take age factors into consideration owing to the decline in performance revealed.

Conclusions

The BVRT is a well-validated and highly reliable neuropsychological test of visuo-spatial an visuo-memory abilities. However, data documented from previous studies to date that seeks to validate this test is drawn from solitary samples of adults representing a wide range of ages. This study sought to validate the BVRT as a useful neuropsychological assessment in young adults aged 18-35 years against another highly validated neuropsychological assessment, the NART because data on this age group is incompletely documented.

The results demonstrated a significant relationship between performance on the BVRT and performance on the NART in this age group thus providing valuable new data for this important test. No significant relationship was found between depression and performance on the BVRT. However, a weak, non-significant relationship was found between anxiety and BVRT performance.

The results of this study support prior research purporting that the BVRT is a suitable assessment of visuo-spatial memory and visuo-spatial ability that is not affected by depression, although may be influenced by the presence of anxiety. Therefore, administrators should proceed with caution when using the test to infer the presence of neuropsychological dysfunction following neurological insult owing to the frequent occurrence of anxiety post-neurological injury.

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Illustrations

Illustration 1

List of 50 words from the National Adult Reading Test

Ache	Bouquet	Subtle	Courteous	Superfluous
Debt	Deny	Nausea	Gaoled	Radix
Psalm	Capon	Equivocal	Procreate	Assignate
Depot	Heir	Naïve	Quadruped	Gist
Chord	Aisle	Thyme	Catacomb	Hiatus
Simile	Gouge	Aeon	Beatify	Demesne
Rarefy	Placebo	Détente	Banal	Campanile
Cellist	Façade	Gauche	Sidereal	Labile
Zealot	Aver	Drachm	Puerperal	Syncope
Abstemious	Leviathan	Idyll	Topiary	Prelate

Illustration 2

Spearmans rank order correlations between NART Error scores and BVRT Correct and Error scores on Administrations A, B and C
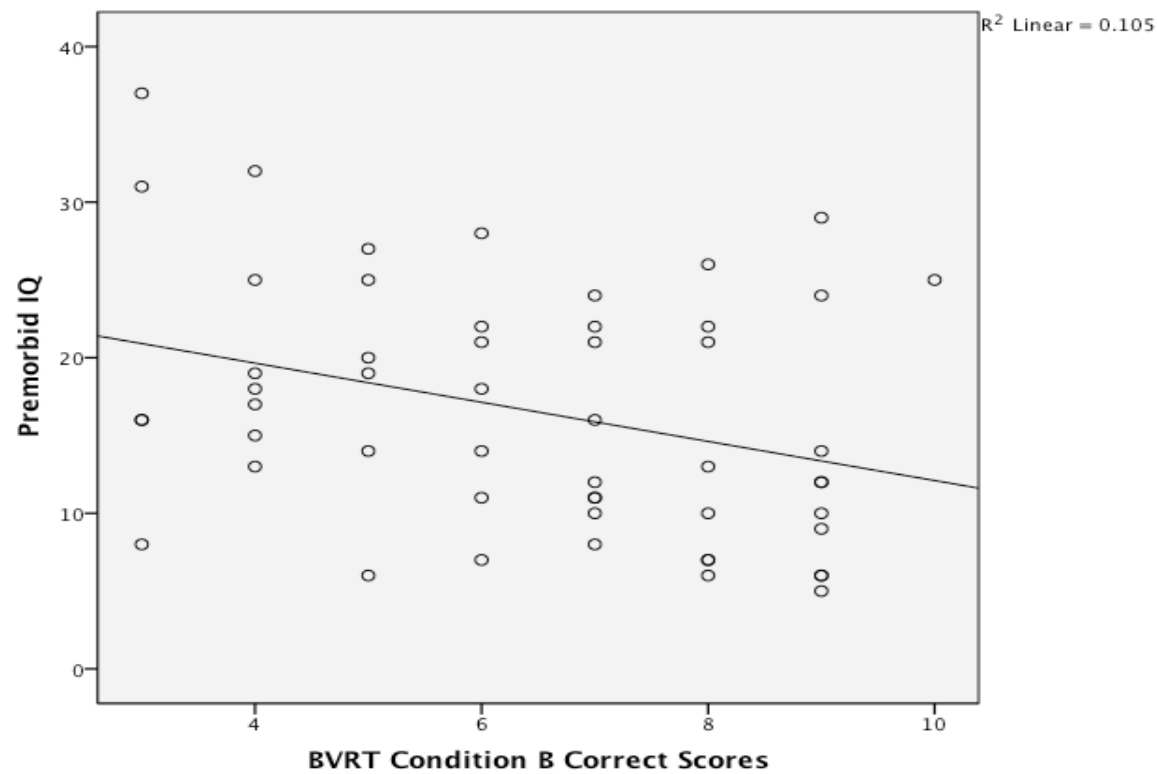
	Rs	P
BVRT – A Correct Scores and NART	-.125	.371
BVRT – A Error Scores and NART	.113	.420
BVRT – B Correct Scores and NART	-.318	.020*
BVRT – B Error Scores and NART	.318	.020*
BVRT – C Correct Scores and NART	-.325	.017*
BVRT – C Error Scores and NART	.376	.005**

*. Correlation is significant at the .05 level (two-tailed)

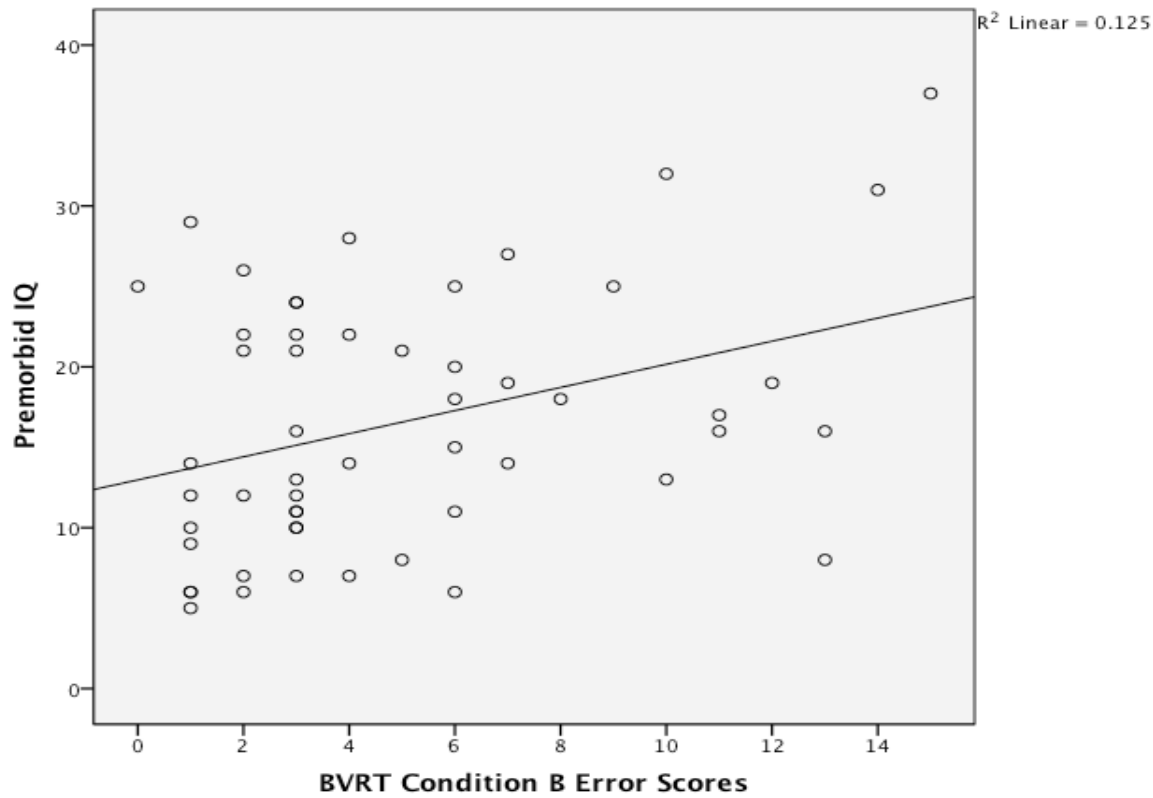**. Correlation is significant at the .005 level (two-tailed)

Illustration 3

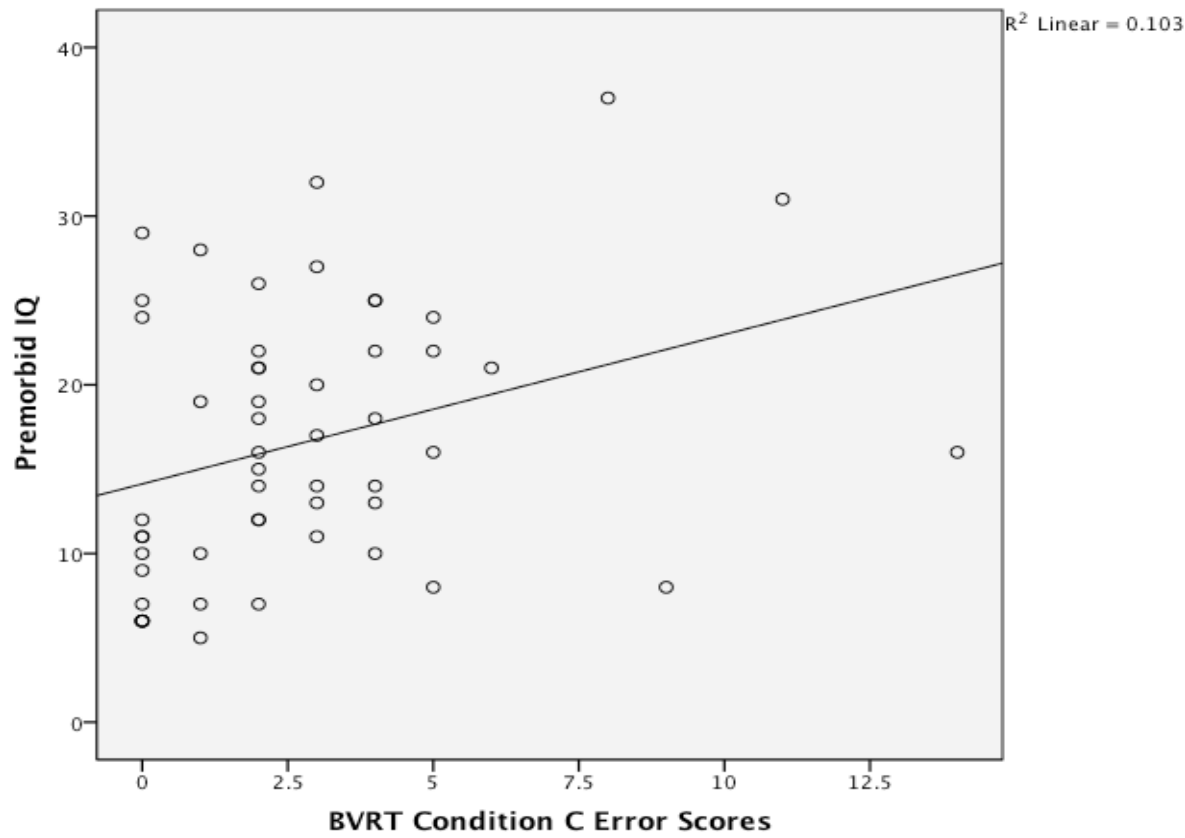Line of best fit for BVRT Condition B Correct scores and NART performance

Illustration 4

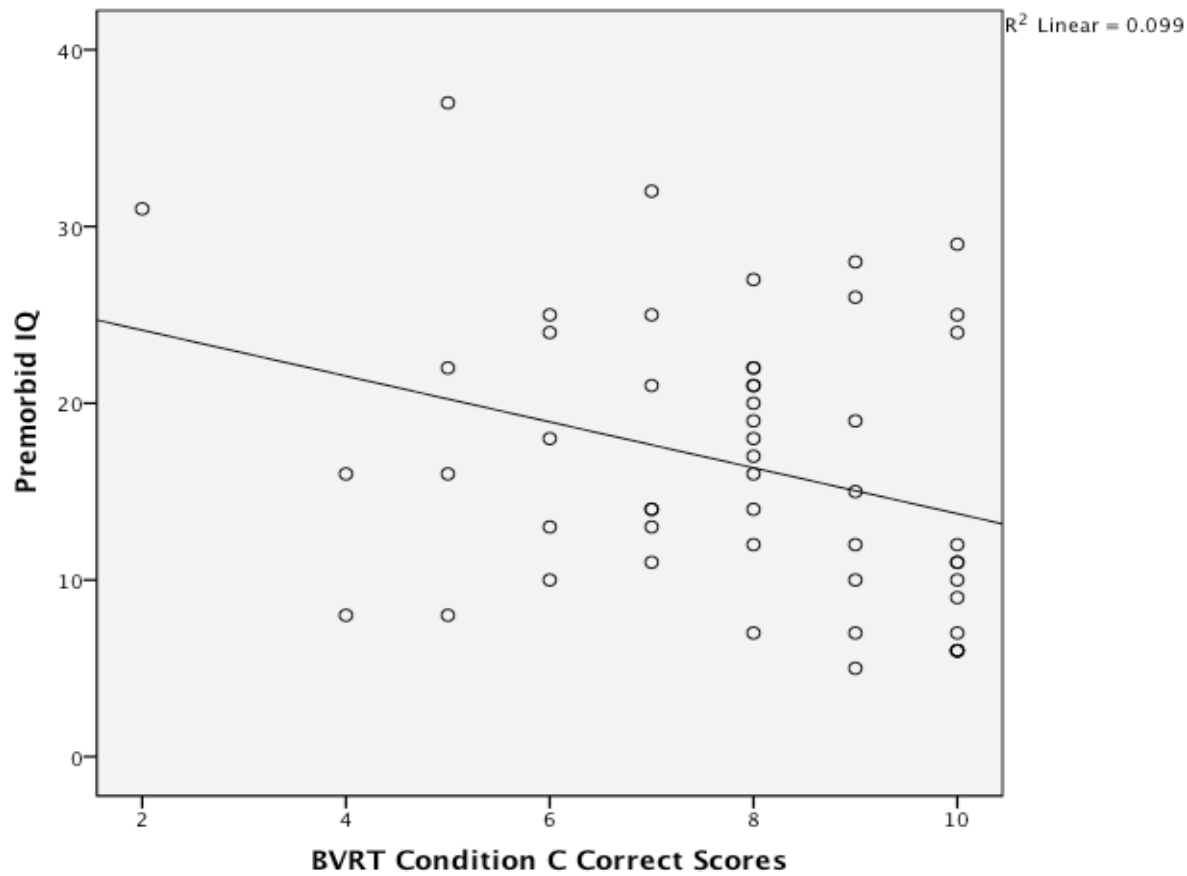Line of best fit for BVRT Condition B Error scores and NART performance

Illustration 5

Line of best fit for BVRT Condition C Correct scores and NART performance

Illustration 6

Line of best fit for BVRT Condition C Error scores and NART performance

Illustration 7

Spearmans rank order correlations between Anxiety scores on the HADS and BVRT Correct and Error scores on Administrations A, B and C

	Rs	*P*
BVRT – A Correct Scores and HADS anxiety	-.219	.116
BVRT – A Error Scores and HADS anxiety	.248	.073
BVRT – B Correct Scores and HADS anxiety	-.165	.239
BVRT – B Error Scores and HADS anxiety	.157	.261
BVRT – C Correct Scores and HADS anxiety	-.169	.226
BVRT – C Error Scores and HADS anxiety	.196	.160

*. Correlation is significant at the .05 level (two-tailed)

**. Correlation is significant at the .005 level (two-tailed)

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