Interactive influences on BVRT performance level: geriatric considerations

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Abstract

We examined the interactive influence of specific demographic and diagnostic variables on Benton Visual Retention Test (BVRT) performance in three commonly presenting groups of older adults. Cross-sectional data from three archival samples were utilized: “normals” (n = 156), “normals with memory concerns” (n = 435), and a “mixed neurologic” group (n = 196). In both normal groups, as well as in a “no/low deficit” neurologic subgroup, we confirmed that the higher one’s age, the lower their BVRT accuracy, while the higher one’s level of education, the greater their BVRT accuracy (at least through age 84). For normal subjects, gender had no impact on BVRT performance. Variability in BVRT performance increased consistently, but not significantly, through age 85.

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1. Introduction

In a recent study (Coman et al., 1999), we derived extended geriatric norms for Benton Visual Retention Test (BVRT) number correct scores adjusted for variables that contributed
significantly to the variance. In so doing, we addressed the impact of demographic and diagnostic variables on level of BVRT performance. However, we were also interested in clearly delineating the influence of the demographic and diagnostic variables on BVRT scoring profiles in older adults. Such interactive influences comprise our current focus of investigation.

2. History of prior work

2.1. Demographic variables

2.1.1. Age


Five studies focused on age-related patterns of performance (Benton et al., 1981; Giambra et al., 1995; Resnick et al., 1995; Shichita et al., 1986; Youngjohn et al., 1993; Zappala et al., 1995). Of these, only two (Shichita et al., 1986; Youngjohn et al., 1993) have targeted BVRT total number correct scores. We also note that the current BVRT manual (Sivan, 1992) presents number correct data for normals from two studies (Benton et al., 1981; Poitrenaud & Clément, 1965; Prakash & Bhogle, 1992; Resnick et al., 1995) specifically document declines in BVRT performance after age 50 and/or acceleration in performance decrements after age 70. Indeed, Giambra et al. (1995, p. 134) found evidence of a “positively accelerating age function” with ages 65–70 “particularly important because cognitive decrements begin to appear.” They pointed to the 65–74-year-old decade as a “watershed for decremental changes in immediate visual memory” (Giambra et al., 1995, p. 123).

Five studies focused on age-related patterns of performance (Benton et al., 1981; Giambra et al., 1995; Resnick et al., 1995; Shichita et al., 1986; Youngjohn et al., 1993). Of these, only two (Shichita et al., 1986; Youngjohn et al., 1993) have targeted BVRT total number correct scores. We also note that the current BVRT manual (Sivan, 1992) presents number correct data for normals from two studies (Benton et al., 1981; Poitrenaud & Clément, 1965). These data suggest that “for successive age groups there is a progressive decline in performance level” (Sivan, 1992, p. 65). Whether this is true for commonly presenting diagnostic groups, as well as for normal older adults, requires clarification.

2.1.2. Education and gender

The impact of education and gender on the level of BVRT performance in older adults has also been investigated thoroughly (Giambra et al., 1995; Resnick et al., 1995; Robinson-Whelan, 1992; Shichita et al., 1986; Youngjohn et al., 1993; Zappala et al., 1995). However, only a few studies have focused on the interactive influence of these variables. Shichita et al. (1986) studied adults who were between the ages of 69 and 71 at baseline. Although limited by a narrow age range, their results suggest that as age increases, the performance of more highly educated subjects declines less than that of subjects with lower levels of education.

Resnick et al. (1995) studied BVRT error profiles according to gender. They found that women made significantly more omission and rotation errors than men. However, most studies have not found gender differences on the BVRT. A goal of the present study was to clarify the
interactive impact of age, education, and gender on BVRT performance across successive age groupings with regard to number correct scores.

2.2. Diagnostic variables

Multiple studies have examined BVRT performance in different diagnostic groups. Eslinger, Damasio, Benton, and Van Allen (1985) compared normal older adults to patients with dementia syndromes of varying etiology. Their objective, however, was to determine the ability of their specific neuropsychological battery to distinguish between these groups. Similarly, Younjohn, Larrabee, and Crook (1992) compared age-associated memory impairment (AAMI) and Alzheimer’s disease (AD) subjects in order to examine the efficacy of a computer-simulated vs. a traditional neuropsychological battery. Both studies focused on level of performance differences between groups.

A number of studies have compared the BVRT error profiles of various patient groups with those of normal controls. Poitrenaud and Barrere (1972) compared normal subjects to a mixed neurologic group and found a significant difference in error types between them. Vollant, le Poncin Lafitte, and Rapin (1986) documented an increased frequency of omission and perseveration errors in AD patients compared with normal subjects. Similar results were reported for patients with either probable AD (increased omission errors; La Rue, D’Elia, Clark, Spar, & Jarvik, 1986) or unspecified dementia (increased omissions and perseverations; Eslinger, Pepin, & Benton, 1988).

Most recently, Robinson-Whelan (1992) undertook an extensive cross-sectional investigation of BVRT performance in subjects at varying levels of cognitive function, e.g., normal, very mild AD, mild AD, and moderate AD groups. Her goals were twofold: (1) to determine the degree to which dementia differentially impacts memory and copying functions; and (2) to examine the extent of constructional deficits with disease progression. The interactive influences of the demographic and diagnostic characteristics of her sample on BVRT performance were not examined.

2.3. Aims of present study

2.3.1. Research questions

The purpose of the present investigation was to analyze the interactive influence of demographic variables on BVRT performance in three commonly presenting diagnostic groups of older adults. To do so, we reexamined the following hypotheses drawn from published studies (Arenberg, 1978; Benton et al., 1981; Shichita et al., 1986). The first three hypotheses are presented in the current BVRT manual (Sivan, 1992). We have framed them as research questions and present them as follows (below):

Question 1: “Short-term visual memory declines with age” (Sivan, 1992, p. 64).
Question 2: “For successive age groups up to age 80 years, there is a consistent increase in variability in performance” (Sivan, 1992, p. 65).
Question 3: “The performance of highly educated subjects tends to decline less than that of examinees with limited education” (Sivan, 1992, p. 65).
Question 4: Gender-related BVRT scoring patterns have not been described in the BVRT manual. To understand more about the relationship between this variable and BVRT accuracy, we included gender as a variable in our reexamination of the influences on BVRT performance.

2.4. Dependent variable

We chose the BVRT total number correct score as our dependent variable of interest. We note that the total number correct has been found to discriminate more efficiently between dementia patients and normals than the total number of errors (Eslinger et al., 1985).

3. Method

3.1. Participants

We utilized archival data gathered from three different medical centers (n = 787). All three cross-sectional samples consisted of older adults who had been administered the BVRT (Administration A). Our groups were as follows: “normals” (n = 156; from Benton et al., 1981, University of Iowa), “normals with memory concerns” (n = 435; from Brooks, Friedman, Pearman, Gray, & Yesavage, 1997, Aging Clinical Research Center, Stanford University Medical School), and a “neurologic” group (n = 196; from Moses, 1986, 1989, Psychological Assessment Unit, Veterans Affairs Palo Alto Health Care System—VAPAHCs). The composition of these cross-sectional sample groups has been described in detail (Coman et al., 1999). We present them again here for purposes of clarity.

3.1.1. Normal group

One hundred sixty-two adults participated in earlier research on dementia (Benton et al., 1981). A subset of the original sample (n = 156; 31 males and 125 females) was made available for analysis in the present study. All participants were healthy volunteers aged 61–97 (mean = 77.7 years, S.D. = 7.89). They were primarily Caucasian and well educated (mean = 12.67 years of education, S.D. = 3.46, range = 4–20 years).

3.1.2. Normals with memory concerns

Four hundred thirty-five individuals (129 male and 306 female volunteers) were recruited from the San Francisco Bay Area to participate in a study on mnemonic training in older adults (Brooks et al., 1997). All participants were required to: (1) indicate absence of dementia by scoring ≥27 on the Mini-Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975); (2) show no gross evidence of a DSM-III-R Axis I diagnosis (American Psychiatric Association, 1987); and (3) be off any medications that could interfere with cognitive function. Participants were 55–93 years of age (mean = 69.44 years, S.D. = 7.24) and highly educated (mean = 15.19 years of education, S.D. = 2.71, range = 8–25 years). Seventy-six percent of the group was denoted as “AAMI” based on criteria suggested by the original AAMI work group (Crook et al., 1986).
3.1.3. Neurologic group (mixed etiologies)

Data for this group are based on the BVRT performance of 196 geriatric veterans with documented histories of neurologic insult who were referred to the Psychological Assessment Unit at the VAPAHCS for a dementia evaluation. Neurologic etiologies for 189 of the cases represented in this group included degenerative dementing disorders \( (n = 73; 39\%) \), cerebrovascular disease \( (n = 61; 32\%) \), head trauma \( (n = 29; 15\%) \), epilepsy \( (n = 9; 5\%) \), metabolic and toxic disorders \( (n = 9; 5\%) \), neoplasms \( (n = 4; 2\%) \), infectious brain disease \( (n = 3; 1.5\%) \), and hydrocephalus \( (n = 1; <1\%) \). The degree of cognitive impairment varied greatly across cases. Diagnostic breakdowns based on test performance were as follows: without cognitive deficit \( (n = 38; 20\%) \), cognitive disorder NOS \( (n = 46; 24\%) \), amnestic disorder \( (n = 12; 6\%) \), mild dementia \( (n = 33; 18\%) \), moderate dementia \( (n = 55; 29\%) \), and severe dementia \( (n = 5; 3\%) \). As moderately and severely demented patients performed similarly to each other but significantly lower than patients subsequently showing either no or mild levels of cognitive deficit, the neurologic group was subdivided into “no/low deficit” and “moderate/severe deficit” categories for further statistical analyses.

The no/low deficit subgroup consisted of 129 patients (124 males, 5 females) aged 55–89 years \( (\text{mean} = 67.42 \text{ years, S.D.} = 8.50) \). They were highly educated \( (\text{mean} = 13.26 \text{ years of education, S.D.} = 3.38, \text{range} = 4–20 \text{ years}) \). The moderate/severe deficit subgroup consisted of 60 patients (59 males, 1 female) aged 56–87 years \( (\text{mean} = 70.73 \text{ years, S.D.} = 8.03) \). They were less well educated \( (\text{mean} = 11.82 \text{ years of education, S.D.} = 3.59, \text{range} = 2–20 \text{ years}) \). About one-third of the total cerebrovascular disease cases \( (n = 18) \) and one-half of the degenerative dementia cases \( (n = 37) \) fell in the moderate/severe deficit category—together accounting for 92\% of this particular subgroup.

3.2. Procedure

Administration A (immediate recall) of the BVRT was given according to standard format \( (\text{Sivan, 1992}) \). Participants in all the three groups were tested either by a staff neuropsychologist or by a psychology intern, technician, or research assistant supervised by a doctoral level psychologist.

4. Results

4.1. Demographics

The composition of our cross-sectional groups has been described in detail elsewhere \( (\text{Coman et al., 1999}) \). Males were underrepresented in normals and normals with memory concerns and overrepresented in the neurologic group. Our groups also differed in sample composition (veterans vs. nonveterans), recruitment method (patient referrals vs. volunteers), and period of actual data collection.

As reported in an earlier paper \( (\text{Coman et al., 1999}) \), an analysis of variance (ANOVA) on the total number correct score across the three main groups revealed significant differences in BVRT performance \( [F(2, 783) = 138.15, P < .0001] \). There were also significant
differences between groups in both age \( F(2, 784) = 79.77, P < .0001 \) and years of education \( F(2, 784) = 63.04, P < .0001 \). Thus, normals were significantly older than participants in the other two groups while normals with memory concerns were significantly more highly educated (both \( P < .0001 \)). These differences may explain the significantly higher scores achieved by normals with memory concerns who were both younger and more highly educated than subjects in the normal group. Means and standard deviations for BVRT total number correct (raw scores) were as follows: normals (mean = 5.37, S.D. = 1.92), normals with memory concerns (mean = 6.27, S.D. = 1.55), no/low deficit neurologic subgroup (mean = 4.49, S.D. = 2.09), and moderate/severe deficit neurologic subgroup (mean = 1.90, S.D. = 1.53).

Given the between-groups differences, as well as the heterogeneity of the neurologic group, we proceeded to focus on each diagnostic group separately. To maintain the integrity and generalizability of each group, we included all available participants in each sample. We did not reduce sample size and match individuals demographically to make further between-groups comparisons. For the sake of clarity, however, we present results for each diagnostic group organized by our research questions.

4.2. Within-groups influences on BVRT performance

4.2.1. Overall dimensional analyses

Our four research questions imply significant overall relationships between BVRT accuracy, age, education, and gender. Thus, Questions 1 and 2 relate to the effect of age. Question 3 hypothesizes that decline in BVRT performance level differs according to level of education. The fourth research question seeks to examine the effect of gender.

To better understand the associations between BVRT accuracy and these demographic variables, we performed multiple linear regression analyses in both normal groups using BVRT total number correct as the dependent measure and gender, age centered at 71, education centered at 14, and the interaction term for age and education as our independent variables. We note that there were too few women to meaningfully include gender in the computations in the neurologic subgroups (\( n = 5 \) in the no/low deficit subgroup; \( n = 1 \) in the moderate/severe deficit subgroup).

Results of our multiple regression analyses (reported in detail in Coman et al., 1999) revealed significant main effects for age and education in normals, normals with memory concerns, and the no/low deficit neurologic subgroup. Age was negatively associated with BVRT accuracy, while education was positively associated with it. Thus, the higher one’s age the lower their BVRT accuracy (first research question), while the higher one’s level of education the higher their BVRT accuracy (third research question). There was no significant interaction between age and education in these same groups. Gender did not significantly impact the BVRT performance of either group in which it could be assessed (normals and normals with memory concerns; fourth research question). We note that, in contrast, neither age nor education was significantly associated with BVRT performance in the moderate/severe deficit neurologic subgroup.

The multiple regression analyses evaluated level of performance relationships. However, we performed additional analyses for each research question to more finely delineate the interactive influence of these variables on BVRT performance within each group.
Table 1
Means table for successive age groups: BVRT total number correct, normal group (n = 156)

<table>
<thead>
<tr>
<th>Age group comparisons</th>
<th>n</th>
<th>Mean</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age 55–64</td>
<td>6</td>
<td>6.83</td>
<td>1.17</td>
</tr>
<tr>
<td>Age 65–74</td>
<td>54</td>
<td>6.30</td>
<td>1.59</td>
</tr>
<tr>
<td>Age 75–84</td>
<td>67</td>
<td>4.90</td>
<td>1.75</td>
</tr>
<tr>
<td>Age 85+</td>
<td>29</td>
<td>4.45</td>
<td>2.13</td>
</tr>
</tbody>
</table>

* Data are cross-sectional.

4.3. BVRT performance differences

4.3.1. Question 1: “Short-term visual memory declines with age” (Sivan, 1992, p. 64)

4.3.1.1. Normal group (n = 156). A Spearman rank correlation calculated across normals revealed a significant and negative association between age and BVRT total number correct: rho corrected for ties = −.42 (P < .0001). When this sample was divided into four age groups (e.g., 55–64, 65–74, 75–84, and 85+), a comparison of means revealed a consistent decline in scores between these cross-sectional age samples (see Table 1). A larger-than-expected drop in scores between the 65–74-and 75–84-year-old age groups prompted us to divide the data into smaller age groupings to more clearly delineate the nature of this change. When we did so, we found that the greatest decline in mean BVRT scores actually occurred between the 70–74-and 75–79-year-old age groupings.

4.3.1.2. Normals with memory concerns (n = 435). Spearman rank correlations revealed a significant negative association between age and BVRT total number correct: rho corrected for ties = −.29 (P < .0001). When this sample was divided into four age groups (e.g., 55–64, 65–74, 75–84, and 85+), a comparison of means revealed a consistent decline in scores between cross-sectional age samples (see Table 2). Similar to normals, the largest drop in scores occurred between the 65–74-and 75–84-year-old age groups. However, when we divided the data into smaller groupings to delineate the nature of the change, we found that the greatest decrement in BVRT performance occurred between the 75–79-and 80–84-year-old age groups.

4.3.1.3. Neurologic subgroups. Spearman rank correlations revealed a significant negative association between age and BVRT total number correct only in the no/low deficit sample:

Table 2
Means table for successive age groups: BVRT total number correct, normals with memory concerns (n = 435)*

<table>
<thead>
<tr>
<th>Age group comparisons</th>
<th>n</th>
<th>Mean</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age 55–64</td>
<td>114</td>
<td>6.64</td>
<td>1.43</td>
</tr>
<tr>
<td>Age 65–74</td>
<td>220</td>
<td>6.45</td>
<td>1.47</td>
</tr>
<tr>
<td>Age 75–84</td>
<td>90</td>
<td>5.51</td>
<td>1.59</td>
</tr>
<tr>
<td>Age 85+</td>
<td>10</td>
<td>5.00</td>
<td>1.76</td>
</tr>
</tbody>
</table>

* One case missing.
Table 3
Means table for successive age groups: BVRT total number correct, neurologic subgroups (n = 196)*

<table>
<thead>
<tr>
<th>Age group comparisons</th>
<th>n</th>
<th>Mean</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>No/low deficit neurologic subgroup</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age 55–64</td>
<td>59</td>
<td>5.05</td>
<td>2.17</td>
</tr>
<tr>
<td>Age 65–74</td>
<td>43</td>
<td>4.53</td>
<td>1.74</td>
</tr>
<tr>
<td>Age 75–84</td>
<td>20</td>
<td>3.10</td>
<td>1.83</td>
</tr>
<tr>
<td>Age 85+</td>
<td>7</td>
<td>3.43</td>
<td>2.30</td>
</tr>
<tr>
<td>Moderate/severe deficit neurologic subgroup</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age 55–64</td>
<td>15</td>
<td>2.40</td>
<td>1.59</td>
</tr>
<tr>
<td>Age 65–74</td>
<td>26</td>
<td>1.81</td>
<td>1.27</td>
</tr>
<tr>
<td>Age 75–84</td>
<td>15</td>
<td>1.73</td>
<td>1.94</td>
</tr>
<tr>
<td>Age 85+</td>
<td>4</td>
<td>1.25</td>
<td>0.96</td>
</tr>
</tbody>
</table>

*Seven cases missing data on level of deficit.

rho corrected for ties = -.30 (P < .001). When the no/low deficit subgroup was stratified by age groups (e.g., 55–64, 65–74, 75–84, and 85+), a comparison of means revealed a consistent decline in scores through age 84 (see Table 3). For the oldest subjects (85+, n = 7), BVRT performance was slightly improved relative to the other three age groupings. In the moderate/severe deficit subgroup (also Table 3), declines were consistent (but nonsignificant) for successive age groups through age 85+. However, in both subgroups, the 85+ age group consisted of fewer than 10 subjects, making interpretation of these results preliminary at best.

In the no/low deficit subgroup, as in the two normal samples, there was a larger-than-expected decline in scores between the 65–74 and 75–84-year-old age groups. When we examined smaller age groupings, we found the pattern of scoring to be inconsistent, with performance declining most sharply for subjects aged 75–79. We note again that these findings are limited by small sample sizes for ages 79–85+.

4.3.2. Question 2: “For successive age groups up to age 80 years, there is a consistent increase in variability in performance” (Sivan, 1992, p. 65)

4.3.2.1. Normal group. As Table 1 (above) indicates, variability in memory performance consistently increased across progressively older age samples (through age 85+) in this group of normals. Homogeneity of variances F tests, however, did not show these differences to be significant (all P > .05).

4.3.2.2. Normals with memory concerns. As Table 2 suggests, variability in BVRT performance consistently increased across progressively older cross-sectional age samples through age 85+. Again, homogeneity of variances F tests did not show significant differences between the four main age groupings (all P > .05).

4.3.2.3. Neurologic subgroups. Table 3 shows that this pattern was not replicated in either neurologic reference group. In the no/low deficit subgroup, variability initially decreased and then increased consistently after age 75. In the moderate/severe deficit subgroup, there was a
sawtooth pattern across age groups. The smallest amount of variability occurred after age 85 when BVRT performance was reduced to scores of between 1 and 3 correct. Homogeneity of variances F tests, however, did not show significant differences between the four age groupings in either neurologic subgroup (all $P > .05$).

4.3.3. Question 3: “The performance of highly educated subjects tends to decline less than that of examinees with limited education” (Sivan, 1992, p. 65)

4.3.3.1. Normal group. Figure 1 presents mean scores for BVRT total number correct stratified by both educational level and age group. Age-stratified mean scores suggest that, through age 84, cross-sectional groups of normal individuals with higher levels of education consistently perform better than those with lower levels of education. Although the relative pattern of decline is similar between age groupings, at any given age, the absolute level of performance depends on level of education.

A one-way ANOVA examining the effect of educational level groupings on BVRT total number correct revealed significant differences in memory performance [$F(2, 153) = 16.59, P < .0001$]. Post hoc analyses indicated what Figure 1 shows: for example, those with less than a high school education performed significantly more poorly than those with either a high school diploma or a college degree ($P < .0001$). Differences between the two higher educational levels were nonsignificant. We note that for the 85+ age group, results for these levels of education are based on less than 10 subjects and should be interpreted cautiously.

Fig. 1. Interactive influences of age and education: normal group ($n = 156$). The letter “a” denotes data not entered for cells with $≤5$ subjects. For each datapoint noted, numbers in parentheses indicate number of subjects per cell.
4.3.3.2. Normals with memory concerns. Figure 2 likewise presents mean scores for BVRT total number correct stratified by both educational level and age group. We note that this group was significantly more highly educated than the other two samples. Thus, there were insufficient data to allow for analysis of BVRT performance patterns in individuals with less than a high school education in the 55–64-year-old age group. Normals with memory concerns were also significantly younger than those in the other two samples. Thus, there were less than 10 subjects in the 85+ age group.

Age-stratified mean scores for cells with sufficient numbers of subjects suggest that, through age 84, normals with memory concerns having higher levels of education consistently perform better than those with lower levels of education. Although their relative pattern of decline is similar, at any given age, one’s level of performance is a function of level of education. We note that performance differences between subjects with different levels of education narrow by age 75 (see Fig. 2).

A one-way ANOVA examining the effect of educational level groupings on BVRT accuracy revealed significant differences in memory performance \( F(2, 431) = 11.84, P < .0001 \). Post hoc analyses confirmed what Figure 2 shows: For ages 65–74, those with less than a complete high school education in this particular group performed significantly more poorly than those with either a high school diploma or a college degree \( P < .01 \). By age 75, however, differences between educational level groupings did not approach significance at \( P < .05 \).

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Fig. 2. Interactive influences of age and education: normals with memory concerns \( (n = 435) \). The letter “a” denotes data not entered for cells with \( \leq 5 \) subjects. For each datapoint noted, numbers in parentheses indicate number of subjects per cell.
4.3.3.3. Neurologic subgroups. Figure 3 presents mean scores for BVRT total number correct in the no/low deficit subgroup stratified by both educational level and age. Age-stratified mean scores suggest that, at least through age 74, individuals at this level of cognitive deficit having a college degree perform better than those with lower levels of education. After age 74, there were too few subjects per cell to gauge the influence of educational level on BVRT performance.

A one-way ANOVA examining the effect of educational level groupings on BVRT total number correct in this subgroup revealed significant differences in memory performance \( F(2, 126) = 4.97, P < .01 \). Post hoc analyses indicated what Figure 3 shows: Subjects with a college or advanced degree performed significantly better than those without a college degree \( (P < .05) \). This is a different pattern than the one that we observed in the two normal groups where differences in performance were found between those with and without a high school diploma.

The number of subjects in the moderate/severe cognitive deficit subgroup was not sufficient to stratify the data by age and educational level. As previously noted, results of our multiple regression analysis showed that the association between these variables and BVRT total number correct did not approach statistical significance at \( P < .05 \). One-way ANOVAs investigating these same associations likewise did not approach significance at \( P < .05 \) regardless of age group or educational level. This is a different scoring pattern than the one that was demonstrated in the no/low cognitive deficit subgroup. It suggests that as deficit level increases (e.g., from no/low to moderate/severe), the influence of demographic variables on cognitive function declines.
4.3.4. Question 4: Gender and BVRT performance

4.3.4.1. Normal group. As documented above, results of our multiple regression analysis showed that the association between gender and BVRT total number correct did not approach statistical significance at \( P < .05 \). Women were overrepresented in this group, comprising 80% of the sample. However, both the 65–74- and 75–84-year-old groupings had 10 or more subjects of each gender. When we examined the impact of gender on BVRT performance within these age groups, results were statistically nonsignificant as expected and the effect sizes appeared to be of minimal clinical significance. We found the same results when we examined the impact of gender on BVRT performance within each of the three educational level groupings. These results suggest that gender has little impact on memory performance for normal older subjects regardless of age or educational level. We conducted similar analyses for our reference groups of clinical interest (as follows).

4.3.4.2. Normals with memory concerns. As already documented, the results of our multiple regression analysis indicated that the association between gender and BVRT total number correct did not approach statistical significance at \( P < .05 \). We note that the oldest age group (85+ years of age) included only one male participant. When we examined the impact of gender on BVRT performance within the three younger age groups, results were statistically nonsignificant as expected, and effect sizes were of minimal clinical significance. We found the same results when we examined the impact of gender on BVRT performance within educational groupings. These results suggest that gender has little impact on memory performance for normal older individuals with memory concerns regardless of age or educational level.

4.3.4.3. Neurologic subgroups. There were too few women (\( n = 7 \)) to examine the influence of gender on performance in either of the neurologic subgroups.

5. Discussion

5.1. Overview

Our analyses extend the work of prior BVRT studies by examining the interactive influence of demographic and diagnostic variables on BVRT performance within three distinct geriatric samples. In terms of age range, number of diagnostic groups, and demographic variables included, this is the most thorough investigation to date of BVRT accuracy (i.e., total number correct scores) in older adults.

5.2. Research questions: a reexamination of influences on BVRT performance level

5.2.1. Question 1. “Short-term visual memory declines with age” (Sivan, 1992, p.64)

Our cross-sectional data showed a consistent linear decline in visual memory with advancing age. This pattern was observed in the normal group, in the normals with memory concerns group, and in the no/low cognitive deficit neurologic subgroup. Data from these
same groups also showed a marked decline in the level of performance between the 65–74-and
75–84-year-old age groups. The threshold for cognitive change would appear to be age 75 for
normals and for the no/low cognitive deficit subgroup. In contrast, the threshold for normals
with memory concerns does not appear until approximately age 80.

These results support earlier findings of marked declines in the seventh and eighth decades
based on BVRT error scores (Arenberg, 1987; Benton et al., 1981; both cited in Sivan, 1992).
Resnick et al. (1995) found that the impact of age on BVRT performance (total number of
errors) accelerates after age 70 in normals. Most recently, Giambra et al. (1995) targeted
the 65–74-year-old decade as “the watershed for decremental changes in immediate visual
memory” (p. 123). Our research extends and refines these findings to no/low cognitive deficit
subjects, as well as to normal older adults who have expressed concerns about their memory
function.

It is of interest that the period of marked decline in BVRT accuracy occurred later in the
normals with memory concerns group than in the other two groups. As normals with memory
concerns were more highly educated, one might hypothesize that education served as a buffer
and delayed the period of accelerated memorial decline. While our cell sizes for this group
were small in some cases, they suggest some interesting trends. For example, education-related
differences in BVRT scores appear to be minor by age 75 (see Fig. 2). Thus, education alone
may not be sufficient to explain the difference in their performance profile. We note that this is
a group of subjects who perform well (significantly higher than the normals) yet perceive a loss
in cognitive function. We hypothesize that for these subjects, it is not only higher education but
also a higher level of self-awareness or motivation to learn compensatory memorial strategies
that helps them to delay any marked decline in visual memory function. This finding has clinical
relevance since individuals with these very characteristics are likely to be good candidates for
successful memory retraining.

In contrast, increasing age was not a significant predictor of BVRT performance in the
moderate/severe cognitive deficit neurologic subgroup. This finding is both consistent with
and different from results reported by Reitan and Wolfson (1995, 1996). They found that age
was less strongly associated with cognitive performance in brain-damaged subjects than in
same-age normal peers. Their studies, however, targeted severely brain-lesioned subjects. Our
results indicate that level of cognitive deficit is a moderating factor that influences the extent
to which demographic variables contribute to performance level in subjects with neurologic
disorders.

5.2.2. Question 2: “For successive age groups up to age 80 years, there is a consistent
increase in variability in performance” (Sivan, 1992, p. 65)

Variability in BVRT performance increased consistently through age 85 in normal subjects,
as well as in normals with memory concerns. However, these increases were not significant. The
fact that the “envelope” of the normal range of performance does not widen significantly has
important implications. It suggests that the limits of “normal” vs. “abnormal” visual memory
performance can still be defined despite the effects of increasing age.

We note that we found no consistent increase in variability with age for either neurologic
subgroup. However, given the multiple etiologies that are inherent in these subgroups, one
would not expect to find a linear progression in variability.
5.2.3. **Question 3.** “The performance of highly educated subjects tends to decline less than that of examinees with limited education” (Sivan, 1992, p. 65)

This observation is based directly on the results of a 5-year longitudinal study by Shichita et al. (1986). The age range that they sampled (69–71 years at baseline) was too narrow, however, to serve as a basis for drawing general conclusions about the general effects of age and education.

The current study investigated interactive influences on performance level in subjects ranging in age from 55 to 85+. Our results confirm the findings of Shichita et al. (1986) and suggest that their conclusions extend to other sample populations as well. In both of our normal groups, as well as in the no/low cognitive deficit subgroup, subjects with higher levels of education continued to perform more accurately on the BVRT. This was so even though BVRT task demand is relatively easy (e.g., these visual stimuli are easy to encode, verbally translate, and immediately recall).

We also found variations in BVRT performance that are specific to particular patient groups. In normals with memory concerns, performance differences associated with educational level appear to be nonsignificant by age 75. In the 75–84-year-old age range, subjects with high education showed mild decline in BVRT performance. However, a relatively smaller sample of subjects in the same-age range with less than 12 years of education showed no significant age effect. Evaluation of this trend in larger samples of older adults is necessary to clarify individual differences. These findings suggest that not only education but also self-awareness and/or motivation to compensate for memorial inefficiency can positively affect BVRT performance.

In addition, attainment of either a high school diploma or a college degree was sufficient to buffer the effects of increasing age on BVRT performance in the two normal groups (at least through age 74). This positive effect was obtained in the no/low cognitive deficit subgroup only for subjects with a college degree. In the moderate/severe cognitive deficit subgroup, the more generalized effects of neurologic insult adversely impacted BVRT performance regardless of age or educational level.

5.2.4. **Question 4: Gender and BVRT performance**

To clarify the relationship between gender and BVRT accuracy, we included it in our reexamination of BVRT performance. Limited numbers of women precluded our ability to investigate gender effects in either neurologic subgroup. Findings for normal subjects revealed no significant association between gender and BVRT performance regardless of age group or educational level. In the group of normals with memory concerns, the men were better educated than the women but did not perform significantly better on the BVRT. This confirms prior research that indicates that BVRT accuracy is not affected by differences in gender (Coman et al., 1999; Giambra et al., 1995; Resnick et al., 1995; Shichita et al., 1986; Youngjohn et al., 1993).

5.3. **Future directions**

We note that our findings are limited by the cross-sectional nature of our data. Furthermore, they are limited by small numbers of subjects at the extremes of age and education, as well as by a paucity of women in both neurologic subgroups. For this reason, performance differences
are most clearly and reliably seen in the middle age range of each sample. The validity of our findings will also depend on the extent to which an individual is demographically similar to our sample groups. Our subjects were primarily Caucasian, aged 55–97, and reported educational levels ranging from the elementary grades to postgraduate school (e.g., 2–25 years of education).

The demographic patterns suggested by our respective groups require replication and further refinement. There are, for example, additional demographic variables that can impact memory function. These include socioeconomic status, occupational complexity, and level of social/educational activity. The effect of these variables on level and pattern of BVRT performance in similar populations of older adults remains to be clarified.

References


