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Rey Auditory Verbal Learning Test (AVLT) Performance in Individuals With Recent-Onset Spinal Cord Injury

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ABSTRACT. ***Objective:*** To present Rey Auditory Verbal Learning Test (AVLT) normative data for persons with recent-onset spinal cord injury (SCI). ***Setting:*** A Southeastern rehabilitation facility. ***Participants:*** One hundred eighty-four persons (133 males and 51 females) with recent-onset SCI assessed with the Rey AVLT during their inpatient rehabilitation hospitalization. ***Results:*** General trends toward decreased recall with increasing age and increased recall with increasing educational level were noted. Gender differences were not detected. Average scores are presented in tables by age and by education separately. ***Conclusions:*** The normative information presented may assist rehabilitation psychologists in providing interpretations and recommendations to rehabilitation team members regarding each individual's ability to learn and benefit from verbal instruction in rehabilitation therapies in comparison with other individuals with SCI.

Individuals engaged in rehabilitation subsequent to an acute spinal cord injury (SCI) are compelled to learn about their health and about living with an SCI through educational materials and instruction in rehabilitative therapy sessions. Verbal (oral and print) methods of education and communication are the most frequent methods used among rehabilitation professionals, although alternative modes of communication (e.g., visual aids) should be available to patients who require or prefer them (Lollar & Ericson, as cited in Rohe, 1996).

Rehabilitation psychologists assess verbal learning and memory abilities in an

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effort to identify individuals with difficulties in these areas who might benefit from alternative modes of education (Elliott & Jackson, 1996). Consistently poor performance on verbal learning and memory tasks should prompt recommendations regarding techniques to assist in the encoding, storage, and retrieval of important therapeutic and medical information and identification of areas of cognitive strength that can compensate for difficulties identified by assessment. Cognitive deficits may influence response to rehabilitation (Davidoff, Roth, & Richards, 1992; Morris, Roth, & Davidoff, 1986). Likewise, the ability to learn new information may be associated with functional gains during inpatient rehabilitation (Jackson, Johnson, & Elliott, 1995). Therefore, studies have focused on identifying cognitive impairments that may have occurred comorbid with or previous to the SCI (e.g., head injury) or that may have stemmed from other factors (e.g., depression, anxiety, or the effects of hospitalization, medication, or simply having been injured; Davidoff, Morris, Roth, & Bleiberg, 1985; Davidoff et al., 1992; James & Richards, 1991; Roth et al., 1989).

Research has suggested that a significant percentage of acutely injured patients with SCI (from 13% to 58%, depending on the study) can be expected to exhibit cognitive deficits (Morris et al., 1986). Unfortunately, the definition of cognitive sequelae (and head injury) has varied significantly across studies, making verification of incidence difficult.

USE OF THE REY AUDITORY VERBAL LEARNING TEST (AVLT)

The Rey AVLT (Rey, 1964) has enjoyed widespread use within psychology and neuropsychology, particularly in medical settings, despite concerns about the normative data (Geffen, Moar, O'Hanlon, Clark, & Geffen, 1990; Savage & Gouvier, 1992; Vakil & Blachstein, 1997). The Rey AVLT has the advantage of extensive research regarding its structure and function (cf. Lezak, 1995; Spreen & Strauss, 1998). In addition, because the word list is estimated at about the seventh-grade reading level, its use ranges across several populations, including various ages and education levels (Taylor, 1959).

One particularly salient concern is that the comparison samples for the Rey AVLT may not be appropriate for use with persons with SCI. Demographic variables, such as educational or occupational level, and culture differences may not adequately match individuals with SCI. For example, norms compiled by Geffen and colleagues (1990; Geffen, Butterworth, & Geffen, 1994) are widely used and cited in several normative texts. Her samples included nondisabled persons from the community ranging from age 16 years to older than 70 years, with an average education level of 11.2 years. However, the samples (a) had several members with professional occupations, (b) had an estimated Full Scale IQ score that fell in the upper 75th percentile, and (c) were from Australia, which suggests the possibility of culture-specific issues that may make the norms less

applicable for persons in North America. Other norms may not be appropriate to use for comparison to a typical person with SCI because the samples are largely comprised of college graduates or are not age-appropriate (cf. Schmidt, 1996).

There are several available normative data sets for this test (Lezak, 1995; Schmidt, 1996). Although there is an advantage to having a set of norms that captures the particular style of administration used, some norms may be outdated by current administration standards. In addition, selection of some norms may result in higher rates of impairment classification than other norms (e.g., Savage & Gouvier, 1992; Wiens, McMinn, & Crossen, 1988).

Indicators of typical performance on tests of verbal learning and memory for individuals without physical disabilities or memory deficits have been reported by Lezak (1995) and Spreen and Strauss (1998). For example, on the Rey AVLT, examinees without memory deficits or physical disabilities typically (a) learn about five words from Trial 1 to Trial 5, (b) recall about the same number of words on the interference (Trial B) recall compared with Trial 1, (c) recall one to two fewer words on the short-term recall task than on Trial 5, and (d) have few false positive errors on the recognition trial. Furthermore, a general trend toward decrease in words recalled occurs with increasing age beginning at about age 60 years. The authors also suggested that women's average scores are typically higher than men's scores. However, the results across normative data sets are inconsistent, which prompted Schmidt (1996) to conclude that "this appears to be a marginal effect that is of limited importance in interpreting RAVLT results" (p. 32). In their literature reviews, both Lezak and Spreen and Strauss cited several articles and chapters that included normative data for the Rey AVLT. However, because neither Lezak nor Spreen and Strauss reported how they determined the indicators of typical performance or on which specific studies the indicators were based, comparison of demographic information among samples cannot be made directly.

REY AVLT AND PERSONS WITH RECENT-ONSET SCI

There is a relative dearth of information regarding typical Rey AVLT performance among persons with SCI. Roth and colleagues (Roth et al., 1989) found that prevalence rates for impaired scores were lower (15% to 35%) for persons with SCI in their study compared with previous studies of cognitive impairment in SCI. However, they compared their sample with a control group of paid, demographically matched volunteers rather than with norms available at the time. Furthermore, in his Rey AVLT handbook, Schmidt (1996) cited one study of acutely injured SCI patients showing that Rey performance was not significantly different among high and low Zung Depression Scale scorers (Davidoff et al., 1990). Unfortunately, standard deviations and the mean scores on delayed recall and the total of five learning trials were not reported; therefore, these data are of limited usefulness for interpreting data in individual cases.

Few other studies have provided information on Rey AVLT performance in persons with SCI. Given concerns regarding normative information referred to previously and concerns that Rey AVLT normative data may artificially inflate the prevalence of cognitive deficits in persons with SCI (Davidoff et al., 1992; Trieschmann, 1988), the incidence of memory impairment cited in those studies may be suspect. Furthermore, some studies have not included data on all sections of the Rey and may have left out the short-term recall, long-term recall, or recognition components. Finally, the studies have focused on overall cognitive (neuropsychological) deficits in the context of brain injury comorbid with SCI and have not examined performance from the perspective of a brief inpatient screening evaluation for application to recommendations for rehabilitation.

The purpose of this article is to present "normative" Rey AVLT data in persons with recent-onset SCI. Our normative data provide information on all aspects of the Rey AVLT and are derived from a brief inpatient screening evaluation focused on provision of recommendations for rehabilitation. The recently revised *Standards for Educational and Psychological Testing* (American Educational Research Association, 1999), and Standard #10.9 (p. 107) in particular, encourage the establishment and use of normative data that are based on populations of persons with similar characteristics. The essence of Standard #10.9 is that interpretation should be based on normative data from "the population of individuals with the same level or degree of disability," particularly when "the test taker's functioning relative to individuals with similar disabilities is at issue" (American Educational Research Association, 1999, p. 107). The controversy surrounding prevalence and severity of cognitive deficits in SCI has prompted the need for this comparison group (Davidoff et al., 1992; Trieschmann, 1988).

METHOD

Participants

Participants were consecutively admitted to an inpatient rehabilitation program after incurring an SCI without concomitant severe head injury (by physician's diagnosis). Per protocol, all persons with SCI in this Southeastern rehabilitation facility were consecutively referred for psychological evaluation. The Rey AVLT was administered as part of the standard initial psychological evaluation to 301 persons after they gave their informed consent for the assessment. One hundred seventeen persons were removed from consideration for this study because they did not meet the following criteria for inclusion: (a) injury onset within 52 weeks of administration of the Rey AVLT, (b) paraplegic or tetraplegic injury, and (c) complete Rey AVLT protocol. Reasons for incomplete protocols included the following: interruptions for urgent care needs (e.g., bowel or bladder

accidents), system-wide emergency (e.g., fire alarm), and patient refusal to continue testing or inability to finish tests due to pain, fatigue, or other somatic complaints. The final study sample consisted of 184 persons who completed the Rey AVLT. Table 1 contains the demographic characteristics of the sample. Indication of presence or absence of loss of consciousness (LOC) was obtained

Table 1. Sample Characteristics

Characteristic	*n*	%	*M*	*SD*
Gender				
Male	133	72.3		
Female	51	27.7		
Race				
Caucasian	126	68.5		
African American	58	31.5		
Injury level				
Paraplegia	91	49.5		
Tetraplegia	93	50.5		
Injury severity				
Complete	103	56.0		
Incomplete	81	44.0		
Cause of spinal cord injury				
Vehicular accidents	96	52.2		
Violence	29	15.7		
Falls–industrial accidents	25	13.6		
Sports–recreational accidents	11	6.0		
Other	23	12.5		
Loss of consciousness				
Yes	86	46.7		
No	98	53.3		
Drug and alcohol use at injury onset				
None	128	69.6		
Alcohol only	51	27.7		
Drug only	2	1.1		
Both drugs and alcohol	3	1.6		
Drug and alcohol use history				
None	31	16.9		
Alcohol only	94	51.0		
Drug only	2	1.1		
Both drugs and alcohol	57	31.0		
Age (years)			34.26	13.82
Education (years)			11.73	2.66
Time since injury onset (months)			7.24	9.24

through patient self-report and the patient's medical chart. Indication of drug and alcohol use both at the time of injury onset and in the past was derived from the patient's medical records and self-report. This information pertains only to use, not to issues of abuse or dependence. With the exception of gender, the demographic data of this sample appear to closely resemble data from the National Spinal Cord Injury Database (NSCID; DeVivo, Jackson, Dijkers, & Becker, 1999; Nobunaga, Go, & Karunas, 1999).

Procedure

The Rey AVLT was given as part of a psychological evaluation that also included measures of personality and emotional adjustment. Administration of the Rey AVLT closely followed the standardized instructions (Lezak, 1995; Spreen & Strauss, 1998), with one exception. The recognition portion used a paragraph form instead of a word list. Instructions and the paragraph used for this recognition version can be found in Lezak (1976) and Schmidt (1996). All participants received the recognition portion, contrary to Lezak's suggestion of using this only when the prior recall trial is three or more words fewer than previous trials. In our administration, all participants read the short paragraph and told the examiner which words they recognized as being in the original list. All of the words in the original list are in the paragraph, embedded within distractors. In previous versions of this paragraph recognition format, the examinee was asked to circle those words that appeared familiar. In contrast, we asked participants to indicate verbally which words they recognized because many participants were unable to use their hands to circle the words because of their SCI. The visual format allowed all the participants to use additional sensory inputs. We encountered only one situation in which the participant performed substantially poorer on this recognition format than in previous trials (by 4 words). If individuals had compromised sight or were otherwise unable to read the paragraph, it was read to them and they indicated verbally the words they recognized.

In addition to calculating the total amount recalled across all of the aforementioned trials, we calculated the difference between Trial 5 and Trial 1 as immediate learning. Freedom from distractibility was operationalized as the difference between recall on Trials 5 and 6. A nonparametric signal detection, p(A), measure was used to correct the recognition score by taking into account false positives (Geffen et al., 1990). The proportion of words correctly recognized on List A was considered the hit rate (HR), and the proportion of distractors identified was considered the false positive rate (FP). The signal detection variable, p(A), was calculated as $0.5(1 + HR - FP)$ and ranged from 0.5 (random guessing) to 1.0 (perfect performance).

RESULTS

There were no significant differences in education, $F(1, 260) = 0.23, p = .63$, or race, $\chi^2(1, N = 299) = 3.07, p = .08$, between those who were included in the study and those who were excluded from the study. However, there was a significant difference in age between the final study sample and those removed from the study, $F(1, 260) = 49.66, p < .001$, such that those included in the study were significantly younger ($M = 34.26$ years, $SD = 13.82$) than those not included ($M = 49.14$ years, $SD = 19.26$). Additional chi-square analyses showed that proportionately more females than males were excluded from the study, $\chi^2(1, N = 301) = 6.30, p < .02$. Also, participants were more likely to be excluded if (a) they did not experience a loss of consciousness, $\chi^2(1, N = 301) = 4.02, p < .05$; (b) they had an incomplete lesion instead of complete lesion, $\chi^2(1, N = 301) = 23.52, p < .001$; and (c) their etiology was "other" rather than vehicular accident, violence, sports–recreational accident, or fall–industrial accident, $\chi^2(5, N = 301) = 42.89, p < .001$.

Overall means and standard deviations for all Rey AVLT variables are presented in Table 2. We computed a 6 (age groups: 15–19 years; 20–29 years; 30–39 years; 40–49 years; 50–59 years; and 60 years and older) × 2 (male vs. female) × 3 (11 years or less education; 12 years education; more than 12 years education) multivariate analysis of variance with dependent variables of Rey

Table 2. Mean Rey AVLT Scores for all Participants

Variable	*M*	*SD*
1	5.65	2.01
2	8.03	2.43
3	9.35	2.74
4	10.36	2.88
5	11.26	2.84
Total	44.65	11.15
IL	5.61	2.57
DL	5.04	1.98
FFD	0.79	0.27
STR	9.07	3.67
LTR	9.11	3.72
Rec.	13.04	2.48
FP	1.01	1.49
SD	0.81	0.09

Note. AVLT = Auditory Verbal Learning Test; 1–5 = Initial learning trials; Total = total of initial learning trials; IL = immediate learning; DL = distractor list; FFD = freedom from distraction; STR = short-term recall; LTR = long-term recall; Rec. = recognition task; FP = false positives; SD = signal detection.

total recall over 5 trials, Trial B recall, short-term recall, long-term recall, and recognition. The overall multivariate statistic was significant, $F(5, 148) = 647.42$, $p < .001$. There were no significant interactions, but main effects were found for age, $F(25, 552) = 2.22$, $p = .001$, and education, $F(10, 296) = 3.04$, $p = .001$. Table 3 provides means and standard deviations by age, and Table 4 provides means and standard deviations by education. Means by gender and for combined age and education are not provided because neither of these analyses revealed significant differences between the groups.

Subsequent analysis of the univariate tests revealed that age had a significant effect on the Rey variables except Trial B recall (Fs > 4.50; ps $< .001$), such that recall decreased as the age of the group increased. Education level was significantly associated with all Rey variables (all Fs > 3.60; all ps $< .03$), such that recall increased as the educational level was greater. Given the significant associations between the Rey AVLT variables with age and education, means for memory performance are presented separately by age and education.

We performed one-way analyses of variance on each of the Rey variables to determine whether those individuals who had lost consciousness subsequent to their SCI had significantly different scores than those who did not lose consciousness. There were no significant differences between the groups on any of

Table 3. Mean Rey AVLT Performance by Participant Age

	Age (in years)											
	15–19 (n = 22)		20–29 (n = 66)		30–39 (n = 37)		40–49 (n = 32)		50–59 (n = 18)		≥60 (n = 9)	
Variable	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
1	6.05	2.03	5.77	2.01	5.86	2.03	5.84	2.17	4.67	1.50	4.11	1.27
2	9.05	2.19	8.26	2.12	7.97	2.71	8.50	2.75	6.50	1.42	5.44	1.33
3	10.45	2.42	9.42	2.29	9.54	3.24	9.72	3.01	7.94	2.55	6.89	1.27
4	11.50	1.99	10.59	2.37	10.62	3.06	10.63	3.15	8.39	3.35	7.78	2.82
5	12.82	1.79	11.42	2.47	11.27	2.80	11.75	2.96	9.06	3.67	8.89	1.90
Total	49.86	8.15	45.47	9.17	45.27	12.21	46.44	12.78	36.56	10.79	33.11	6.66
IL	6.77	2.51	5.65	2.60	5.41	2.34	5.91	2.16	4.39	3.26	4.78	2.44
DL	5.09	2.14	5.62	2.19	5.00	1.56	4.69	1.67	4.33	1.85	3.56	1.74
FFD	0.86	0.27	0.81	0.31	0.80	0.23	0.79	0.20	0.69	0.31	0.65	0.26
STR	11.05	3.24	9.11	3.42	9.35	3.66	9.41	3.59	6.83	4.05	6.00	2.78
LTR	11.14	2.27	9.05	3.40	9.70	3.80	9.63	3.69	6.39	4.37	5.89	3.06
Rec.	13.73	1.45	13.39	1.78	13.54	2.71	12.72	2.57	11.06	3.42	11.78	3.42
FP	0.82	1.30	0.92	1.42	1.00	1.53	1.00	1.81	1.33	1.41	1.44	1.42
SD	0.84	0.08	0.81	0.08	0.81	0.11	0.82	0.11	0.76	0.09	0.72	0.04

Note. AVLT = Auditory Verbal Learning Test; 1–5 = initial learning trials; Total = total of initial learning trials; IL = immediate learning; DL = distractor list; FFD = freedom from distraction; STR = short-term recall; LTR = long-term recall; Rec. = recognition task; FP = false positives; SD = signal detection.

Table 4. Mean Rey AVLT Performance by Participant Education Level

	Education					
	≤11 years (n = 66)		12 years (n = 73)		>12 years (n = 45)	
Variable	*M*	*SD*	*M*	*SD*	*M*	*SD*
1	5.36	2.13	5.52	2.02	6.27	1.70
2	7.70	2.54	7.90	2.30	8.71	2.37
3	8.82	2.83	9.42	2.54	10.02	2.81
4	9.62	3.05	10.47	2.71	11.27	2.63
5	10.56	3.17	11.44	2.67	12.00	2.38
Total	43.47	11.29	43.47	11.29	48.27	10.00
IL	5.20	2.59	5.92	2.73	5.73	2.21
DL	4.47	1.89	5.64	2.02	4.91	1.81
FFD	0.74	0.28	0.80	0.30	0.85	0.21
STR	8.15	3.71	9.10	3.64	10.36	3.34
LTR	8.00	3.81	9.30	3.59	10.44	3.39
Rec.	12.11	3.11	13.42	2.14	13.78	1.33
FP	1.24	1.75	0.90	1.44	0.82	1.11
SD	0.79	0.10	0.81	0.09	0.83	0.10

Note. AVLT = Auditory Verbal Learning Test; 1–5 = initial learning trials; Total = total of initial learning trials; IL = immediate learning; DL = distractor list; FFD = freedom from distraction; STR = short-term recall; LTR = long-term recall; Rec. = recognition task; FP = false positives; SD = signal detection.

the Rey AVLT variables (all Fs < 0.22; all ps $> .64$). Additional analyses indicated that the Rey variables did not differ significantly by current alcohol or drug use (all Fs < 0.94; all ps $> .55$), time since injury onset (all rs $< .07$; all ps $> .38$), or severity of injury (complete vs. incomplete lesion; all Fs < 3.03; all ps $> .08$). In contrast, when examining the Rey variables within the context of past alcohol or drug use, we found a significant difference for the interference trial, $F(3, 180) = 3.14$, $p < .03$. Post hoc analyses with the Bonferroni correction revealed that those individuals with a reported history of drug and alcohol use had significantly higher mean scores ($M = 5.56$, $SD = 2.30$) on the interference trial than those with only an alcohol use history ($M = 4.63$, $SD = 1.69$; mean difference $= .93$, $p < .03$).

Individuals with a paraplegic injury scored significantly higher on long-term memory, $F(1, 182) = 82.54$, $p < .02$; recognition, $F(1, 182) = 35.73$, $p < .02$; and total of the five learning trials, $F(1, 182) = 845.03$, $p < .01$, than those with a tetraplegic injury: long-term memory $M = 9.79$ ($SD = 3.08$) versus $M = 8.45$ ($SD = 4.17$); recognition $M = 13.48$ ($SD = 1.72$) versus $M = 12.60$ ($SD = 3.00$); and total of five learning trials $M = 46.81$ ($SD = 9.09$) versus $M = 42.53$

(SD = 12.55). Also, a significant difference was found for etiology with Trial B only, $F(5, 178) = 2.44$, $p < .04$. Although this omnibus test result was significant, pairwise comparisons with the Bonferroni correction were not significant (all mean differences < 1.47; all ps > .18), suggesting there is no consistent pattern of differences. Finally, the level of injury was not associated with the incidence of LOC, $\chi^2(1, N = 184) = 1.09$, $p > .29$.

DISCUSSION

The mean Rey AVLT scores of our participants matched the typical performance for non-memory-impaired, nondisabled participants with respect to four features outlined by Lezak (1995) and Spreen and Strauss (1998). Specifically, the group as a whole (a) learned about five words from Trial 1 to Trial 5, (b) recalled about the same number of words on the interference (Trial B) recall compared with Trial 1, (c) recalled one to two fewer words on the short-term recall task than on Trial 5, and (d) had few false positive errors on the recognition trial.

Furthermore, our data demonstrated age and education differences similar to those found in the Rey AVLT literature (Davidoff et al., 1992; Tun, Tun, & Wingfield, 1997). When we examined the data within the age groups, a trend toward lower scores in older age groups and in persons with a lower education level was apparent. There were no gender differences, which is consistent with some available normative data (Northam, Bowden, Anderson, & Court, 1992; Savage & Gouvier, 1992) but not others (Bleecker, Bolla-Wilson, Agnew, & Meyers, 1988; Geffen et al., 1990; Vakil & Blachstein, 1997).

Although our sample performed similarly to typical nondisabled, non-memory-impaired samples, it is important to note that (a) the demographic characteristics of the study samples that Lezak and Spreen and Strauss used to derive their indicators of typical performance are unknown; (b) the individuals in our sample did not have a concomitant severe head injury, which may reduce performance on the Rey AVLT; and (c) other salient factors, such as long-term substance abuse (Parsons, 1996), that may have contributed to a reduction in scores were not assessed. We measured substance *use* and found that persons with a history of both drug and alcohol use had significantly higher scores on the interference trial (Trial B) than those with only a history of alcohol use. Interpretation of this lone significant finding is difficult, and the difference may not be clinically significant. Alternatively, an additional unmeasured variable (or variables) may have affected this finding, such as the person's age, frequency of use, or amount of substance used per episode of use.

When compared with some of the available normative data for nondisabled, non-memory-impaired samples, our participants' scores were below average, which is consistent with previous studies of people with SCI (Davidoff et al., 1985; James & Richards, 1991; Morris et al., 1986). However, as previously

indicated, demographic characteristics of our sample do not closely match the existing Rey AVLT normative samples. Trieschmann and others have asserted that existing normative data for some neurocognitive tests may inflate the incidence of cognitive deficits in individuals with SCI (Davidoff et al., 1992; Trieschmann, 1988). Perhaps the demographic characteristics of the comparison samples used in previous studies of individuals with SCI did not appropriately match the persons with SCI and therefore overestimated the occurrence of memory deficits.

Contrary to previous research (Richards, Brown, Hagglund, Bua, & Reeder, 1988; Tun et al., 1997), significant differences between the groups on injury-related variables (e.g., etiology, paraplegia vs. tetraplegia) were shown. Although the differences among the etiological groups did not show a consistent pattern that was interpretable, persons with paraplegia had higher scores in long-term memory, recognition, and the total of five learning trials than persons with tetraplegia. These differences may not be clinically significant when considering that the range of average scores one could derive for clinical comparison includes the mean values of both groups. However, the statistical difference in scores suggests the possibility of a mediating variable. Although persons with tetraplegia were not more likely to have lost consciousness than persons with paraplegia, we recognize that our index of LOC (yes/no) is not sensitive to potential for and level of head injury. Clearly, presence or absence of LOC is an indicator of *potential* traumatic brain injury (TBI), but it is not sufficient information to make a certain diagnosis of TBI.

Clinical Implications

Comparison of individuals with SCI to hospitalized peers with similar disabling conditions can be advantageous in that the rehabilitation psychologist can provide tailored recommendations for assistance or alternative methods of communication for those patients with verbal learning and memory difficulties. The interpretation of test results and ensuing recommendations made by psychologists regarding each patient's performance is dependent on the group to which the individual is being compared. For example, a person with SCI who has impaired scores on the Rey AVLT compared with a nondisabled sample may have an average score when compared with other hospitalized individuals with recent-onset SCI. In this case, unnecessary recommendations may have been made and the patient may become angry, oppositional, or anxious if the psychologist had relied solely on the first comparison. Furthermore, a diagnosis of memory difficulties may cause (a) additional anxiety or undue stress on the family, (b) staff members to treat the patient as if he or she cannot direct his or her own care, and (c) the patient to feel more dependent on others. Additional and unnecessary stress stemming from the diagnosis of memory impairment can be alleviated if the patient, family, and staff are also told that the Rey AVLT

performance was average when compared with that of other individuals who are hospitalized with recent-onset SCI.

In contrast to other investigators who examined the Rey AVLT within the context of a battery of neuropsychological measures (e.g., intelligence, visual–spatial abilities, verbal fluency), we used the Rey AVLT as part of a brief inpatient psychological evaluation. The data should be interpreted within this context. The Rey AVLT measures only one component of cognitive functioning; thus, average scores on this measure do not necessarily rule out cognitive decline in other areas (e.g., visual–spatial deficits) or TBI.

Limitations

As with any normative information, the user of these norms must consider the qualities of the sample and procedures that may affect the interpretation of scores. Notably, appropriate normative information on age and education was restricted by a limited sample size within some categories, especially at higher education levels and within oldest and youngest age ranges. Therefore, a table with age by education normative information would be of limited usefulness and was not provided. However, normative information may differ for some individuals, depending on whether comparing by age or by education. For example, a 55-year-old with a bachelor's degree who obtained a long-term recall score of 6 would have a T score of 49 compared with others his same age but a T score of 37 compared with others who had greater than a 12th-grade education. Norm users will need to rely on clinical judgment for each specific case regarding choice of scores to report.

Sample representativeness must also be considered. Sixty-one percent of the original sample of potential participants was included in the final normative sample. The extent to which exclusionary factors (time since injury onset, paraplegic or tetraplegic injury, completion of Rey AVLT) may play a role in the normative outcome is difficult to determine. However, males are more likely than females to incur SCI, and the more common causes result from traumatic insult. Persons excluded from the study were more likely to be female and have "other" etiology, which suggests that our group may more closely parallel the typical male SCI population in general.

Finally, our recognition format allowed for alternative (visual) sensory input rather than a strictly oral presentation format. This may have positively biased the recognition scores for some individuals. In addition, the paragraph format may not be as widely used as a word list format.

Future Directions

Managed health care has propelled rehabilitation psychologists toward use of brief screening evaluations for inpatients in rehabilitation. Establishment of a

standard screening evaluation may be beneficial. The normative information in this article facilitates accurate interpretation of a measure of verbal learning and memory that can be used in a brief cognitive screening evaluation. However, further research on the utility of these norms must be undertaken. Studies using this normative information in comparison with other existing normative information may assist in ascertaining the prevalence and incidence of memory deficits in persons with SCI. Factors such as substance use and abuse and factors associated with the injury (e.g., paraplegia vs. tetraplegia, etiology) that may affect these norms should be considered. Other potential contributors to neuropsychological performance, such as mood states, pain, medication effects, and learning disabilities, deserve further examination in persons with SCI. Finally, understanding the impact of memory on psychosocial adjustment over time may enhance our cognitive and psychological interventions (Elliott & Jackson, 1996).

Standard #10.9 in the *Standards for Educational and Psychological Testing* encourages us to establish and use normative information for similar peer groups so that within-group comparison can be accomplished for more accurate interpretation. Thus, normative studies of similar disability groups (e.g., multiple sclerosis, systemic lupus, cerebral palsy) may also be necessary. Comparative studies of different diagnostic groups may lead to increased understanding of the potential differential impact of developmental disabilities compared with late-onset disabilities. Finally, future studies examining other factors that may affect verbal learning and memory, such as mood states, medication effects, pain, decreased motivation, preoccupation with implications of SCI, and the influence of hospitalization, can assist in defining the expectations for cognitive performance in persons with SCI.

REFERENCES

American Educational Research Association. (1999). *Standards for educational and psychological testing.* Washington, DC: Author.

Bleecker, M. L., Bolla-Wilson, K., Agnew, J., & Meyers, D. A. (1988). Age-related sex differences in verbal memory. *Journal of Clinical Psychology, 44,* 403–411.

Davidoff, G., Morris, J., Roth, E., & Bleiberg, J. (1985). Cognitive dysfunction and mild closed head injury in traumatic spinal cord injury. *Archives of Physical Medicine and Rehabilitation, 66,* 489–491.

Davidoff, G. N., Roth, E. J., & Richards, J. S. (1992). Cognitive deficits in spinal cord injury: Epidemiology and outcome. *Archives of Physical Medicine and Rehabilitation, 73,* 275–284.

Davidoff, G., Roth, E., Thomas, P., Doljanac, R., Dijkers, M., Berent, S., Morris, J., & Yarkony, G. (1990). Depression and neuropsychological test performance in acute spinal cord injury: Lack of correlation. *Archives of Clinical Neuropsychology, 5,* 77–88.

DeVivo, M. J., Jackson, A. B., Dijkers, M. P., & Becker, B. E. (1999). Current research outcomes from the Model Spinal Cord Injury Care Systems. *Archives of Physical Medicine and Rehabilitation, 80,* 1363–1364.

Elliott, T. R., & Jackson, W. T. (1996). Psychologic assessment in spinal cord injury rehabilitation: Benefiting patient, treatment team, and health care delivery system. *Topics in Spinal Cord Injury Rehabilitation, 2*(2), 34–45.

Geffen, G. M., Butterworth, P., & Geffen, L. B. (1994). Test–retest reliability of a new form of the auditory verbal learning test (AVLT). *Archives of Clinical Neuropsychology, 9,* 303–316.

Geffen, G., Moar, K. J., O'Hanlon, A. P., Clark, C. R., & Geffen, L. B. (1990). Performance measures of 16- to 86-year-old males and females on the Auditory Verbal Learning Test. *The Clinical Neuropsychologist, 4,* 45–63.

Jackson, W. T., Johnson, M. O., & Elliott, T. (1995, September). *Verbal learning and memory: SCI norms and implications for rehabilitation.* Presentation at the American Association of Spinal Cord Injury Psychologists and Social Workers Annual Conference, Las Vegas, NV.

James, J. W., & Richards, J. S. (1991, April). *Research update: Concomitant traumatic brain injury and spinal cord injury.* (Available from the Medical Rehabilitation Research and Training Center at the University of Alabama at Birmingham, Spain Rehabilitation Center, 1717 6th Avenue South, Birmingham, AL 35233)

Lezak, M. D. (1976). Memory. In *Neuropsychological assessment* (pp. 352–356). New York: Oxford University Press.

Lezak, M. D. (1995). Memory I: Tests. In *Neuropsychological assessment* (3rd ed., pp. 438–445). New York: Oxford University Press.

Morris, J., Roth, E., & Davidoff, G. (1986). Mild closed head injury and cognitive deficits in spinal-cord-injured patients: Incidence and impact. *Journal of Head Trauma Rehabilitation, 1,* 31–42.

Nobunaga, A. I., Go, B. K., & Karunas, R. B. (1999). Recent demographic and injury trends in people served by the Model Spinal Cord Injury Care Systems. *Archives of Physical Medicine and Rehabilitation, 80,* 1372–1382.

Northam, E., Bowden, S., Anderson, V., & Court, J. (1992). Neuropsychological functioning in adolescents with diabetes. *Journal of Clinical and Experimental Neuropsychology, 14,* 884–900.

Parsons, O. A. (1996). Alcohol abuse and alcoholism. In R. L. Adams, O. A. Parsons, J. L. Culbertson, & S. J. Nixon (Eds.), *Neuropsychology for clinical practice: Etiology, assessment, and treatment of common neurological disorders* (pp. 175–201). Washington, DC: American Psychological Association.

Rey, A. (1964). *L'examen clinique en psychologie* [The clinical examination in psychology]. Paris: Universitaires de France.

Richards, J. S., Brown, L., Hagglund, K., Bua, G., & Reeder, K. (1988). Spinal cord injury and concomitant traumatic brain injury: Results of a longitu-

dinal investigation. *American Journal of Physical Medicine and Rehabilitation, 67,* 211–216.

Rohe, D. E. (1996). Personality and spinal cord injury. *Topics in Spinal Cord Injury Rehabilitation, 2*(2), 1–10.

Roth, E., Davidoff, G., Thomas, P., Doljanac, R., Dijkers, M., Berent, S., Morris, J., & Yarkony, G. (1989). A controlled study of neuropsychological deficits in acute spinal cord injury patients. *Paraplegia, 27,* 480–489.

Savage, R. M., & Gouvier, W. D. (1992). Rey Auditory–Verbal Learning Test: The effects of age and gender, and norms for delayed recall and story recognition trials. *Archives of Clinical Neuropsychology, 7,* 407–414.

Schmidt, M. (1996). *Rey Auditory Verbal Learning Test: A handbook.* Los Angeles: Western Psychological Services.

Spreen, O., & Strauss, E. (1998). *A compendium of neuropsychological tests: Administration, norms, and commentary* (2nd ed., pp. 326–340). New York: Oxford University Press.

Taylor, E. M. (1959). *The appraisal of children with cerebral deficits.* Cambridge, MA: Harvard University Press.

Trieschmann, R. B. (1988). *Spinal cord injuries: Psychological, social, and vocational rehabilitation* (2nd ed.). New York: Demos.

Tun, C. G., Tun, P. A., & Wingfield, A. (1997). Cognitive function following long-term spinal cord injury. *Rehabilitation Psychology, 42,* 163–182.

Vakil, E., & Blachstein, H. (1997). Rey AVLT: Developmental norms for adults and the sensitivity of different memory measures to age. *The Clinical Neuropsychologist, 11,* 356–369.

Wiens, A. N., McMinn, M. R., & Crossen, J. R. (1988). Rey Auditory Verbal Learning Test: Development of norms for healthy young adults. *The Clinical Neuropsychologist, 2,* 67–87.

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