*Journal of the International Neuropsychological Society* (1999), **5**, 534–539.


# The relationship between employment and neuropsychological impairment in HIV infection

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(RECEIVED May 26, 1998; REVISED November 16, 1998; ACCEPTED November 30, 1998)

**Abstract**

The relationship between neurocognitive impairment and employment in a cohort of 130 predominantly symptomatic individuals with HIV–1 infection was examined. Participants were classified as employed (full or part-time for pay) or unemployed ($N = 64$) and administered a neuropsychological test battery. When covarying for CD4 count, age, and physical limitations, the results revealed that unemployed men performed below that of employed participants on tasks of memory, set shifting–cognitive flexibility, and psychomotor speed. The results are discussed within the context of similar findings in other illnesses. (*JINS*, 1999, *5*, 534–539.)

**Keywords:** HIV, AIDS, Work, Neuropsychology, Cognition, Employment

## INTRODUCTION

The ability to remain in the work force within the context of a serious illness represents a critical issue confronted by many persons with HIV/AIDS. Because of the complex symptom constellation often present in persons with HIV infection (including medical debilitation, physical limitations, fatigue, distress, and/or cognitive impairment), the decision to leave the work force and go on disability for most individuals is multidetermined. O'Dell et al. (1996) reported that up to 50% of a sample of 546 persons diagnosed with AIDS who were evaluated between 1989 and 1994 had some degree of activity-specific disability in one or more functional domains. These investigators found a significant relationship between mild to moderate physical disability and number of HIV related medical symptoms, fatigue, and number of opportunistic infections.

The identification of the relationship between severity of medical illness and disability status is not surprising. However, it is less clear to what degree the development of HIV-associated cognitive impairment contributes to changes in work status for those who are medically symptomatic. In the above mentioned study, O'Dell et al. (1996) included an aggregate "cognition index" but did not assess the contribution of specific neuropsychological functions to disability. In fact, the majority of studies which have examined factors related to functional disability in HIV infected individuals did not assess actual cognitive ability or impairment at all (O'Dell et al., 1991; Stanton et al., 1994).

To date, only three studies have examined the relationship between work and neuropsychologic impairment in HIV infection, and most of these studies have focused upon persons with asymptomatic infection. Investigation of the relationship between work and HIV infection in the asymptomatic state is useful since the majority of these individuals also have not stopped working. However, many individuals with symptomatic infection are now considering return to work as their physical health improves on newly instituted combination therapies including protease inhibitor agents. Albert et al. (1995) examined incident work disability over 4.5 years of follow-up and the relationship between onset of disability and neuropsychological status in a predominantly asymptomatic HIV+ sample of gay men. These investigators confirmed that the development of neuropsychological impairment was associated with incident work disability even after adjustment for number of physical symptoms and CD4 cell count, though the authors did not investigate whether there was a particular *pattern* of neuropsychological impairment that might be more related to disability work status. Heaton et al. (1994) reported that HIV+ individuals with mild neuropsychological impairment had a higher unemployment rate than those with no evidence of

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cognitive impairment. Further, these findings remained even when medical symptoms and depression were taken into account. As with the study by Albert et al. (1995), the authors did not formally investigate the relationship between *pattern* of neuropsychological impairment and employment status. Heaton et al. (1996) extended their earlier findings to performance on a standardized work sample test battery. These authors demonstrated that those individuals with neuropsychological abnormalities had evidence of a decline in worker qualifications relative to those with no neuropsychological impairment. As with previous studies, this cohort consisted primarily of men with asymptomatic infection.

The extent to which neuropsychological factors relate to work performance in a predominantly symptomatic cohort has not yet been fully addressed. The current study was intended to augment the previous research with asymptomatic individuals and examine the association between work status and specific aspects of neuropsychological performance, after accounting for the effects of medical status including HIV-associated physical limitations and fatigue, as well as depression.

## METHODS

### Research Participants

One hundred thirty HIV–1 seropositive men participated in this study. All participants were enrolled in a longitudinal natural history study, which was begun in July 1995 to examine a variety of factors associated with psychosocial adjustment to HIV/AIDS. The study procedure is described in more detail elsewhere (Rabkin et al., 1997). While individuals at all stages of HIV infection were included in the sample, special effort was made to recruit those with symptomatic stages of HIV–associated illness.

The 130 participants had a mean age of 41 years ($SD$ = 8), and 42% were nonwhite (20% Hispanic, 16% African American, 4% mixed race, 1% Asian, 1% Native American), and 87% had some post-high-school education. Mean CD4 cell count of the sample was $296 \times 10^6/1$ ($SD = 227$), mean HIV RNA was 3.8 $\log_{10}$ copies/ml ($SD$ 1 $\log_{10}$), and 106 (82%) participants had an AIDS diagnosis. All were self-identified gay or bisexual men.

Participants' employment status at the time of the neuropsychological testing was reviewed, and they were classified as either employed (employed full or part-time for pay) or unemployed. Based upon this classification scheme, 66 participants were in the employed group and 64 were unemployed. Those in the employed group had remained employed throughout the course of their HIV infection.

### Measures

#### *Neuropsychological*

Subjects were administered the following neuropsychological (NP) test battery: the Trail Making Test A and B (Trails A and Trails B; Reitan & Wolfson, 1985); the California Verbal Learning Test (CVLT; Delis et al., 1987); the Grooved Pegboard Test–Dominant (GP–D) and Nondominant (GP–ND) Hands (Lezak, 1995); Digit Symbol subtest of the Wechsler Adult Intelligence Scale–Revised (Wechsler, 1981); the Stroop Color Word Test (Stroop; Golden, 1978); the Auditory Consonant Trigrams Test (ACT, also called Brown-Peterson Technique; Lezak, 1995).

#### *Medical*

*Laboratory.* Assays to determine CD4 lymphocyte count and peripheral HIV RNA viral load were performed. The lower limit of detection of the HIV RNA assay was 400 copies/ml. Patients whose viral load was "undetectable" were conservatively considered to have 399 copies/ml for the purpose of the calculations. Laboratory tests were performed by Corning-Metpath (now Quest) Laboratory, a widely used regional commercial service.

*Fatigue.* The Chalder Fatigue Scale (CFS; Chalder et al., 1993) was administered in order to assess fatigue. The CFS is a self-report measure developed to assess physical and cognitive fatigue in general medical populations. Given the significant correlation of the cognitive fatigue items on the CFS with the cognitive (i.e., nonphysical) symptoms on the Beck Depression Inventory [BDI; $r(145) = .51$, $p < .01$], only the seven items of the CFS that address physical fatigue were used.

*Physical limitations.* The Physical Limitations Questionnaire (Phys–L; Brooks et al., 1979) is a self-report inventory administered to assess perceived limitations in physical function. The total score consists of the sum of 12 items and its range is 12 to 36. These items assess the ability to perform everyday physical activity such as walking up stairs, cleaning house, and participating in sports.

#### *Psychological*

The Beck Depression Inventory (BDI; Beck et al., 1961) was administered in order to provide a self-report measure of depression. To avoid the potential confound of depression-related *versus* HIV-related somatic symptoms, only the first 15 items of the BDI reflecting cognitive (*vs*. physical) symptoms were used. The total score consists of the sum of the 15 items with a range of zero to 45.

### Procedure

Participants were concurrently administered the self-rating scales, NP assessments and blood tests at the 18-month assessment of the longitudinal study. This visit (Visit 4) was the first at which the NP measures were administered. NP measures were administered by pre- and post-doctoral trainees in an NIMH-sponsored HIV training program under the supervision of the primary author (WVG). Written informed consent was obtained under the Institutional Review

https://doi.org/10.1017/S1355617799566071 Published online by Cambridge University Press

Board guidelines of Cornell University Medical College. Participants were paid $40.00 for their participation in this study.

### Definition of Neuropsychologic Impairment

Participants were classified as NP-impaired if they scored 2 or more standard deviations in the impaired direction on two or more nonredundant NP measures relative to the overall mean and standard deviation of the entire cohort (i.e., more impaired than the other participants). In this method, redundant tests (e.g., Trail Making Test A and B or Grooved Pegboard dominant and nondominant hands) were counted as a single measure, such that impaired performance on both Trails A and Trails B only contributed as a single measure toward the outlier definition.

## RESULTS

As can be seen in Table 1, there were no differences between the employed and unemployed groups on education, ethnicity, level of depression (as assessed by the modified BDI or the full BDI), $LOG_{10}$ HIV RNA, though the unemployed participants were slightly older and had lower CD4 counts than the employed participants. As Table 1 also indicates (not surprisingly), unemployed participants reported more medical symptoms commonly but not exclusively associated with HIV, such as night sweats or oral candidiasis ($p < .05$), physical limitations ($p < .001$) and higher levels of fatigue than employed participants ($p < .004$).

### Neuropsychological Impairment and Work Status

We first sought to determine whether participants who were unemployed evidenced a greater frequency of overall neuropsychological impairment than their employed counterparts. To examine this question, chi-square analyses were conducted between the two employment status groups on the percent of participants with NP impairment in each group. Results revealed that there were twice as many unemployed participants who were neuropsychologically impaired (22%) as there were employed participants who were impaired [11%; $\chi^2(1) = 8.53$, $p < .004$].

This analysis, however, did not account for the potential confounding effects of increased immunosuppression, physical limitations, or the slightly older age of the unemployed participants on the prevalence of neuropsychological impairment. Because these factors could be responsible for the higher levels of neuropsychological impairment in the un-

**Table 1.** Tests of between-group differences on demographic, psychological, and medical variables

| | Employed $N = 66$ | | Unemployed $N = 64$ | | | | |
|---|---|---|---|---|---|---|---|
| Variable | *M* | *SD* | *M* | *SD* | *t* | *df* | *p* |
| Age | 39.04 | 6.22 | 43.78 | 8.44 | −3.63 | 115.77* | <.001 |
| BDI | 7.78 | 6.46 | 9.19 | 6.95 | −1.19 | 128 | .24 |
| BDI-Cog | 4.70 | 4.80 | 5.13 | 4.79 | −0.59 | 128 | .56 |
| Fatigue | 22.48 | 6.88 | 25.84 | 6.25 | −2.90 | 126 | .004 |
| Physical Limitations | 13.24 | 1.93 | 15.33 | 3.72 | −3.89 | 94.27* | <.001 |
| Medical Symptoms | 1.41 | 1.42 | 2.02 | 1.88 | −2.08 | 128 | .04 |
| CD4 | 336.11 | 266.89 | 253.73 | 167.66 | 2.11 | 109.89* | .04 |
| Log RNA | 3.73 | 1.04 | 3.85 | 1.07 | −0.65 | 128 | .52 |
| Variable | *N* | % | *N* | % | $\chi^2$ | *df* | *p* |
| Education | | | | | | | |
| ≤8 years | 3 | 2.3 | 3 | 2.3 | | | |
| 9–11 years | 5 | 3.8 | 6 | 4.6 | | | |
| 12 years | 22 | 16.9 | 28 | 21.5 | | | |
| 13–15 years | 23 | 17.7 | 15 | 11.5 | | | |
| ≥16 years | 13 | 10.0 | 12 | 9.2 | 2.51 | 4 | .64 |
| Ethnicity | | | | | | | |
| African American | 10 | 7.7 | 11 | 8.5 | | | |
| White | 42 | 32.3 | 34 | 26.2 | | | |
| Hispanic | 13 | 10.0 | 13 | 10.0 | | | |
| Other | 1 | 0.8 | 6 | 4.6 | 4.43 | 3 | .22 |
| English first language | | | | | | | |
| Yes | 56 | 43.8 | 57 | 44.5 | | | |
| No | 9 | 7.0 | 6 | 4.7 | 0.58 | 1 | .45 |

*Based on Levene's test of unequal variance.

https://doi.org/10.1017/S1355617799566071 Published online by Cambridge University Press

employed group, univariate analyses of covariance were conducted using age, CD4 count, and total score on the physical limitations scale as covariates to determine whether unemployed and employed participants differed on individual NP tests. The results, as shown in Table 2, indicate that, even when controlling for age, CD4 count and physical limitations, the unemployed participants still evidenced significantly lower levels of performance than the employed participants on tasks of learning and memory (CVLT–Total; $p = .02$), response inhibition (Stroop Color–Word; $p = .02$) and cognitive flexibility (Trails B; $p = .02$).

### Predictors of Work Status Membership

In order to determine which variables were most associated with employment status in our cohort, we conducted two logistic regression analyses, each using the demographic and medical variables (Table 1) as well as the neuropsychological variables (Table 2) that were significantly different between the employed and unemployed groups as predictors of work status. The following eight variables were used in the logistic regression analyses: CD4, Fatigue, Age, Physical Limitations, Medical Symptoms, CVLT Total, Stroop Interference, and Trail Making Test B.

The first logistic regression analysis was performed using a forward conditional procedure. This procedure retained only two significant variables, Physical Limitations ($p < .001$) and Trail Making Test B ($p < .004$), after two steps. These two variables rendered a prediction rate of 77% correct ($n = 49$) for the employed group and 55% correct ($n = 35$) for the unemployed group [$\chi^2(1) = 26.02$, $p < .001$]. The overall prediction rate for the entire group was 66% correct.

A second logistic regression analysis was performed using the enter procedure on all eight variables previously listed. This analysis substantially increased the prediction rate for the unemployed group to 70% correct ($n = 45$) but did not alter the prediction rate for the employed group, which remained at 77% correct [$n = 49$, $\chi^2(1) = 38.54$, $p < .001$]. The overall prediction rate for the entire group in this analysis was 73% correct.

## DISCUSSION

This study revealed three primary findings. First, those participants who were unemployed evidenced a greater frequency of NP impairment than their employed counterparts even though both groups consisted of predominantly symptomatic participants with similar levels of viral load and the employed group had lower CD4 counts. This finding confirms that in addition to the well known relationship between physical functioning and disability, HIV+ individuals who are unemployed are likely to have a higher frequency of cognitive impairment than those who remain in, or return to, the workplace full- or part-time. Although many persons with HIV infection stop work due to physical/medical factors, our research indicates that cognitive factors may well play a role in many individuals as well, even beyond the effects of medical illness. This finding is consistent with reports by at least two other research groups (Albert et al., 1995; Heaton et al., 1996).

It could reasonably be argued that the greater frequency of cognitive impairment present in the unemployed group is primarily the result of physical limitations, lower CD4 count, or older age rather than being independent of these factors. Our findings suggest, however, that this is not entirely the case. When these variables were used as covariates in order to control for their effects on the neuropsychological measures, we *still* found worse performance on measures of memory, response inhibition, and cognitive set shifting in the unemployed group. It is also apparent that the differences between the employment groups were not due to level of depression, as the groups did not differ on their score on the full or the modified BDI. It could also be

**Table 2.** Analysis of covariance of neuropsychological measures by work status controlling for age, CD4, and physical limitations

| | Employed $N = 66$ | | Unemployed $N = 64$ | | | |
|---|---|---|---|---|---|---|
| Neuropsychological variable | *M* | *SD* | *M* | *SD* | *F* | *p* |
| Auditory Consonant Trigrams | 45.14 | 7.80 | 41.86 | 9.56 | 1.89 | *ns* |
| CVLT Total, Trials 1–5 | 50.92 | 9.48 | 45.23 | 11.43 | 5.36 | .02 |
| Digit Symbol | 55.85 | 11.52 | 50.98 | 11.42 | 1.99 | *ns* |
| Grooved Pegboard–D | 69.56 | 11.68 | 74.86 | 14.73 | 1.39 | *ns* |
| Grooved Pegboard–N | 73.56 | 14.10 | 81.13 | 19.07 | 1.96 | *ns* |
| Stroop–Color | 68.68 | 11.07 | 65.94 | 12.98 | 0.99 | *ns* |
| Stroop–Word | 96.12 | 15.02 | 92.17 | 17.79 | 1.85 | *ns* |
| Stroop Interference | 39.85 | 8.87 | 34.64 | 9.40 | 5.84 | .02 |
| Trail Making Test A | 29.52 | 10.04 | 34.23 | 11.34 | 2.40 | *ns* |
| Trail Making Test B | 63.64 | 20.19 | 80.59 | 35.11 | 5.64 | .02 |

*Note*. $df = 1, 121$.

https://doi.org/10.1017/S1355617799566071 Published online by Cambridge University Press

argued that our findings are related to the number of univariate *F* tests performed. This is unlikely, however, as it can be seen in Table 2 that only three variables demonstrated significant differences between the groups, and these occurred on variables that are know to be frequently affected in persons with HIV infection.

The *pattern* of neurocognitive impairment in the unemployed group was also notable. After taking medical and demographic variables into account, unemployed participants evidenced lowered performance exclusively on tasks of learning efficiency and executive functioning. While a greater number of variables were required to increase the prediction rate for unemployment beyond chance, it could be reasonably argued that there are many more factors associated with becoming, or remaining, unemployed. Nonetheless, even with this adjustment, a cognitive set shifting task (Trail Making Test B), together with physical limitations, offered the greatest discrimination between the employed and unemployed participants. Although our analyses offered better group prediction rates for those who were employed, the overall classification for the participants was fair at best. Future studies might extend this research by examining the impact of specific NP impairments as they relate to participants' vocations, as these may differ across vocational categories.

These findings are significant in that they suggest that cognitive difficulties, and specifically, lower performance on tasks of learning efficiency and executive functioning (set shifting and response inhibition) are important predictors of who will remain fully employed *versus* who will reduce or discontinue working, even when such factors as physical debilitation, level of immunosuppression, and older age are taken into account. It may well be that impairment on tasks of memory and executive function are more critical to maintaining work in many HIV infected individuals than other, more basic cognitive functions. Individuals who lack the ability to shift cognitive set, adapt to changing or novel demands in the workplace, anticipate and plan problem solving strategies to work issues or learn and recall new information are at greatest risk for reduced hours or unemployment. Although not with HIV, in a comprehensive review of the functional consequences of neurocognitive deficits in schizophrenia, Green (1996) found that verbal memory and vigilance were the two cognitive processes that were essential for adequate functional outcome. He proposed that deficits in these two domains can serve as "neurocognitive rate-limiting factors." It is interesting that these results mesh with the findings in our study with HIV. Hence, it appears that memory, attention, and cognitive flexibility/set shifting may be important factors related to functional outcome in many illnesses that affect overall cognitive processes.

These results must be regarded as preliminary. Although our data were collected prospectively, these results are based upon cross-sectional data. Because we did not follow participants over time, we cannot ascribe causal inferences to our findings. That is, we cannot state with certainty that difficulties with memory, set shifting or response inhibition have contributed to or caused our participants to become unemployed. Nevertheless, these findings, along with those of others (e.g., Heaton et al., 1996), point toward the importance of memory and executive function as key cognitive variables relevant to work in persons with HIV/AIDS. The importance of these cognitive functions to functional capacity, disability, and maintained (or return to) employment should be examined in other disease states as well, relating functional status to neuropsychological performance.

Newly introduced pharmacologic protocols (such as highly active antiretroviral therapy) have been shown to reduce the overall frequency of neurocognitive impairment (Ferrando et al., 1998). This may also help to remove potential cognitive barriers that have been present in individuals' desire to potentially return to work. A prospective, longitudinal investigation will be needed to further define this issue.

## ACKNOWLEDGMENTS

This work was supported by the National Institute of Mental Health, Grant #MH42277-11 (Dr. J.G. Rabkin).

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