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Functional disability in medication management and driving among individuals with HIV: A 1-year follow-up study

April D. Thames¹, Alyssa Arentoft^{1,2}, Monica Rivera-Mindt^{3,4}, and Charles H. Hinkin^{1,2}

¹Department of Psychiatry and Biobehavioral Sciences, UCLA School of Medicine, Los Angeles, CA, USA

²Greater Los Angeles VA Healthcare System, Los Angeles, CA, USA

³Department of Psychology, Fordham University, New York, NY, USA

⁴Department of Neurology and Psychiatry, Mount Sinai School of Medicine, New York, NY, USA

Abstract

Approximately 50% of individuals with HIV report cognitive deficits that can affect social or occupational functioning. The present study used a longitudinal design (1 year) to examine the relationship between cognitive factors and incidental functional deficits in medication management and driving ability among a cohort of 101 HIV+ participants. Participants were classified into groups of functionally “stable” and “disabled” for each laboratory-based functional task (i.e., Medication Management Task–Revised, MMT–R, and PC-based driving simulator). We hypothesized that participants who exhibited a functional deficit in either MMT–R or driving at follow-up assessment would demonstrate significantly poorer baseline cognitive performance at study entry than participants who remained functionally stable. As hypothesized, participants who demonstrated significantly lower baseline performance in learning/memory and executive functioning also demonstrated functional disability on the MMT–R at follow-up when compared to functionally stable participants. Poor baseline performance in speed of information processing was associated with a deficit in driving ability at follow-up assessment. Our results suggest that lower baseline cognitive functioning predicts downstream functional disability, and that deficits in learning/memory and information processing speed are particularly predictive of deficits in medication management and driving ability.

Keywords

HIV; Instrumental activities of daily living; Cognitive function; Medication management; Driving

While approximately 50% of HIV+ individuals will develop cognitive decline, only a subset will develop severe functional impairments (Heaton et al., 2004). Functional capacity is often divided into two categories: “activities of daily living” (ADL), such as personal hygiene, dressing, eating, and general mobility, and “instrumental activities of daily living” (IADL), which require more complex abilities, such as housework, financial transactions, use of the telephone, or the ability to go out alone (Lawton & Brody, 1969). Difficulties with IADLs are estimated in about 50% of HIV+ individuals with neuropsychological (NP) impairment (Heaton et al., 2004), suggesting that impairments in IADLs are an important area of assessment, particularly among individuals with HIV-associated neurocognitive

disorders (HAND; Heaton et al., 2004; Mindt et al., 2003; Thames et al., 2010). Significant functional deficits are used to distinguish between HAND classifications (Antinori et al., 2007) and are required for diagnosing dementia (American Psychiatric Association, 2000). Therefore, early detection of functional deficits, or, better yet, factors that precede functional deficits, are essential for clinical neuropsychological assessment. Early detection may help inform patients and healthcare providers of the specific types of functional impairments that are likely to occur.

Given that the prevalence of HIV-associated dementia (HAD) has decreased since the advent of antiretroviral treatment, clinicians working with HIV-infected individuals often observe mild deficits in daily functioning. In a recent study conducted by the CHARTER group (Heaton et al., 2010), 47% presented with some degree of NP impairment, and, of those, 70% were considered “asymptomatic” (i.e., their self-reports did not suggest their NP impairment was interfering significantly with their everyday functioning), and even fewer (2%) presented with HAD.

Assessment of functional capacity

Common functional assessment methods include self-report and informant reports. However, self- and informant-based reports are limited by their lack of ecological validity (Heaton et al., 2004; Moore, Palmer, Patterson, & Jeste, 2007) and degree of subjectivity (Moore et al., 2007; Thames et al., 2011). Moreover, informant-reports may be impractical to obtain, particularly among the HIV population where as many as 40% of HIV+ adults (Emlet, 2006; Emlet & Farkas, 2001) and up to 70% of older HIV+ adults live alone (Karpiak & Shippy, 2006).

Essential to any attempt to accurately measure disability with behavioral assessments of skills is the separation of assessment domains into what the person *can* do and what they *actually* do (Harvey, Velligan, & Bellack, 2007). Functional capacity may not represent real-world performance, which can be due to characteristics of the individual (e.g., motivation) or the environment (e.g., disability status). Therefore, evaluation of functional capacity should tease apart extraneous characteristics from those that play a more prominent role in capacity (e.g., cognition).

Performance-based measures in the HIV literature provide valuable insights into the varying types of functional impairments in HIV that are not easily detected by standard rating methods. Studies have documented declines in a number of IADLs including medication management (Albert et al., 1999; Heaton et al., 2004; Mindt et al., 2003; Thames et al., 2010), finance management (Benedict, Mezhir, Walsh, & Hewitt, 2000; Heaton et al., 2004; Mindt et al., 2003), driving (Heaton et al., 2004; Marcotte et al., 1999; Marcotte et al., 2004), cooking (Mindt et al., 2003), shopping (Heaton et al., 2004), and work (Heaton et al., 1996; van Gorp et al., 2007). There is also evidence of separate cognitive domain contributions to functional outcomes across a number of HIV investigations (Ettenhofer, Foley, Castellon, & Hinkin, 2010; Heaton et al., 2004; Marcotte et al., 2006; Thames et al., 2010). For instance, Marcotte et al. (2006) found that deficits in visual attention were associated with higher rates of reported driving accidents among HIV+ individuals. A recent study by members of our lab used the Medication Events Monitoring System (MEMS) cap to better understand the direction of the relationship between neurocognition and adherence to HIV medications. Study results revealed that this relationship was bidirectional, with executive functioning and learning/memory predicting medication adherence and medication adherence predicting better processing speed, attention, executive functioning, and motor functioning (Ettenhofer et al., 2010). Other studies have linked scores on self-reported functional deficits with poorer episodic memory (Benedict et al., 2000; Heaton et

al., 1994; van Gorp et al., 2007) and prospective memory performance (Woods et al., 2008). However, performance-based functional measures were not explored in these studies.

In the largest and most comprehensive study to date of functional capacity in HIV (Heaton et al., 2004), most participants reported experience with the types of tasks measured (i.e., checkbook balancing, cooking, medication management). However, NP impairments predicted failures on the functional battery. Using a laboratory-based performance measure of medication management, HIV+ individuals with cognitive impairment performed significantly worse on the medication management task than did nonimpaired individuals (Thames et al., 2010), which is consistent with the notion that cognitive impairment may predispose individuals to functional disability.

Nonetheless, a majority of the extant literature examining relationships between neuropsychological and functional performance is limited by the use of subjective ADL/IADL measures. Even among studies that have used laboratory-based measures to examine HIV-related neuropsychological impairments (Heaton et al., 2004; Mindt et al., 2003; Thames et al., 2010), most have used cross-sectional data, which do not allow for examining changes in functional capacity over time. Identifying which types of cognitive impairment are likely to lead to functional disability is critical for optimizing patient treatment and care.

While there is evidence that neuropsychological and functional deficits co-occur, it is still unclear whether cognitive factors precede and possibly predict later functional impairments. This limits our ability to identify functionally normal individuals at risk for future functional impairment. Therefore, the present study used a longitudinal design (1 year) to examine which baseline neuropsychological factors were associated with deficits in IADLs using validated performance-based functional measures: the Medication Management Task (MMT) and a PC-based driving simulator (Heaton et al., 2004; Marcotte et al., 2004). The MMT involves laboratory tasks that measure the ability to manage medications through questions on when/how to take and refill medications and medication dosage based on pill bottle label instructions. Driving simulators provide an opportunity to safely place individuals into both common and emergency driving situations and to approximate and evaluate real-world driving behaviors. We expected that individuals who demonstrated neurocognitive impairment at baseline would demonstrate functional deficits in either medication management or driving at follow-up compared with individuals who were neurocognitively intact at baseline.

METHOD

Participants

Participants included 101 HIV+ adults who were recruited from community agencies and medical centers within the Los Angeles area. Individuals presenting with a history of psychosis or substance abuse or dependence within the last year were excluded based on results from the Structured Clinical Interview for DSM-IV, Axis I Disorders (SCID; First, Spitzer, Gibbon, & Williams, 1995). Participants were excluded if they presented with history of traumatic brain injury with loss of consciousness greater than 30 minutes or with medical comorbidities apart from HIV that are believed to affect cognitive function—for example, kidney dysfunction, central nervous system (CNS) opportunistic infections, cerebrovascular accident (CVA), seizures, or hepatitis C infection. We excluded participants who presented with a history of drug or alcohol abuse or dependence within the past year, but included participants who reported remote use. At each visit, recent substance use was assessed with urine toxicology analysis. Participants who give any evidence of current intoxication were rescheduled for a different day.

All participants were evaluated at baseline and follow-up (1 year later). (See Table 1 for demographics and characteristics of the entire sample.)

Neuropsychological assessment

All participants underwent neuropsychological assessment. Descriptions of NP tests and domains have been described elsewhere (Thames et al., 2011; Thames et al., 2010). Global neuropsychological functioning was summarized using average *t*-scores.

Functional performance measures

The following functional-based performance measures were used in the current study: Columbia Medication Management Task–Revised (Heaton et al., 2004) and a PC-based driving simulator (STISIM Driving Version 2.0 software; Rosenthal, Parseghian, Allen, & Stein, 1995). The Columbia Medication Management Task–Revised (MMT–R) requires participants to perform tasks and respond to questions about five different medications based on pill bottle labels, the number of pills in each bottle, and directions on package inserts. For the driving simulation task, participants completed the second phase, the Routine and Emergency Driving task, which is designed to simulate city–country driving (Marcotte et al., 1999). During this phase, participants must pass cars, stop at traffic lights, follow curving roads, drive around stalled automobiles, and avoid potential accidents (e.g., a pedestrian stepping onto the road, a car in front slamming on its brakes). Data regarding speed and accidents were collected by the software program and used as outcome variables.

Self-report IADLs

Participants were asked about whether they independently managed their medications and handled their own transportation, which was then rated according to scoring criteria from a modified version of the Lawton and Brody Activities of Daily Living Scale (Heaton et al., 2004; Lawton & Brody, 1969). Percentages of individuals who self-reported that they independently managed their medications and transportation are presented in Table 1.

Medication management and driving performance

Medication management performance was based on the total points (out of a maximum of 17) earned on the medication management task. Driving performance was based on the total number of driving errors (e.g., collisions, pedestrian hits, speeding tickets, illegal turns, off-road accidents) produced during the on-road condition of the driving simulator. Functional impairment groups were created for the medication management and driving tasks separately. Participants who demonstrated incidental functional impairment—that is, normal performance at Time 1, but significant impairment at Time 2—were labeled “impaired.” On the other hand, participants who demonstrated normal performance at baseline and follow-up (i.e., Time 2) were classified as “stable.” Functional disability was defined as both (a) baseline performance within 1 standard deviation (*SD*) of the mean obtained from cognitively normal participants’ baseline performance on medication management and driving, and (b) significantly worse performance at follow-up (i.e., greater than 1 *SD* below the mean performance of follow-up cognitively normal participants). Functional stability was defined as normal baseline and follow-up performance on medication management and driving (i.e., both performances were within 1 *SD* of cognitively normal participants). Of note, 19 of our participants demonstrated poor functional performance at baseline and follow-up on the medication management task, whereas only 3 ($n = 3$) participants demonstrated poor baseline and follow-up performance on the driving simulator. Furthermore, only 1 participant demonstrated significant improvement in medication management performance (i.e., going from impaired at baseline to normal at follow-up), and

none of our participants' demonstrated significant improvement in driving. Therefore, we did not have enough participants to create a group of "improvers."

Participants who were functionally disabled in medication management at both time points (i.e., baseline and follow-up) demonstrated significantly lower performance on baseline, $F(2, 98) = 18.78, p < .0001, \eta^2 = .27$, and follow-up, $F(2, 98) = 18.65, p < .0001, \eta^2 = .27$, global cognition than participants who demonstrated functional impairment at follow-up only and participants who were functionally stable at both time points. These participants also performed significantly worse on measures of attention, learning/memory, executive functioning, language, and processing speed than the other groups (see Table 2). However, given that the main focus of the current study is to examine which factors contribute to functional deficits among participants who initially demonstrated normal functional performance, we decided not to include participants who demonstrated functional impairment at baseline and follow-up in the primary study analyses.

Data analysis

First, functional groups (stable vs. impaired) were compared on demographic and disease-related variables. There were no significant differences in recent CD4, nadir CD4, percentage who met CDC diagnostic criteria for AIDS, and length of HIV infection. There were also no significant differences in the distributions of gender, ethnicity, or self-reported past substance abuse/dependence, among functional groups (all p s $> .05$). However, there was a significant difference in the years of education reported between participants who demonstrated deficits at follow-up ($M = 11.54; SD = 1.67$) and those who remained stable ($M = 13.77; SD = 2.13$) on the medication management task.

Analysis of covariance (ANCOVA) controlling for self-reported years of education was conducted among the MMT groups, whereas analysis of variance (ANOVA) was conducted on the driving group to examine mean differences in baseline and follow-up cognitive performance between both functional groups. We used the false discovery rate (Benjamini & Hochberg, 2000) approach to control for multiple comparisons with alpha set at .05.

RESULTS

There were no significant differences between functionally stable and impaired groups on baseline medication management and driving performance (see Table 2 for means and standard deviations). Ninety-five percent of participants classified as cognitively normal at baseline demonstrated normal driving performance, whereas approximately 85% participants who were cognitively normal at baseline demonstrated normal MMT performance.

Medication management performance

Approximately 16% ($n = 13$) of participants developed functional impairment in medication management from baseline to follow-up. Those who developed functional impairment in medication management performed significantly worse on baseline measures of global neuropsychological performance, $F(2, 81) = 7.906, p = .001, \eta^2 = .09$, than did functionally stable participants ($n = 71$). Further examination into which cognitive domains were driving the relationship between functional deficit and global neuropsychological performance revealed that those who demonstrated deficits at follow-up performed worse on baseline measures of learning/memory, $F(2, 81) = 4.38, p = .01, \eta^2 = .05$, and executive functioning, $F(2, 81) = 7.12, p = .009, \eta^2 = .08$. See Table 2 for group means and standard deviations. No other cognitive domains significantly differed between groups.

Driving performance

Thirty-five participants (33% of sample) with baseline driving performance did not have driving performance data available for follow-up assessment, leaving a sample size of 68 participants for analysis of driving simulator performance. The reasons for not having driving simulator data for participants at Time 2 were as follows: (a) patient arrived late to assessment and could not complete the all modules of the driving simulator task ($n = 12$); (b) patient refused to complete task ($n = 8$); (c) technical difficulties with machine ($n = 2$); (d) patient indicated that they did not drive for an extended period of time ($n = 5$); (e) patient became nauseous during task ($n = 1$); (f) data extraction difficulties ($n = 4$); (g) patient demonstrated difficulties with task, and task was discontinued ($n = 3$). There were no significant group differences on demographic and disease-related variables between those who completed follow-up assessment and those who did not (all $ps > .05$). Functionally impaired participants ($n = 19$) performed significantly worse on baseline measures of processing speed, $F(1, 66) = 4.76$, $p = .03$, $\eta^2 = .07$, than did functionally stable participants ($n = 49$).

Follow-up neuropsychological performance among functional groups

Among the MMT-R performance group, those who developed functional disability on MMT continued to demonstrate significantly worse performance on Time 2 global neuropsychological functioning, $F(2, 81) = 6.69$, $p = .01$, and learning/memory at follow-up, $F(2, 81) = 4.77$, $p = .03$. There were no significant differences in cognitive performance between driving groups at follow-up assessment.

DISCUSSION

The current study examined incidental functional impairment/disability among HIV-infected individuals. To our knowledge, this is the first study to assess functional capacity using laboratory-based functional measures and a longitudinal design among HIV+ individuals. The current study extends prior cross-sectional findings (Heaton et al., 2004; Hinkin et al., 2002) by highlighting the importance of baseline neuropsychological impairment in incident functional impairments in medication management and driving. Interestingly, we observed differential relationships between distinct cognitive domains and functional performance, such that lower baseline information processing speed was associated with follow-up impairments in driving performance, whereas lower baseline learning/memory and executive functioning performance was associated with follow-up impairments in medication management. Although the observed effect sizes were relatively small, this is not unexpected given that we investigated subtle functional changes over one year in participants who were functionally normal at baseline. Furthermore, our effect sizes are generally consistent with most studies examining cognitive performance in mild-to-moderately impaired populations. Our findings are both logically expected as well as consistent with past work on medication management and driving (Heaton et al., 2004; Marcotte et al., 2004; Thames et al., 2010) as well as work with other populations, including community-dwelling older individuals (Bell-McGinty, Podell, Franzen, Baird, & Williams, 2002; Cahn-Weiner, Malloy, Boyle, Marran, & Salloway, 2000; Royall, Palmer, Chiodo, & Polk, 2005), individuals with mild cognitive impairment (Tomaszewski et al., 2008), and Alzheimer's disease patients (Monaci & Morris, 2012; Tomaszewski et al., 2008).

Medication management requires a high degree of mental flexibility and intact episodic and prospective memory, whereas on-road driving requires a greater degree of cognitive speed and efficiency.

The ability to manage a medication regimen is critical for individuals with HIV. It is well-known that suboptimal adherence can lead to dire health consequences as well as a host of clinically significant health-related setbacks (Gifford et al., 2000; Mullen et al., 2002; Paterson et al., 2000).

Impaired cognition has been demonstrated to result in decreased medication adherence (Hinkin et al., 2002), which may partially result from difficulties in medication management. A study by Albert and colleagues (1999) found that patients with significantly lower cognitive performance ($-1\ SD$ below normal) demonstrated greater difficulty in managing medicines.

The ability to identify patients with subtle problems in medication management is critical for early intervention. For example, cognitive retraining/remediation programs could be implemented to specifically target HIV-associated cognitive deficits in executive functioning, information processing speed, and memory. Through cognitive remediation, patients can learn to use compensatory strategies for everyday functional impairments (e.g., use of day timers to remember to take medications). Further, patients who are aware of their cognitive limitations may be more proactive in seeking methods to reduce the risk of such errors.

While studies have demonstrated that performance on MMT correlates with self-reported adherence to HIV medications (e.g., Albert et al., 1999), what remains to be determined is how performance on MMT extends to adherence to more complex regimens. Many HIV+ patients have complex regimens for other medical-related problems (e.g., diabetes, hypertension, hyperlipidemia) that warrant clinical attention as well. According to CDC's National Center for Health Statistics (2010), the use of multiple prescription drugs increased by 20%, and the use of five or more drugs increased by 70%. On the MMT task, the maximum number of medications that participants are asked to manage is five. Therefore, for participants who manage more than five medications—which is rather common among HIV+ adults—the MMT may actually underestimate medication management ability. Therefore, even subtle problems on the MMT for a patient with a complex regimen may signal an even greater likelihood of real-life medication management failures.

Our results also replicate a number of prior investigations that have relied upon self-reported driving histories, driving simulators, and on-the-road driving evaluations (Marcotte et al., 1999; Rebok, Bylsma, Keyl, Brandt, & Folstein, 1995; Rizzo, Reinach, McGehee, & Dawson, 1997). Poor driving simulator performance has been shown to predict real-world driving difficulties in HIV (Marcotte et al., 2004), supporting the utility of laboratory-based measurements in detecting everyday functional capacity.

Although our participants who demonstrated follow-up functional impairments performed significantly lower on baseline cognitive measures than did participants who were functionally stable, functionally impaired participants' cognitive performance still placed them in the mild-to-moderately impaired range suggesting that even mild deficits at baseline serve as a predictor of downstream functional disability.

Functionally stable and impaired groups demonstrated similar cognitive performance at follow-up, suggesting that for some domains (e.g., motor functioning and spatial functioning), the functionally impaired group may have benefitted slightly from practice effects, whereas in other domains (e.g., executive functioning and processing speed), the functionally stable group declined from baseline performance. This suggests that certain cognitive domains may be susceptible to practice effects, and that our functionally stable participants who demonstrated cognitive deficits may eventually develop functional impairment downstream. A follow-up assessment (i.e., Time 3 follow-up) to those

functionally stable participants who demonstrated cognitive deficits at Time 2 would add further understanding to the current study findings.

Although laboratory-based measures of functional capacity are more ecologically valid than self- or informant-based report, laboratory-based functional capacity measures still do not fully capture actual functional abilities. Future investigations comparing performance on functional measures to real-world performance (e.g., comparing simulated driving performance to on-road driving, such as was done by Marcotte et al., 2004) would help to clarify the accuracy of performance-based functional measures. Although the role of aging was not assessed in the current study, the ability to detect functional disability is important considering the growing population of older HIV+ individuals. Future studies should incorporate longitudinal assessments to examine the impact of aging and HIV-associated cognitive impairments on the ability to function independently.

Despite these limitations, the primary study results have scientific and clinical implications for working with individuals infected with HIV. The ability to function independently is an important consideration when determining a diagnosis of HIV-associated neurocognitive disorder (HAND; Antinori et al., 2007). As outlined in the HAND nosology, in order to diagnose HIV-associated mild neurocognitive disorder, cognitive impairment must produce mild interference with daily functioning. This may be assessed by the use of performance-based functional measures such as those in the current study, as well as by patient self-report or observation by others. Our findings highlight the various cognitive factors that may precede downstream functional impairments. This underscores the importance of early detection of cognitive inefficiencies that may lead to problems with performing important but routine tasks such as driving and medication management. Historically, variability in disease course has made it difficult to predict which HIV+ individuals will eventually develop functional impairments (Antinori et al., 2007). Our results show that poor baseline cognition in specific domains preceded subtle impairments in driving and medication management. This suggests not only that (even prior to a diagnosis of asymptomatic neurocognitive impairment, ANI) individuals with subtle cognitive deficits (i.e., diagnosis of asymptomatic neurocognitive disorder) may be at greater risk for progression to functional impairment, but also that at-risk individuals may be identified prior to severe decline. Therefore, close monitoring at the early stages of cognitive change may ultimately result in earlier detection of mild neurocognitive disorder (MND) and HAND. This is clinically relevant as it may provide opportunities for intervention or planning for patient safety in the event of future decline and may also help identify individuals who require follow-up assessment. Many researchers have discussed the importance of identifying individuals prior to functional decline in order to prevent disability (Gill, Williams, Richardson, & Tinetti, 1996; Rozzini, Frisoni, Bianchetti, Zanetti, & Trabucchi, 1993). Eventually, by improving our ability to identify individuals prior to decline, we may be able to develop targeted interventions to reduce the rates of individuals who progress to MND or even HAND.

Overall, this research contributes to the growing literature examining neuropsychological and functional deficits and may help improve patient care and safety through early detection. Our results may have important implications for other neurodegenerative populations where cognitive and functional disabilities occur. This is especially important as the U.S. population becomes increasingly older: The percentage of individuals aged 65 years and older will double in the next 20 years (U.S. Census Bureau News, 2008, 2010). Our findings suggest that by monitoring cognitive functioning, functional deficits can be detected prior to clinically significant impairment, which has several important clinical implications. First, it implies that routine neuropsychological assessment may be beneficial for individuals suspected to be at risk for functional decline, particularly individuals at risk for dementing disorders such as HAND, Alzheimer's disease, and Parkinson's dementia. However,

trajectories, as well as affected cognitive domains and functional abilities, may differ across diseases; therefore, continued research with other neurological populations is needed. Second, this would allow for early identification, monitoring, and planning for such patients, which may help improve quality of life and patient safety. And finally, it may also allow for intervention. Our findings pave the way for research that designs and evaluates interventions aimed at preventing or reducing continued functional decline. Such intervention would be beneficial not only to patients and caregivers, but also to society as a whole.

Severe functional disabilities in instrumental activities of daily living inhibit one's ability to live independently. Caring for patients who are unable to perform IADLs or care for themselves puts significant financial burdens on families as well the healthcare system. Research has shown that even minor deficits in functional ability correspond to steep increases in care costs (Zhu et al., 2006). Currently, it is estimated that the total direct and indirect costs of health and long-term care for individuals with dementia is over \$300 billion annually, and this number is projected to increase exponentially over the next decades (Wimo & Prince, 2010). There are also significant psychological ramifications for caregivers, including increased stress and depression (Mystakidou, Tsilika, Parpa, Galanos, & Vlahos, 2007; Son et al., 2007). Therefore, continued research in this area may help reduce the significant social and financial burdens of functional disability.

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TABLE 1
Demographic and clinical characteristics of functionally stable versus impaired groups

Variable	Driving (n = 68)		MMT (n = 84)		p < .05
	Impaired t2 (n = 19) (a)	Stable (n = 49) (b)	Impaired t2 (n = 13) (c)	Stable (n = 71) (d)	
Age (years)	49.0 (10.4)	50.1 (10.4)	47.6 (9.1)	49.6 (10.4)	ns
Education (years)	13.1 (2.3)	13.8 (2.2)	11.5 (1.7)	13.8 (2.1)	c < d
Male (%)	79	86	70	82	ns
Ethnicity					
Caucasian (%)	16	43	18	37	ns
African American (%)	63	41	53	46	ns
Hispanic (%)	11	14	23	14	ns
Asian American (%)	6	1	8	1	ns
Native (%)	0	0	0	1	ns
Other (%)	6	0	1	2	ns
Recent CD4 count ^a	360 (188)	468 (423)	400 (350)	450 (398.5)	ns
Nadir CD4 count ^a	59 (132)	126.5 (235.7)	200 (322)	130 (230)	ns
Undetectable viral load (%)	68	72	79	81	ns
Meets AIDS criteria ^b (%)	73	67	53	67	ns
Number of years infected	12	15	13	11	ns
BDI-II	7.2 (7.0)	9.6 (9.0)	12.3 (10.2)	8.3 (9.1)	ns
Past substance abuse/dependence					
Alcohol (%)	24.0	20.0	15.4	15.0	ns
Marijuana (%)	12.0	16.0	8.5	8.4	ns
Opiates (%)	6.7	6.3	4.5	5.1	ns
Stimulants (%)	6.7	6.3	23.1	19.7	ns
Independently manage medications					
Baseline (%) ^c	79	85	75	86	ns
Follow-up (%) ^c	78	84	79	83	ns
Drive independently					
Baseline (%) ^c	90	83	92	86	ns

Variable	Driving (n = 68)		MMT (n = 84)		p < .05
	Impaired t2 (n = 19) (a)	Stable (n = 49) (b)	Impaired t2 (n = 13) (c)	Stable (n = 71) (d)	
Follow-up (%) ^c	89	80	85	85	ns

Note. t2 = Time 2 (follow-up assessment). MMT = Medication Management Task. BDI-II = Beck Depression Inventory-II.

^aMedian value and interquartile range.

^bBased upon opportunistic infection or CD4 < 200.

^cBased upon self-report.

TABLE 2
Performance on baseline and follow-up (1-year) neuropsychological and functional measures among functional groups

Variable	Driving (n = 71)			MMT (n = 101)			*p < .05
	Stable (n = 49) (a)	Impaired (t2) (n = 19) (b)	Impaired (t1 & t2) (n = 3) (c)	Stable (n = 71) (d)	Impaired (t2) (n = 13) (e)	Impaired (t1 & t2) (n = 17) (f)	
MMT-R							
Baseline	14.5 (3.0)	13.6 (3.6)	13.0 (2.6)	15.0 (2.1)	15.6 (1.1)	7.5 (1.6)	d, e > f
Follow-up	14.9 (2.4)	14.9 (2.2)	15.6 (1.5)	15.8 (1.3)	11.7 (1.3)	10.2 (1.2)	d > e,f
Driving errors							
Baseline	6.1 (2.0)	5.9 (3.2)	13.3 (3.2)	6.8 (2.8)	5.7 (1.9)	7.5 (4.9)	c > a,b
Follow-up	4.9 (1.8)	10.8 (3.2)	12.3 (4.3)	6.5 (3.0)	5.8 (2.7)	7.0 (3.0)	b, c > a
Global NP							
Baseline	43.6 (6.8)	40.5 (6.2)	32.3 (8.1)	43.9 (5.8)	39.0 (5.2)	33.4 (10.1)	d > e, f, e > f
Follow-up	45.3 (11.1)	41.0 (10.8)	40.0 (10.0)	41.6 (5.3)	37.6 (3.6)	33.8 (4.9)	d > e, f, e > f
Attention							
Baseline	35.3 (13.4)	30.9 (9.1)	28.9 (10.6)	34.1 (13.2)	28.9 (11.2)	25.0 (14.6)	a > c, d > f
Follow-up	34.2 (12.3)	29.2 (9.0)	26.5 (11.2)	33.1 (14.3)	30.2 (12.4)	26.5 (13.2)	a > c, d > f
Processing speed							
Baseline	43.8 (11.1)	37.7 (8.3)	35.9 (10.3)	43.5 (9.3)	38.8 (7.4)	38.5 (18.3)	a > b,c
Follow-up	38.7 (7.8)	38.6 (7.8)	31.7 (6.2)	39.1 (6.6)	36.2 (6.8)	34.7 (5.4)	d > f
Learn/mem							
Baseline	43.6 (10.1)	37.3 (17.4)	30.8 (11.1)	44.0 (10.1)	35.8 (9.7)	28.5 (8.9)	d > e, d > f
Follow-up	42.4 (10.3)	38.6 (11.2)	37.3 (14.0)	43.3 (10.0)	37.0 (5.9)	32.3 (10.3)	d > f
Executive							
Baseline	48.1 (6.6)	43.9 (5.7)	34.2 (6.2)	48.8 (6.6)	43.6 (5.4)	37.8 (9.3)	a > c, d > e, f, f
Follow-up	49.4 (6.4)	46.0 (7.6)	45.1 (3.5)	48.9 (7.4)	46.6 (5.8)	41.2 (6.9)	d > e, d > e, f
Motor							
Baseline	45.3 (8.1)	45.3 (8.7)	45.6 (13.5)	45.4 (8.1)	45.6 (8.6)	38.6 (9.7)	d > f
Follow-up	45.3 (11.2)	47.0 (10.8)	40.0 (19.0)	45.3 (10.8)	45.1 (9.5)	41.6 (8.9)	d > f
Spatial							
Baseline	49.8 (9.6)	48.6 (10.9)	47.3 (8.0)	51.1 (10.7)	47.7 (10.4)	41.2 (8.9)	d > f
Follow-up	49.9 (9.6)	49.2 (10.5)	47.3 (8.0)	51.0 (10.0)	48.5 (9.9)	41.2 (8.7)	d > f

Note. Means, Standard deviations in parentheses. Neuropsychological scores are reported as *t*-scores. NP = neuropsychological. Learn/mem = learning/memory. MMT-R = Medication Management Task-Revised. Stable = normal functional performance at both baseline and follow-up. Impaired (I2) = normal functional performance at baseline, impaired performance at follow-up. Impaired (I1 & I2) = impaired performance at both baseline and follow-up. Post-hoc comparisons conducted separately for MMT and Driving functional groups.