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The Role of Employment on Neurocognitive Reserve in Adults with HIV

David E. Vance, PhD, MGS [Associate Professor],

The University of Alabama School of Nursing, Room 2M026, 1701 University Boulevard,
University of Alabama at Birmingham (UAB), Birmingham, AL 35294-1210, Office: 205-934-7589,
Fax: 205-996-7183, devance@uab.edu

Shameka C. Humphrey, MSN, ANP, GNP-C,

University of Alabama at Birmingham School of Nursing, Room 1020P, 1701 University
Boulevard, University of Alabama at Birmingham (UAB), Birmingham, AL 35294-1210, Office:
205-996-9457, Fax: 205-975-6194, slcody@uab.edu

Moka Yoo-Jeong, BSN, RN [Doctoral Student],

1520 Clifton Rd NE, Nell Hodgson Woodruff School of Nursing, Emory University, Atlanta, GA,
30322, meyoo@emory.edu

Gwendolyn "Lynn" D. Jones, PhD, MED [Assistant Professor], and

Department of Psychology and Sociology, JKH Rm. 44 - 300, Tuskegee University, Tuskegee,
AL, 36083, Office: 334-727-8830, Fax: 334-724-4196, jonesg@mytu.tuskegee.edu

William C. Nicholson, MSN, PMHNP-BC

University of Alabama at Birmingham-School of Nursing, Room 343, 1701 University Boulevard,
University of Alabama at Birmingham (UAB), Birmingham, AL 35249-1210, Office: 205-996-9821,
chancen@uab.edu

Abstract

The benefits of employment are enormous; being employed, one naturally: 1) socially engages with the public and colleagues/co-workers; 2) learns new skills to increase job productivity and competence; 3) establishes a routine that can prevent lethargy and boredom and may regulate sleep and healthy behaviors; 4) is provided purposeful and meaningful activity that may protect one from depression; and 5) gains income to pursue interests which are cognitively stimulating. All of these and other employment influences can provide an enriched personal and social environment that stimulates positive neuroplasticity and promotes neurocognitive reserve. Such potential neurocognitive benefits are particularly relevant to adults with HIV for two reasons: 1) approximately 50% of adults with HIV experience observable cognitive impairments that can adversely affect everyday functioning such as medication adherence, and 2) approximately 45% of adults with HIV are unemployed and do not receive the neurocognitive benefits of employment. From these considerations, implications for healthcare research and nursing practice are provided.

Keywords

Employment; Access to Care; Cognitive Reserve; HIV; Poverty

As HIV has become manageable due to the effectiveness of the combination antiretroviral therapies (cART) that inhibit the replication of the virus, those living with HIV are now able to survive up to an older age and have better health and prognosis (Vance, McGuiness, Musgrove, Orel, & Fazeli, 2011). Yet, many complexities such as medication toxicity, multi-morbidities, and cognitive impairment persist (Vance, 2010). HIV-Associated Neurocognitive Disorders (HAND) remain quite prevalent, ranging from 52% to 59% of the adult population (Bonnet et al., 2013; Heaton et al., 2010). The severity of HAND varies from Asymptomatic Neurocognitive Disorder (33%), Mild Neurocognitive Disorder (12%), Confounded Neurocognitive Disorder (5%), and AIDS-related Dementia (2%) (Heaton et al.). Many factors contribute to such cognitive deficits including poor educational background, the presence of metabolic and psychiatric co-morbidities, substance use and abuse, and APOE-4 genotype, to name a few (Malaspina et al., 2011). Albeit, one factor that has been rarely investigated is employment, which can be referred to as occupation.

Many adults with HIV may have stopped working due to illness or have had limited employment for a variety of reasons such as psychiatric problems, poor health, stigma, and limited education; in a sample of 925 adults with HIV, Ezzy and colleagues (1999) found that 71% left work for psychosocial reasons and half left for declining health. According to one study, only 20% of gay men with HIV were continuously employed full-time over a 30-month period, while 40% were continuously unemployed during this period (Rabkin et al., 2004). This is unfortunate because engagement in employment provides cognitive stimulation which may facilitate enhanced cognitive functioning in adults, especially for adults with HIV (Fazeli et al., 2014). As seen in Figure 1, five mechanisms are proposed in which active employment exerts a positive influence on brain health and neurocognition. These included social engagement, learning new skills, established routine, purpose/meaning, and increased income. All of these mechanisms, separately or in tandem, can directly and indirectly influence brain health, thus helping those with HAND protect, maintain, or even improve their neurocognition. But with limited employment, individuals may lack intellectual and social engagement and may replace those with cognitively poor activities such as having: 1) unfocused time to ruminate; 2) a lack of purpose or meaning in one's life; 3) a lack of structure to fill one's time; and 4) limited income to explore intellectually stimulating activities such as vacations. All of these may lead to depression and anxiety, which studies have shown are also detrimental to cognitive health and produce cognitive impairments (Vance, Larsen, Eagerton, & Wright, 2011).

The purpose of this article is to provide an overview of the impact in which cognitive reserve is influenced by employment. From this overview, the social and behavioral context of HIV is examined as it relates to decreased employment and its consequence on neurocognitive reserve and functioning. Practical implications such as seeking alternative engagement including part-time work or volunteer work are considered. Research implications are presented as well.

Neurocognitive Reserve

Neurocognitive reserve, also known as brain reserve, refers to how well the brain can absorb physiological insults from injury, disease, disuse, and/or aging and yet maintain its normal function. Generally, greater neurocognitive reserve is linked to stronger, more sophisticated, and denser connections between neurons. As physiological insults accumulate, damaged neuronal pathways become less efficient in processing information, which hinder neurocognitive functioning. Yet, if there is robust neurocognitive reserve, adjacent neuronal pathways that are unaffected may be utilized, allowing neurocognitive function to continue despite such neurological damage. This process of neurocognitive reserve parallels the process of organ reserve. For example, as observed with the heart, when some arteries are occluded due to plaque and calcium build up, collateral arteries that by-pass the blockage are utilized, allowing the blood to flow and maintaining heart function (Berry et al., 2007).

Just as the heart is strengthened by physical exercise, the brain is also strengthened by mental exercise and stimulation. When animals are exposed to novel and challenging stimuli, adaptation to such the stimuli produces neurobiological changes that strengthen and increase connections between neurons, a process referred to as positive neuroplasticity. Likewise, animals lacking exposure to novel and challenging exercises experience neurobiological changes that conserve physiological resources, which weaken and decrease connections between neurons, a process referred to as negative neuroplasticity (Vance, Roberson, McGuiness, & Fazeli, 2010). This process is observed in the enriched environmental paradigm.

Animals observed in the enriched environmental paradigm studies display these positive and negative neuroplastic processes. Typically, to control for genetic influences on brain health, rats from the same colony are randomly assigned to live in one of three cages: 1) an enriched cage, 2) a standard cage, or 3) an impoverished cage. An enriched cage has several rats in it along with a variety of toys for the rats to interact and explore; these toys are also replaced periodically with new toys to explore. A standard cage simply has three rats in it; no toys are available. An impoverished cage has only one rat in it with no other rats or toys to engage. Researchers have found that over time, rats in the enriched cage have larger brains, more synapto-dendritic connections between their neurons, more brain-derived neurotropic factors, and perform better on maze tests compared to those rats in the standard cages; likewise, parallel findings are observed for the rats in the standard cage compared to those in the impoverished cage. Thus, rats in the enriched cages reflect positive neuroplasticity and rats in the impoverished cages reflect negative neuroplasticity (Kobayashi, Ohashi, & Ando, 2002; Vance, Roberson et al., 2010).

Positive and negative neuroplasticity is also observed in humans. For instance, in the London Taxi Driver Study, Maguire and colleagues (2006) used magnetic resonance images (MRIs) to observe and compare structural brain changes between taxi drivers and bus drivers. In London, licensed taxi drivers are required to attend 2 to 4 years of intense training to develop a working knowledge of London's 25,000 streets and recall various points of interest. Taxi drivers have no set route and this reflects an enriched environmental condition that results in positive neuroplasticity. On the other hand, bus drivers receive a

less rigorous training protocol required for their profession and drive a predictable route; this reflects the standard environmental condition. Using MRIs, these researchers observed that the mid-posterior hippocampi of the taxi drivers were significantly larger compared to the bus drivers; in fact, years of driving was significantly related to the size of the hippocampi. This study shows that stimuli and environmental challenges may cause neurobiological changes which influence neurocognitive reserve. Other studies in humans also suggest that neurocognitive stimuli may increase neurocognitive reserve and protect one from developing neurocognitive impairments (Giogkaraki et al., 2013; Wilson et al., 2013).

In a longitudinal study of 294 older adults, Wilson and colleagues (2013) investigated if neurocognitive reserve, as measured by early-life and late-life neurocognitive activity, such as reading books or playing a musical instrument, was predictive of neurocognitive deficits after accounting for neuropathological burden including neocortical Lewy bodies, tau positive tangle density, and amyloid burden. These participants underwent annual neurocognitive testing on average for 5.8 years until they died; after this, neuropathological burden was determined at autopsy. These researchers observed that after accounting for age at death, neuropathologic burden, and other covariates, engagement in more early-life and late-life neurocognitive activity predicted 14% of neurocognitive impairments over time. This and other studies also support the role that neurocognitive activity and stimuli play in preventing or abating the development of such neurocognitive deficits in lieu of such neuropathological burden (Vance, Roberson et al., 2010). Giogkaraki and colleagues (2013) found that with age, the greater amount of neurocognitive reserve was predictive of greater preservation of episodic memory and executive function. In their study, a combination of measures of reading ability, vocabulary, and years of education served as the proxy measure for neurocognitive ability. Reading, vocabulary, and education can be an integral part of one's employment. As such, it is logical to postulate that engagement in employment will likewise increase neurocognitive reserve, which could help preserve neurocognitive functioning over the lifespan.

Employment and Neurocognitive Reserve

The underlying premise of this article is that employment has particular characteristics which promote positive neuroplasticity, prevent negative neuroplasticity, and facilitate the quality and quantity of neurocognitive reserve. Support for this premise comes from the Health and Retirement Study which followed a nationally representative sample of people over time as they transitioned to retirement. Using data from 4,182 (50% women) participants in this study across 1992-2010, Fisher and colleagues (2014) examined neurocognitive functioning before and after retirement to determine whether lower or higher levels of mental work demands of their employment was protective against neurocognitive impairments, particularly episodic memory as measured by an immediate and delayed word recall test. The participants' occupation description was linked to the O*NET SOC occupation codes provided by the U.S. Department of Labor/Employment and Training Administration (www.onetonline.org) which has hierarchical taxonomic occupation-specific descriptors; this provided these researchers the ability to rate the neurocognitive demands of such employment. Compared to those with lower levels of employment-related neurocognitive demands, Fisher and colleagues found that those with higher levels of

neurocognitive demands experienced: 1) higher neurocognitive functioning before retirement, and 2) slower neurocognitive decline following retirement. These results remained even after controlling for age, gender, education, and depressive symptomatology.

In a similar longitudinal study of 903 adults, the Leipzig Longitudinal Study of the Aged, Then and colleagues (2013) also used the O*NET SOC occupation codes to operationalize the enriched work environment of the longest held occupation that their participants engaged. From this, four quantifiable indices of an enriched work environment emerged: 1) Novelty – exposure of new stimuli; 2) Fluid – engagement of tasks requiring fluid intelligence; 3) Verbal – engagement of tasks requiring crystallized intelligence; and 4) Executive – engagement in tasks requiring independent planning and execution of such tasks. These researchers found those participants who had higher levels of executive stimuli associated with their job experienced a lower risk of incident dementia ($OR = 0.61$; $p < 0.001$); as in the previous study, these results remained after controlling for additional covariates including age, level of education, gender, marital status, history of depression, and living situation. This study likewise suggests that certain types of employment-related environmental exposure may facilitate increased positive neuroplasticity and neurocognitive reserve that may protect one from dementia.

Furthermore, Leist and colleagues (2013) examined the employment gaps of six months or greater of 18,259 respondents of the Survey of Health, Ageing, and Retirement in Europe Study. After controlling for education, school performance, and early life socioeconomic status, employment gaps from sickness and unemployment were associated a higher risk of neurocognitive impairment compared to those without such gaps. Interestingly, those who experienced employment gaps due to maternity leave and training, which represents novel challenge (i.e., positive neuroplasticity), experienced better late-life neurocognitive functioning. These finding are germane, especially considering the spotty employment histories of many living with HIV (Rabkin et al., 2004). As seen in Figure 1, there may be several ways to conceptualize how employment facilitates positive neuroplasticity, neurocognitive reserve, and neurocognition which include: social engagement, learning new skills, established routine, purpose/meaning, and income. Each of these mechanisms of employment can have direct and/or indirect effects in how one neurocognitively is stimulated.

Social Engagement

Individuals with HIV are at an increased risk for neurocognitive declines related to social isolation and loneliness; social isolation in this population is related to increasing age, stigma, depression, and financial constraints (Slater et al., 2013; Vance, Larsen et al., 2011). According to Ellwardt, Aartsen, Deeg, and Steverink (2013), individuals who are isolated or lonely experience a more rapid neurocognitive decline in comparison to individuals who are socially engaged. In contrast, epidemiologic studies support the premise that social networks and activities that promote social engagement are correlated to a reduced risk of late-age neurocognitive decline and dementia (Agrigoroaei & Lachman, 2011; Pitkala, Routasalo, Kautiainen, Sintonen, & Tilvis, 2011).

Researchers assert that social engagement promotes positive psychological adjustment in adults with HIV (Asante, 2012; Mavandadi, Zanjani, Ten, & Oslin, 2009; Vance, 2013). Positive psychological adjustment reduces the intensity of depression, stress, and anxiety often experienced by these individuals; the reduction in these indices contributes directly to neurocognitive health. The extensiveness of social engagement provides protective effects due to the complexity of coordinating and switching between variable social roles, dynamics, and settings (Ellwardt et al., 2014). Social engagement requires unique neurocognitive operations to negotiate each encounter such as attending to emotional stimuli, interpreting body language, language processing, flexibility needed to manage multiple conversations, recalling details from previous conversations, and anticipating others' reactions, just to name a few. In fact, due to the complexity involved in each social interaction, studies indicate that individuals with larger social networks actually show improved performance in episodic memory, working memory, and perceptual speed (Dickinson, Potter, Hybels, McQuoid, & Steffens, 2011; Jedrzewski, Ewbank, Haidong, & Trojanowski, 2014). Frias and Dixon (2013) suggest social engagement functions as a moderator of neurocognitive status in executive function which supports previous studies related to the social engagement hypothesis that purports positive effects of socialization in higher ordered neurocognition. In support of existing research, Saczynski and colleagues (2012) found persons less socially engaged in their midlife had the highest risk of neurocognitive decline. Likewise, Vance (2013) suggested that social engagements could provide enriched environmental opportunities that increase neuroplasticity and contribute to neurocognitive reserve.

Learning New Skills

Active engagement in learning new skills may improve neurocognition. In a sample of 221 older adults, Park and colleagues (2014) investigated the impact of sustained engagement on neurocognition. These participants were randomly assigned to two conditions categorized by the level of engagement: 1) productive engagement condition which required participants to *learn* a new skill (i.e., digital photography, quilting) and, 2) receptive engagement (i.e., required participants to *participate in* facilitator-led social interactions, field trips, and entertainment, or in more familiar activities at home such as listening to classical music and completing word puzzles). In both conditions, participants engaged in a particular activity for 15 hours a week over three months. These researchers found that the adults in the productive engagement condition showed improvements in memory compared to those in the receptive engagement condition. These findings suggest that actively learning mentally challenging and novel skills provide neurocognitive benefits, while passively participating in less demanding activities may not be as efficient to improve neurocognition.

Likewise, in 41 older (60 – 84 years) participants who were naïve to reading music or playing a musical instrument, Seinfeld, Figueroa, Ortiz-Gil, and Sanchez-Vives (2013) assessed their neurocognitive and psychological well-being at baseline and then assigned them to either a control group or piano training group. Participants in the control group participated in leisure activities such as exercise, dance, and yoga whereas those in the piano training group received a weekly lesson complemented by 45 minutes of individual practice every day. After four months of engagement, researchers found significant improvement in a

neurocognitive measure of executive functioning and a decrease in depressive symptomatology for those in the piano training group. Similarly, employment may provide adults with HIV a window of opportunities to learn new skills that may be mentally challenging.

Established Routine

Having a stable routine from employment can facilitate healthy behaviors which may also promote positive neuroplasticity and neurocognitive reserve. A meta-analysis of 104 studies that examined the impact of unemployment on psychological and physical well-being showed a positive association between unemployed individuals' level of time structure and mental health (McKee-Ryan, Song, Wanberg, & Kinicki, 2005). Those who were able to impose daily routines on their lives, remain active, and use their time in a structured way experienced better mental health outcomes. Similarly, Warr's (1987) vitamin model and Jahoda's (1981) deprivation theory of employment proposed that there is a positive relationship between time structure and well-being such that daily routines, similar to the routines held at work, provide positive consequences. Warr's vitamin model postulates that characteristics of work environment influence mental health such that the absence of employment or overburden from employment impairs one's mental well-being. Jahoda's latent deprivation model focuses on manifest and latent functions of employment such that income (manifest function) primarily drives individuals to engage in work yet there are a number of latent benefits (latent functions) that improves mental well-being as a result of being employed. Particularly, among the five most important latent functions (i.e., regular social contact, collective effort or purpose, social identity or status, regular activity, imposition of a time structure), time structure, regular activity, and collective purpose have been linked to predicting mental health (McKee-Ryan et al.). These theoretical frameworks suggest that positive health outcomes among unemployed individuals are possible when their lives are similar to a normal employment experience with a scheduled routine full of productive activities. Such mental and physical well-being can result from a structured routine established by employment, which in turn may support brain health and neurocognitive reserve.

Findings also reveal that a stable and structured routine may improve sleep quality. In a cross-sectional study of 96 elderly adults ($M_{age} = 75$ years) living in a retirement community, Zisberg, Gur-Yaish, and Shochat (2010) found a strong association between daily routine and subjective sleep quality. Because sleep influences mood and neurocognitive symptoms, it is expected that neurocognition may benefit from improved sleep quality (Vance, Heaton, Eaves, & Fazeli, 2011). This point is particularly relevant given that many adults with HIV also experience poor sleep quality or poor sleep hygiene (Vance & Burrage, 2005).

An employment routine also provides a means of filling up one's time and distracting one from negative thoughts; likewise, the concerns from one's employment may be pivotal in keeping other personal concerns (e.g., argument with a spouse, financial uncertainty, medical worries) in perspective. Unfortunately, individuals lacking such routine and having excessive unfocused time also have the opportunity to ruminate on negative aspects of their

disease or life circumstances and become depressed. Such depression and anxiety, especially if severe or prolonged, activates the hypothalamus-pituitary-adrenal axis resulting in cortisol release that over time can cause neuroinflammation and reduce neurocognitive reserve (Miller, Chen, & Zhou, 2007; Satori, Vance, Slater, & Crowe, 2012). Similarly, damage and reduction in functional connectivity of the prefrontal-striato-thalamo circuitry is commonly observed in brain scans of those with HIV (Langford, Everall, & Malish, 2005); as a result, executive dysfunction, including decreased reasoning and problem solving, may exacerbate such negative rumination which can further contribute to depression and suicidal ideation (Vance, Moneyham, Fordham, & Struzick, 2008). In fact, McManus and colleagues (2014) observed that unemployment was significantly related ($OR = 5.86$) to suicide and violent/accidental death in men with HIV. Such depression, anxiety, and other mood disorders are associated with poorer neurocognitive functioning and are already quite prevalent in adults with HIV (Vance, Larsen et al., 2011); in fact, across all decades, the prevalence of anxiety and depression in young and old adults with HIV is approximately 20% and 50%, respectively (Vance, Mugavero et al., 2011). Fortunately, in a 2-year longitudinal study of 118 adults with HIV seeking employment, van Gorp and colleagues (2007) observed that those who found some form of employment experienced an increase in enjoyment and quality of life compared to those who did not find such employment. Thus, routines established by employment may enhance neurocognition of adults with HIV by improving mental and physical well-being and stability.

Purpose/Meaning

Participating in purposeful and meaningful employment can be protective against stress-related neurocognitive declines (Matuska, 2014). According to Matuska (2013), engaging in meaningful employment helps develop mental constructs that manage stress and promote resilience in the face of adverse events such as an HIV diagnosis. Resiliency refers to the neurocognitive adaptive ability to regulate the negative effects of stress, with particular reduction in depressive symptoms and neurocognitive risk factors (Herrman et al., 2011; Vance, Struzick, & Masten, 2008). Unfortunately, individuals without meaningful employment tend to experience higher levels of occupational stress and depressive symptoms (Hakanen & Wilmar, 2012). Fortunately, resiliency can be strengthened through meaningful employment and social support which provides a buffer against neurocognitive deficits (Matuska, 2014). Puterman and Epel (2012) explored resiliency in relation to examining DNA biomarkers (i.e., telomere length) that reflect the consequences of accumulated stress on aging. Based on prior findings, these researchers posit that people with greater severity and duration of stress exposure experienced shortened telomere length as a result. Shorter telomeres indicate increased cellular aging. Resiliency is associated with telomere length and protects against stress-induced shortening. This is particularly important given that shorter telomeres are associated with an increase in HIV-related dementia (Giesbrecht et al., 2014). Fortunately, Stevens-Ratchford (2011) and White, Lentin, and Farnworth (2012) found significant correlations between longstanding, meaningful employment and successful aging; this research suggests that meaning or purpose of employment is highly contributory to reduction in stress and increased life satisfaction. As mentioned, reducing stress can be neuroprotective since stress and corresponding release of

cortisol via hypothalamus-pituitary-adrenal axis causes neuroinflammation which has a negative effect on neurocognition (Satori et al., 2012).

Income

Income is a tandem result of employment. As a general observation, higher income normally accompanies more neurocognitively complex and demanding employment, which in itself produces an enriched environment. Income itself affords people the opportunity to explore their environment in a variety of ways. With income, one can buy interesting books to read, throw parties where one can socialize and interact with others, and even travel the world while tasting novel foods, learn ancient customs, and speak or learn to speak new languages – all of which can facilitate positive neuroplasticity and neurocognitive reserve. As already mentioned, several studies on leisure time activities show that those adults who are actively engaged in many activities, which usually require money, fare better neurocognitively as they age (Vance, Roberson et al., 2010). However, if sufficient funds are not available to pursue intellectually stimulating activities, other activities that do not promote positive neuroplasticity may fill one's time. To exemplify this, in a study of 135 Alzheimer's disease cases and 331 healthy controls, Lindstrom and colleagues (2005) compared the number of hours participants spent in 26 leisure activities during middle adulthood 40 – 59 years. They found that each additional hour of passive television watching increased the probability of Alzheimer's disease by 1.3 times. Although the quality and complexity of television programming may also play a factor (e.g., Jerry Springer versus Master Piece Theatre), this overall point is well taken.

In addition, sufficient income may have other types of benefits on brain health. Financial stress and worry can obviously activate the hypothalamus-pituitary-adrenal axis; those who have little income and are struggling to survive may have more stress, anxiety, and depression resulting in the release of cortisol resulting in neuroinflammation (O'Connor, O'Halloran, & Shanahan, 2000). Again, studies indicate that such prolonged stress with an accompanying increase in cortisol levels can be systemically inflammatory and neurotoxic which compromises neurocognitive reserve and neurocognitive functioning (Butters et al., 2008; Gomez et al., 2009; Satori et al., 2012).

Employment and HIV

According to some studies, 41% to 45% of adults with HIV are unemployed (Dray-Spira, Gueguen, Ravaud, & Lert, 2007; Rabkin et al., 2004). As mentioned earlier, in one sample of 141 gay men with HIV, only 20% were continuously employed full-time over a 30-month period (Rabkin et al.). Sadly, once adults with HIV stop working, most stay unemployed; furthermore, longer duration of unemployment predicts a lower likelihood of returning to work (van Gorp et al., 2007). Even if someone is reemployed, many do not typically return at the same occupational level (van Gorp et al.). Furthermore, many adults with HIV may lack the neurocognitive stimulation provided by such employment. In a sample of 1,574 adults with HIV, Blackstone and colleagues (2012a) assessed these adults on a seven-domain neurocognitive battery. Compared to those without neurocognitive deficits, those who were classified as having neurocognitive deficits were more likely to have AIDS, have more severe co-morbid conditions, have more depressive symptoms, have more complaints

in everyday functioning, and – be unemployed. Similarly, Blackstone and colleagues (2012b) assessed a sample of 674 adults with HIV for HAND and found that those who also experienced poor performance in laboratory measures of everyday functioning were more likely to be immunosuppressed and unemployed.

As mentioned, such unemployment may not only have a pronounced effect on reducing neurocognitive stimuli needed for maintenance of neurocognition, the lack of money from such unemployment may also create financial uncertainty, anxiety, and depression. This stress may be particularly increased for many adults with HIV if they had to retire prematurely, did not save sufficient funds, and now live on an extremely low fixed income (Longmire-Avital, Golub, Parsons, Brennan-Ing, & Karpiak, 2012).

A lack of discretionary income may also be a source of stress in those adults with HIV. This stress may be exacerbated when one cannot afford to go to dinner and other social events with friends which may further contribute to social withdrawal, already a concern in this stigmatized population (Longmire-Avital et al., 2012; Vance, McGuinness et al., 2011). Lacking such social opportunities may contribute to feelings of loneliness which also has been associated with higher cortisol levels and inflammation (Hackett, Hamer, Endright, Brydon, & Steptoe, 2012), which further threatens neurocognitive reserve. In fact, feelings of loneliness predict the onset of dementia (Holwerda et al., 2014).

Furthermore, in a sample of 139 adults with HIV ($M_{age} = 48.7$ years), Fazeli and colleagues (2014) assessed their neurocognitive functioning as well as several lifestyle factors including social activity, physical activity, and employment status. Overall, they found that those who were more socially active, physically active, and employed full or part-time exhibited better neurocognitive functioning. These findings suggest that an active lifestyle, including employment, may bolster positive neuroplasticity and facilitate neurocognitive reserve. It is also plausible that those who experience such neurocognitive deficits live a less active lifestyle as a result; however, based on the principles of neuroplasticity, it is likely that both interpretations are correct. As adults with HIV experience neurocognitive deficits, they may reduce activities in their lives; this could promote negative neuroplasticity. Likewise, for those who continue to stay active, such efforts could promote positive neuroplasticity which can protect remaining neurocognitive reserve.

Implications for Research

Studying the effects of employment on neurocognitive reserve and neurocognitive functioning in this clinical population, or any population, has many methodological and measurement issues. First, measuring quality of neurocognitive engagement in employment represents an enormous methodological problem because in society, people hold different positions that require various neurocognitive skills and educational competencies. Thus, what guidelines can be used to say that job X requires this much neurocognitive ability and job Y requires that much neurocognitive ability? One strategy that has been used in the literature is to classify occupational level of prestige and to combine it with income, gender, and marital status to form a socioeconomic status (SES) variable. The Hollingshead four-factor index does just that. It classifies different occupations into one of nine categories with

9 being most skilled/prestigious and 0 being less skilled/prestigious (e.g., psychologists = 9, nurses = 8, reporters = 7, dietitians = 6, dental assistants = 5, carpenters = 4, barbers = 3, bartenders = 2, janitors = 1) (Hollingshead, 2011). Furthermore, even within professional circles there is much variability. Using the Hollingshead classification system, a new psychologist at the assistant professor level at a community college is placed in the same category as a psychologist who is an endowed chair at a major tier 1 university. Ostensibly, this measure of SES does not truly capture one's neurocognitive involvement in employment. Yet studies have shown that SES, as measured by the Hollingshead scale, is predictive of better neurocognitive functioning in older adults (Qian, Schweizer, & Fischer, 2014) and other health benefits (Hassan, Loar, Anderson, & Heptulla, 2006).

Second, measuring amount and intensity of engagement in employment represents another methodological challenge. Again, within the same profession, there can be great variability. A psychologist at a community college may engage in a 35-hour work week teaching the same classes over and over while a psychologist at a neighboring university may engage in a 70-hour work week and be intensely devoted to mentoring, writing grants, conducting research, serving on professional boards, and publishing. Still, time engaged in employment may not capture the environmental demands that promote positive neuroplasticity. Using the same example, the psychologist at the community college may engage in a 70-hour work week teaching the same classes over and over; nevertheless, his experience will be different from the other psychologist who is working the same length of time but being engaged in difficult neurocognitively stimulating tasks. Ideally, income may serve as a proxy measure for such intense neurocognitive engagement as one is promoted and awarded for such accomplishments, but life is seldom that linear.

Third, measuring consistency of work histories represents another methodological challenge, especially in many adults with HIV who already have spotty work histories. How does one quantify the amount of time one has worked for 2 years, then did not work for 1.5 years, then worked for 5 months, and then did not work for 7 months, etcetera? This difficulty is compounded if one changes the type of job during these transitions (worked as a barber, then as a nurse, then as a real estate agent). We also know from neurocognitive training studies that the neurocognitive benefits of training can last for several years (Vance, Roberson et al., 2010); perhaps certain types of employment may produce similar long-term neurocognitive benefits when not currently engaged.

Finally, conceptually it is difficult to disentangle whether one already had the neurocognitive aptitude to pursue more "neurocognitively advanced" employment or whether this developed over time. Humans select their employment environments which obviously exerts a profound influence on their neurocognitive functioning. Fortunately, in a seminal cohort study called the Nun Study, nuns were observed over time; because they lived very similar lifestyles, they represented an ideal controlled epidemiological population. When researchers examined the linguistic complexity of these nuns' essays that they wrote in early adult life, a proxy of neurocognition, less linguistic complexity was strongly associated with the development and severity of Alzheimer's neuropathology decades later (Mortimer, 2012). This suggests that early, and perhaps innate, neurocognitive ability and neurocognitive reserve, still plays some role on neurocognitive reserve; yet, other studies

still show that environment, activities, and perhaps types of employment are still important for neurocognitive reserve and function (Qian et al., 2014; Vance, Roberson et al., 2010). Clearly, both environment/behavior and genetic/innate predispositions have a complex dynamic relationship on neurocognitive reserve.

Despite these methodological issues, the next logical steps in this area reside in two primary areas: Need assessment and neurocognitive evaluation of returning to work. A needs assessment would be helpful to assess who and who does not want to return to work, why they do or do not, and what barriers are preventing people from doing so. Through focus groups, interviews, and/or surveys, it is important to determine the reasons why people with HIV who can work are not returning to work. One of the obvious reasons might be a real fear of losing one's benefits and health insurance (Lem et al., 2005). But another reason may be that many are experiencing some neurocognitive problems or possess outdated job skills that would impair their job performance (Hergenrather, Geishecker, Clark, & Rhodes, 2013). Therefore, they may need neurocognitive remediation, job/career coaching, or both; however, such basic inquiry is required to determine how to re-engage people who want to return to work.

Neurocognitive evaluation of returning to work could help determine the neurocognitive benefit of those who have been unemployed. Clearly, people with HIV are being re-employed everyday. If such individuals can be identified, it would be possible to evaluate their neurocognitive abilities before being re-employed and then after being employed over time, perhaps 6 months to 1 year, to determine the degree to which employment does play a role in neurocognitive functioning and brain health. To examine this, a number of covariates should be considered such as: Length of time being unemployed, returning to the same level of employment, age, education, and others (Bravemen, Kielhofner, Albrecht, & Helfrich, 2006; Lem et al., 2005).

Implications for Practice

While HIV is no longer considered acute and life-threatening (Vance, 2010), adults living with the disease are burdened with physical and neurocognitive disabilities that contributed to their lack of control over several domains including employment (van Gorp et al., 2007). Given the high incidence of HAND, interventions to preserve neurocognitive function may include vocational training. Such training may be difficult for those who have been unemployed for long periods as job-seeking skills or office, factory, or professional skills may have atrophied.

In seven African American gay men with HIV, Hergenrather and colleagues (2013) examined benefits of the Helping Overcome Problems Effectively (HOPE) intervention, which included seven weekly 3-hour group sessions on developing employment seeking behaviors. Three months post-intervention, three participants were seeking employment, three were enrolled in college courses, and one was hired as a part-time employee. Career development training that focuses on employment seeking behaviors such as resume development, job interviewing skills, social networking, and goal-setting may be used to help adults with HIV seek employment. Meanwhile, a practical suggestion for helping

people to return to work is by slowly integrating back into it. One could volunteer in AIDS Service Organizations or other charitable groups, serve on community advisory boards, engage in internships or apprenticeships, or work part-time. This limited employment may be particularly important for those individuals concerns about losing their disability benefits or have had limited work experiences; however, their case managers/social workers should be consulted. By engaging in a limited capacity, this helps one rebuild employment skills, professionally network, and still receive intellectual stimulation that may produce a neurocognitive benefit.

Likewise, the benefits of intellectual stimulation were observed in a study of 181 community-dwelling older adults (58 – 93 years) who were randomized to two groups: an experimental group engaged in weekly meetings and team problem-solving similar to being in an employed environment, and a control group that did not participate in weekly meetings (Stine-Morrow, Parisi, Morrow, & Park, 2008). The experimental group demonstrated improvements in neurocognitive ability compared to the control group, which suggests that social engagement and mental activity can promote healthy neurocognitive function in older adults. Group problem-solving may likewise benefit adults with HIV in that it could promote intellectual and social engagement in those who lack opportunities to exercise higher level neurocognitive function. Adults with HIV in group sessions and those in employment settings could possibly acquire similar neurocognitive benefits when they work with others on challenging tasks.

Conclusion

The focus on neurocognition fits within a larger conceptual model of successful aging found in both the gerontological and HIV literature. Briefly, this model states that for one to age successfully, competency in four main areas is needed. These areas include: 1) active engagement in life, 2) prevention of disability and disease, 3) spiritual connection within a developmental context, and 4) optimal neurocognitive and physical functioning (Vance, McGuinness et al., 2011). But one may argue that optimal neurocognition is needed for continued functioning in all of these areas. For example, if people have memory problems, it may be difficult for them to remember to take their medications which could compromise their physical function through the development of disease and subsequent disability. This is especially important for adults with HIV who must adhere strictly to their medication to prevent viral mutation (Raper, 2010). Likewise, individuals with such neurocognitive deficits will require more informal caregiving which can negatively impact leisure time and self-care activities of such individuals which represents a public health concern (Stevens et al., 2004). Thus, as people age with HIV and become vulnerable to reduced neurocognitive reserve, employment opportunities, especially over the lifespan, represent a strategy to buffer them from such risks. Clearly, more investigation into this area is warranted.

References

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Figure 1.
Mechanisms in which Employment Exerts a Positive Influence on Brain Health