Lakehead
UNIVERSITY

OFFICE OF GRADUATE STUDIES

NAME OF STUDENT: Cameron Dokis

DEGREE AWARDED: M.Sc.

ACADEMIC UNIT: Psychology

TITLE OF THESIS: A Neuropsychological Profile of Northern Native Male Solvent Abusers

This thesis has been prepared

under my supervision

and the candidate has complied

with the Master's regulations.

Signature of Supervisor

Sept 23/08

Date

Your file Votre référence
ISBN: 978-0-494-47123-4
Our file Notre référence
ISBN: 978-0-494-47123-4

A Neuropsychological Study of Northern Native Male Solvent Abusers

Thesis submitted in FULFILLMENT of the requirements for the Degree of Masters of Science in Psychology

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August 29, 2008

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Abstract

Solvent abuse constitutes a major health concern in all ethnic groups because of its serious social, medical, and neuropsychological consequences. The present study examined the neuropsychological consequences of long-term solvent use on young Aboriginal males in Northwestern Ontario. It was hypothesized that solvent abusers would score below controls in a variety of neuropsychological measures, with the largest deficits in working memory. The researcher recruited 10 solvent abusers, aged from 18-25. As a comparison control group, this study unsuccessfully attempted to recruit 20 age-and-ethnically matched Aboriginal males without a history of solvent use. The literature suggests that this effect may have been due to the application of a culturally insensitive research methodology with this particular population (Smith, 1999; Steinhauer, 2002). Due to lack of control data, experimental data were compared to normative data drawn from the literature.

The study examined the areas of working memory, attention span, fine motor skills and executive functioning capabilities of solvent users. Covariates were measures of cognitive function, anxiety and depression.

Covariates were not significantly correlated with test measures. Solvent abusers (N = 10) did not differ significantly from control data in measures of working memory, attention span, fine motor skills, or executive functioning capabilities. TONI-3 data correlated with sub-measures in the Connors Continuous Performance Test indicating a relationship with cognitive processing speed. Experimental TONI IQ did not differ significantly from Moland's (2004) solvent abuse group TONI IQ, indicating a

relationship between IQ and solvent use, however, the directionality or structure of this relationship is unknown.

A Neuropsychological Profile of Northern Native Male Solvent Abusers

Solvent abuse in North America constitutes a significant problem in all ethnic groups, because of its serious medical and neuropsychological consequences (Brouette & Anton, 2001; Dick, Semple, Osbome, Soutar, Seaton, Cherrie et al., 2002; Kurtzman, Otsuka, & Wahl, 2001; Mackesy-Amiti & Fendrich, 2000; Storr, Westergaard, & Anthony, 2004). Some studies indicate that the prevalence rate for lifetime solvent use ranges between 8.8% (Howard, Walker, Walker, Cottler, & Compton, 1999) to 9%-9.8% for 12-17 year old children (Beauvais, Oetting, & Edwards, 1985). The Monitoring the Future study reports an overall lifetime prevalence rate for solvent use among 8th grade students at 21.0% (Johnston, O'Malley, & Bachman, 1996). One study reports that the risk of initiating inhalant abuse was found to be as great for 17 year old adolescents as it was for 12 year old children (Neumark, Delva, & Anthony, 1998). In 2006, one study reported a startling statistic that over 23 million people in the United States have reported abusing solvents at one point or another during their lives. This statistic exceeded the total number of people who reported using heroin and cocaine (Bowen, Batis, Peaz-Martinez, & Cruz, 2006). Gerasimov, Schiffer, Marstellar, Ferrieri, Alexoff, and Dewey (2001) report that in the U.S., inhalants rank behind fourth behind alcohol, marijuana and tobacco while in Japan, inhalants are one of the two primary substances of abuse behind methamphetamines.

In regards to solvent use and Native people, one recent study on American Indian children showed that overall lifetime prevalence rates for solvent abuse were at 17% across all age groups, with 7-12th grade children ranging between 31.8% for males and 32.9% for females (Bates, Plemons, Jumper-Thurman, & Beauvais, 1997). During the

1980s, one study indicated that up to 44% of Native students had used solvents during their time at boarding school (Okwumbua & Duryea, 1987). Early reviews of the literature on solvent abuse by American Indian youth by Beauvais, Oetting, and Edwards (1985) reported disturbing statistics that indicated that in 1968, 80% to 90% of adolescents on one American reservation had inhaled glue or gasoline for the purpose of mood alteration. The same review by Beauvais et al. (1985) showed that in 1973, 13% of American Indian students in a boarding school were identified as inhalant users, and that in 1975, 31% of Native students at an American arts and technical school were identified as having tried inhalants (Goldstein, Oetting, Edwards, & Garcia-Mason, 1979).

Other, more recent studies revealed a lifetime prevalence rate among grade school children at 21% with solvent use on the rise, with up to 25% of Native children aged 5-15 years having used solvents (Beauvais, Wayman, Jumper-Thurman, Plested, & Helm, 2002; Fleschler, Tortolero, Baumler, Vernon, & Weller, 2002; Johnston, O' Malley, & Bachman 1998; Uzun & Kendirli, 2005). However, contrary to expectations, a study in Illinois found that inhalant use was not more prevalent in the general population among low-income, ethnic or high poverty groups (Mackesy-Amiti et al., 2000). The literature generally agrees that despite the serious neurological, physiological, and psychological effects of solvents, there exists a relative lack of research in the field (Bates et al., 1997; Beauvais, 1997, 2002; Brouette & Anton, 2001; Gerasimov, Schiffer, Marstellar, Ferrieri, Alexoff, & Dewey, 2001; Howard et al., 1999; Kurtzman et al., 2001; Remington & Hoffman, 1984).

Organic Solvents as Inhalants

Williams and Lees-Haley (1996) define organic solvents as “chemicals used for extracting, dissolving, or suspending materials not soluble in water (p. 104)”. Also included are anesthetic gases and nitrites as inhalants of abuse (although the literature generally agrees that anesthetic gases and nitrites are abused with much less frequency then organic solvents). According to Bowen et al. (2006), inhalants of abuse are volatile compounds at room temperature that are rarely abused by other routes than inhalation, although organic solvents can also be absorbed through the dermal layer (for the purposes of this paper, the term “inhalants” will be used interchangeably with “solvents”). However, the Diagnostic and Statistical Manual-IV-TR (American Psychological Association [APA], 2000) defines inhalant intoxication as: “recent intentional use or short-term, high-dose exposure to volatile inhalants (excluding anesthetic gases and short-acting vasodilators)” (APA, 2000, p. 258-261). Brouette and Anton (2001) define inhalants as being substances of abuse solely by their route of administration through inhalation. Brouette and Anton (2001) also define an inhalant by three main conventions: the substance is volatile at room temperature; it is not already in a pharmacologically distinct class (such as nicotine or cocaine); and it is used by sniffing, snorting, bagging (inhaling from a bag containing the substance); huffing (saturating a rag with the substance and placing it against the mouth to inhale); or spraying the substance into the mouth in order to alter one’s level of consciousness. Kurtzman et al. (2001) define solvent abuse as “the deliberate inhalation of vapors with the intention to alter one’s consciousness or become intoxicated” (p. 170).

Inhalants capable of producing intoxication can be found in thousands of common household products. They can be (but are not limited to): adhesives (airplane glue, rubber cement, PVC cement); aerosols (spray paints, hair sprays, deodorants, air fresheners, asthma sprays); permanent markers; cleaning agents (dry cleaning spot removers); solvents (correction fluids, butane, nail polish removers, paint thinner, lighter fluid, fuel gas); and gasoline (Bowen et al., 2006; Brouette & Anton 2001; Cairney, Maruff, Burns, Currie & Currie, 2003; Fleschler et al., 2002; Kurtzman et al., 2001; Remington & Hoffman, 1984; Uzun & Kendirli, 2005). The literature indicates that the primary factors involved in choosing solvents are: their commonality; legality; and ease of procurement relative to the lack of availability of other drugs of abuse (Brouette & Anton, 2001; Kurtzman et al., 2001; Beauvais, Wayman, Jumper-Thurman, Plested, & Helm, 2002; Howard et al., 1999; Fleschler et al., 2002; Mackesy-Amiti et al., 2000; Remington & Hoffman, 1984; Uzun & Kendirli, 2005).

Psychological effects

According to Brouette and Anton (2001), solvents gain rapid access to the central nervous system (CNS) due to their absorption by inhalation through the lungs and subsequent transmission via pulmonary circulation. They are highly lipophilic (easily absorbed and stored by body fat). Body fat is the also the primary substance in the myelin sheaths that protect the brain's neurons, and is the primary coating in the brain's "white matter" on the cortex. This explains why even low, short term concentrations can lead to rapid intoxication that can extend to well beyond the initial period of solvent inhalation (Morrow & Scott, 1994) for a solvent-exposed adult in an industrial setting (amounts inhaled in industrial settings are usually equal to roughly 100 ppm to a few thousand ppm). Occupations that are "at risk" can include (but are not limited to) painters, spray painters, offset printers, munitions workers, gas station attendants, refinery workers, railway workers and carpet layers (van Hout et al., 2003). Recreational solvent users are usually exposed to dozens or hundreds of times (5000 ppm to 15000 ppm) the levels of routine solvent exposure in occupational or incidental exposures (such as filling your car with gasoline).

The literature suggests that just 15 to 20 inhalations of a solvent are enough to provide euphoria, diplopia, slurred speech, visual hallucinations, and a sense of relaxation over a very short period of time which can resemble alcoholic intoxication (Bowen et al., 2006; Brouette & Anton, 2001; Cairney et al., 2005; Remington & Hoffman, 1984). Storr, Westergaard, and Anthony (2004) report that inhalant users are at greater risk for poly-drug use (opiates), delinquency and co-morbid psychological disorders. Varney, Kubu and Morrow (1998) describe effects similar to post-concussive syndrome such as poor memory, diminished concentration, and problems with decision making, irritability, depression, and fatigue. Haut, Kuwabara, Ducatman, Hartfield, Parsons, Scott, Parsons, et al. (2006) report mental dullness, distractibility, depression, anxiety, and irritability related to Chronic Toxic Encephalopathy (CTE: the neurological condition created by long term inhalant abuse). Bowler, Lezak, Booty, Hartney, Mergler, Levin, et al. (2001) describe emotional status dysfunctions related to CTE. Remington and Hoffman (1984) report euphoric effects, visual hallucinations, increased irritability and psychotic-like behaviour following acute intoxication. Lindgren, Hagstadius, Abjomsson, and Orbaek (1997) report industrial employees with CTE as suffering from aggressive behaviour, difficulty managing occupational or family tasks, decreased initiative, lack of impulse control, and sleep disturbances due to the influence of solvents.

Neuropsychological effects

Due to the highly lipophilic nature of solvents, the neuropsychological effects of acute toxic encephalopathy in the CNS can be diffuse and widespread. In terms of the physical mechanism of solvent action on the CNS, Varney et al. (1998) suggested that the myelin sheath surrounding the brain's neurons and glial cells would be dissolved or transfigured in the presence of organic solvents. Brouette and Anton (2001) discussed a similar effect, pointing to a possible "fluidization" of the lipid tissue surrounding the neuron. In cases of Chronic Solvent Encephalopathy (CSE: where either poly-solvent use or inhalants other than gasoline are the solvents of choice; this term is used interchangeably with CTE), this can result in the eventual permanent segmental demyelination of neurons and other diffuse axonal damage throughout the CNS which explains the Parkinson-like features that some solvent exposed adolescents and adults experience (Armstrong, 1995; Haut et al., 2006; Varney et al., 1998).

Users can also suffer from residual intoxication lasting from hours to days beyond the initial inhalation of the solvent due to being stored in the body's fat stores. In most cases of Chronic Lead Encephalopathy (CLE: toxic levels of lead in the bloodstream due to long term inhalation of leaded gasoline as the sole solvent of abuse), the harmful effects of solvents are compounded by the toxic presence of lead in the CNS. This can lead to clouding of the conscious state, impaired visual attention, impaired visual recognition memory, and visual paired associate learning (Bowler et al. 2001; Cairney et al., 2005). In cases of CSE and CLE, Brouette and Anton (2001) reported: psychosis due to lead encephalopathy, subcortical-like dementia, decreased I.Q., memory loss, poor attention, depression, apathy, generalized atrophy along the corpus callosum and hippocampus, hyperintensity of the thalamus and other white matter degeneration which can lead to poor performance in memory, executive functions, I.Q., and attention-concentration (Haut et al., 2000; Varney et al., 1998). Morrow, Muldoon, and Sandstrom (2001) noted a depression of general brain function in solvent toxicity. Haut et al. (2006) noted a decrease in the volume of the corpus callosum of solvent exposed railway workers. Nilson, Barregard, and Backman (1996) reported memory difficulties and perceptual slowing. Bockelman, Darius, McGauran, Robra, Peter, and Pfister (2002) described deficits in concentration, memory, and reaction time. Morrow, Stienhaur, and Condray (1996) reported that solvent-exposed adults (industrial employees, carpet layers, etc.) show impairments in learning and memory, motor speed, and mental flexibility. Dick et al. (2002) found that solvent exposed workers diagnosed with CTE performed more poorly than controls on tests of visual memory, verbal memory, and planning. Morrow, Stienhaur, Condray and Hodgsen (1997) reported deficits in attention, mental flexibility, and general I.Q. Armstrong (1995) described deficits in memory and attention in solvent exposed workers. Lindgren et al. (1997) reported that industrial employees suffering from CTE suffered from impaired memory function (primarily verbal memory), impaired concentration, disturbed spatial functioning, and prolonged reaction times. Akila, Muller, Kaukiainen, and Saino (2006) described working memory dysfunctions in employees with CTE similar to working memory deficits seen in severe Parkinson's disease. Morrow and Scott (1994) report that there is evidence to suggest that the primary deficits related to solvent exposure are attention and working memory. Van

Hout, Wekking, Berg, and Deelman (2003) report that CTE patients have shown the same symptom complexes as Chronic Fatigue Syndrome and Whiplash Associated Disorder. Haut et al. (2000) describes PET (Positron Emission Tomography) scans showing dysfunction in the temporal or frontal lobes of solvent exposed adults. Varney, Morrow, Pinkston, and Wu (1998) reported hypometabolism in the frontal, hippocampal, and parietal regions of the brain. The evidence confirms that organic solvents adversely affect a wide range of neurological functions and cause white matter atrophy (Lezak et al., 2004)

Motor Skill and Sensory deficits

The literature suggests that inhalant abuse also directly affects motor skills, sensory mechanisms, and general physical health in both industrial and recreational cases of inhalant exposure. Cairney et al. (2005) and Kurtzman et al. (2001) described effects of nystagmus, myoclonus or chorea, limb and gate ataxia, positive palomental reflexes, postural tremors, hyperreflexia, increased saccadic latencies, and convulsive seizures. Brouette and Anton (2001) reported optical neuropathy, EEG slowing, peripheral neuropathy, and depressed reflexes (Haut et al., 2000; Varney et al., 1998). Niklasson, Arlinger, Ledin, Moller, Odkvist, Flodin et al. (1998), and Varney et al. (1998) noted a deficit in dichotic listening ability. Dick et al. (2002) showed an association between solvent exposure (industrial and recreational) and grip strength. Bowler et al. (2001) reports that solvent exposed munitions workers scored below the average on tests of psychomotor function and visuomotor tracking speed. Kurtzman et al. (2001) reports that recreational solvent abusers showed cranial nerve damage, optic atrophy, tinnitus, and sensorineural hearing loss. Chiang et al. (2005) reports that general psychomotor dysfunction in solvent-exposed industrial workers was linked to occupational exposures to lead, benzene, toluene, n-hexane and other solvents contained in standard gasoline.

Controversial Findings

There is still some controversy in the field of solvent abuse as several studies have reported findings contrary to expected effects of chronic leaded encephalopathy (CLE) and CTE. Burns, D'Abbs, and Currie (1995) described several cases of individuals having a history of abusing leaded gasoline who have never suffered any measureable symptoms of leaded gasoline encephalopathy other than minor memory deficits, suggesting that leaded gasoline encephalopathy possibly arises from a combination of chronic neurological damage and a catastrophic injury associated with acute intoxication. Nilson et al. (1996) and Hoosima, Hanninen, Emmen, and Kulig (1993) reported that some studies have shown that there are no discernable differences in cognitive performance between solvent-exposed and unexposed adults. In one study of monozygotic twins, the solvent-exposed twins performed faster on the Digit Symbol test then the non-exposed twins, although they performed more poorly than controls on other cognitive tests (Hanninen, Eskehnen, Husman, & Nurminen, 1976). Muijser, Geuskens, Hoosima, Emmen, and Kulig (1996) found no consistent long-term CTE effects between controls and solvent exposed groups, with the solvent-exposed exposed group performing better than controls on the Symbol-Digit substitution test and Digit Span test. Contrary to other studies, Haut et al. (2000) reported that the majority of patients with CTE do not show observable structural deficits in PET scans, with only the most severe cases of CTE showing obvious structural solvent-induced deficits. Bockelman et al. (2002) reported a controversy about the actual influence of chronic solvent exposure on intellectual functions with accompanying changes in personality and mood of painters. Williams and Lees-Haley (1996) and van Hout et al. (2003) both cited methodological issues as a primary factor in the difficulty in narrowing down more precise effects in many studies of CSE. They argue that this results in problems in accepting CTE as a diagnosis in clinical practice.

In terms of neurological recovery, some studies suggest that a partial to complete recovery may be possible for solvent-exposed adults (industrial settings) and solvent abusers, depending on the length and severity of the exposure to solvents (Armstrong, 1995; Brouette & Anton, 2001; Cairney et al., 2004; Cairney et al., 2005; Chiang, Chan, Tseng, & Wang, 2005; Storr et al., 2004). However, other studies suggest that CTE (possibly even just one massive exposure to organic solvents) can lead to differing degrees of permanent neurological damage (Akila et al., 2006; Haut et al., 2006; Kolb & Wishaw, 2003; Varney et al., 1998). Morrow, Steinhauer and Hodgson (1992) documented slowed latencies of event related potentials (P300 latency) in a small group of solvent-exposed adults with an organic solvent exposure event that occurred two years prior to their study. However, Ericksson, Perfilieva, Bjork-Ericksson et al. (1998) found that the human hippocampal region of the brain (which is one of the areas where the literature shows that solvents appear to have an effect) can generate neurons throughout life. The implications for the study of solvent abuse are unknown at this time.

Domains of Interest

The literature clearly shows that solvent inhalation, whether incidental or recreational, affects a wide range of neurological and psychological functions with the primary cognitive deficits noted in the areas of attention, memory, and response slowing

(Armstrong, 1995; Bowler et al., 2001; Dick et al., 2002; Gerasimov et al., 2002; Haut et al., 2000; Morrow et al., 1994, 1996; Muijser, Geuskens, Hoosima, Emmen, & Kulig, 1996; Niklasson et al., 1998; Uzun & Kedirili, 2005; Varney et al., 1998) and can cause a wide range of physical, motor and sensory deficits even with a minimal dosage (Bowler et al., 2001; Brouette & Anton, 2001; Chiang et al., 2005; Dick et al., 2002; Cairney et al., 2005; Haut et al., 2000; Kurtzman et al., 2001; Morrow et al., 1996; Niklasson et al., 1998; Varney et al., 1998).

There are several areas where more research is needed to better understand the neurological, psychological and physiological effects of solvent abuse on the general population. Much research is also needed to address prevention and treatment of inhalant abuse and addiction (Beauvais, 1997).

Most of the data on the effects of solvent inhalation have been garnered on industrial workers who are commonly exposed to low levels of organic solvents. Some of the literature has focused on the neuropsychological effects of solvent inhalation on recreational solvent abusers. Very little research has focused on the effects of inhalants upon females of any ethnic group (Morrow & Scott, 1994). None of the literature presented in this paper has focused on the neuropsychological effects of inhalants on Native, Métis or Inuit solvent abusers in the north as a specific population, except as a part of a larger study (Bates et al., 1997; Beauvais, 1997; Brouette & Anton, 2001; Gerasimov, Schiffer, Marstellar, Ferrieri, Alexoff, & Dewey, 2001; Howard et al., 1999; Kurtzman et al., 2001; Remington & Hoffman, 1984).

To begin to address this gap in the Native solvent abuse literature, it was the intention of this researcher to assess the neuropsychological effects of inhalants in the areas of working memory, fine motor skills, attention, and executive functioning on Native male solvent abusers in the Canadian north. The choice of working memory and fine motor skills as domains of study was based strictly on the evidence consistently defined in the literature reviewed. The domains of attention and executive functioning have not been covered in great depth throughout the literature, and this researcher attempted to address this gap. In what follows, this researcher examined the rationale for the domains being assessed, some tests used in the literature to assess these domains, and a justification for selecting certain tests as appropriate for the participant groups being studied.

Working Memory

Despite the wide ranging effect of inhalants in all areas of the CNS, the literature strongly supports the hypothesis that inhalants have the strongest effect on working memory, indicating an affinity for the amygdala, hippocampal, and temporal lobes where working memory resides (Bowler et al. 2001; Brouette et al, 2001; Cairney et al., 2005; Haut et al., 2006; Nilson et al., 1996; Varney et al., 1998). Solvent-induced neuropsychological effects were assessed using several well established tests from the Wechsler Adult Intelligence Scale and the Wechsler Memory Scale-III, most notably the Letter-Number sequence test, the WAIS-III Arithmetic and the Digit Span test (Armstrong, 1995; Bowler et al., 2001; Muijser et al., 1996; Wecshler, 1997). Haut, et al. (2000) and Varney, et al. (1998) used Positron Emission Tomography to assess verbal working memory and the temporal, hippocampal, parietal and frontal lobes of solvent exposed adults. Two other tests used to assess memory are the Paragraph Immediate and

Delayed Recall (WMS-R), and the Rey Auditory Verbal Learning test (Armstrong, 1995).

Fine Motor Skills

The literature describes some evidence demonstrating the effect of inhalants on fine motor skills in both solvent exposed industrial workers and recreational abusers. Observations have been included solvent-correlated deficits in reflexes (Brouette & Anton, 2001), grip strength (Dick et al., 2002), hyperreflexia (Cairney et al., 2005; Kurtzamn et al., 2001), and overall psychomotor dysfunction (Bowler et al., 2001; Chiang et al., 2005). The theorized effect of solvent-induced demyelination of neurons, producing a Parkinson-like effect in some inhalant abusers (Armstrong, 1995; Haut et al. 2006; Varney et al. 1998), could also directly affect fine motor skills. However, much more research is needed to demonstrate evidence of specificity and degree of inhalant effects on fine motor skills, and more evidence is needed to support the demyelination theory. The literature described 7 tests used to assess fine motor skills: the Dynamometer; Finger tapping test; the Grooved Pegboard test (Bowler et al., 2001); the Hand-Eye coordination test (Muijser et al., 1996); the Finger Oscillation test; and the Reitan-Klove Sensory Perceptual Exam (Armstrong, 1995)

Attention/Concentration

Several studies have described deficits in attention and concentration in both solvent exposed industrial workers and in recreational abusers, with the degree of deficit in attention/concentration being correlated to the degree of inhalation of an organic solvent (Armstrong, 1995; Haut et al., 2000; Morrow et al., 1997; Varney et al., 1998). However, the data on attention/concentration deficits in Aboriginal solvent abuser populations are still very sparse with more research being needed. The literature shows that the Connors Continuous Performance Test was used to assess this domain (Connors, 2000).

Executive Functioning

The literature is equivocal when assessing the overall effects of inhalants on executive functioning skills. Solvent-induced deficits in executive functioning and planning have been noted, but the specificity of effects and the degree to which they affect recreational abusers is still largely unknown. Varney et al. (1998) and Lindgren et al. (1997) describe deficits in decision making ability and diminished concentration. Brouette and Anton (2001) report reduced general IQ in recreational abusers. Haut et al. (2006) describes effects of mental dullness. Researchers have assessed this domain using several tests: the Wisconsin Card Sorting test, one deck version; the Similarities test; the Written Arithmetic test (Armstrong, 1995); the WAIS full scale IQ (Varney et al., 1998); the COWAT (controlled oral word association test); Trail Making A test; Cancellation H test; and the WAIS-III Symbol Search test (Bowler et al., 1998) and the Tower of London (Culberton & Zillmer, 2001; Kolb & Wishaw, 2003; Lezak et al., 2004). Kolb and Wishaw (2003) noted that the Tower of London test appears to be sensitive to frontal lobe damage and is the purest test of planning functions. This test also appears to be suitable for young adults (Lezak et al., 2004).

Anxiety and Depression

When performing neuropsychological assessment, an investigator must also be aware of the effects of anxiety and depression upon their test results. Researchers have demonstrated that high levels of test anxiety can adversely affect performance on many types of mental ability tests in such ways as: slowed, scrambled, or blocked thoughts and words, and memory failure (Armstrong, 1995; Buckelew & Hannay, 1986; Fletcher, Lovatt & Baldry, 1998; Moland, 2004; Lezak, et al., 2004).

The research shows that depression can interfere with the motivational aspects of memory simply because the client being assessed puts less effort into recall (Akechi, Kugaya, & Okamura, 1999; Hertel, 2000; Lezak et al., 2004). Thus, depression may negatively affect test performance.

Because both anxiety and depression may have such effects on neuropsychological test performance, responsible investigators must take these variables into account.

Cognitive Function

The literature shows that there is a difference in the educational performances of Native solvent abusers as opposed to the general population (Fleschler, Tortolero, Baumler, Vernon, & Weller, 2002). However, few studies have examined cognitive performance among Native solvent abusers compared to non-solvent abusing Aboriginal populations, and there remains a dearth of research in this area. Assessing cognitive function between Native solvent abusers and non-solvent abusing Native men in this study would address some of the gap, and help begin to determine what differences exist (McShane & Plas, 1984; Moland, 2004).

Selection of Instruments

The literature describes many well-established, psychometrically sound tests available to assess neuropsychological deficits on most populations worldwide. However, several key variables affected the selection of instruments used to measure solvent effects on Aboriginal recreational users such as: education level; fluency in the English language; cultural differences; and location. Fleschler et al. (2002) reports that Native American solvent abusers have a generally lower level of education, with only 34.2% achieving a Grade 12 level of education. Bates et al. (1997) report an overall dropout rate among inhalant abusers at 11% in 1992, with ethnic groups such as Mexican-American (18% nationally) and Native American groups (up to 60% in some regions) at the highest risk for dropout. Secondly, in most remote northern Canadian Indian reserves, English is a second language with Cree, Oji-Cree, Ojibway, etc. being the primary spoken languages. The researcher was concerned that this confound could affect results from tests that rely primarily on IQ and also word comprehension based tests such as the: Stroop color-word interference test; Paired-Associate learning test; the Benton Screen Sentence Representation test (Armstrong, 1995; Devers, Bradley-Johnson, & Johnson, 1994; Morrow et al., 1997).

Thirdly, an important consideration in the selection of tests was cultural impact. Native people maintain a distinct, contemporary culture with symbology, language and terms of reference that are different than mainstream non-Native society. The more remote the Indian Reserve is from mainstream society, the more profound the impact of Native culture is on Native peoples. Anastasi & Urbina, (1997) noted that "the evaluation of patients' responses in a neuropsychological examination must take into account the contributions of their social and cultural and attitudes to test performance and to their feelings and understanding of their condition (p. 312)" (Lezak et al., 2003). Thus, test results from instruments like the Boston Naming Test or the WRAT-3 Reading test (Bowler et al., 2001) would be compromised due to the difficulty Native people may experience in understanding symbology and cues based on mainstream non-Native culture.

Without proper consideration there is a strong risk of incorrectly assessing Native solvent abuse populations. These arguments indicate that researchers interested in studying Native solvent abuse populations residing on remote Indian Reserves must consider tests that are: not strongly dependent on English; non-verbal IQ based; and as culture-free as possible in their administration.

There exist several psychometrically established neuropsychological tests which fit the necessary criteria: not strongly dependent on English; non-verbal IQ based; and culture-free as possible. However, many neuropsychological tests are also time and effort intensive to administer, while placing stress on the participants. In consideration of the population being studied, the author selected a minimum battery of tests that are psychometrically sound, brief in administration, and potentially yield useful data about the neuropsychological status of native male solvent abusers from remote Indian Reserves. This choice was also further reinforced by the fact that the participant population is currently in treatment for solvent abuse at Ka Na Chi Hih Specialized Solvent Abuse Treatment Centre, and time available for test administration per day, per participant is limited.

Method

Participants

The present study successfully recruited 10 (N = 10) young adult Native males, ages 18-26, from Ka Na Chi Hih Specialized Solvent Abuse Treatment Centre who have an identified, significant and recent history of inhalant abuse. Aboriginal descendancy was determined by both self-identification, and identifying at least one Aboriginal parent (Moland, 2004). All participants were over 18 years of age.

The original purpose of the study was to compare neuropsychological test performances of the study group to an age and ethnically matched non-solvent abusing controls to see what statistically significant differences arise. It was hypothesized that the solvent abuse group would display significant deficits in overall test performance across all measures, but most notably in memory and attention (Akila et al., 2006; Armstrong, 1995; Morrow & Scott, 1994; Morrow et al., 1997), which would indicate damage to the amygdala and hippocampal regions of the brain (Bowler et al. 2001; Brouette & Anton, 2001; Cairney et al., 2005; Ericksson et al., 1998; Haut et al., 2006; Nilson et al., 1996; Varney et al., 1998). However, because this researcher was unable to successfully recruit a comparison group of age and location matched Native males, it becomes necessary to use a different analytical model.

Normative data were drawn from several previous studies on solvent abuse (Advokat, C., Martino, L., Hill, B.D., & Gouvier, W., 2007; Akila, et al., 2006; Connors, K. C., Epstein, J. N., Angold, A., & Klaric, C., 2003; Moland, 2004). Moland's (2004) solvent abuse study took place in Thunder Bay, ON at both the Thunder Bay Correctional Centre and Lakehead University. Some of the measures used during this study were QEEG (Quantitative Electroencephalopathic), the BDI-II, the TONI-3, the Digit Span, and the Letter-Number Sequencing test. Control participants (N=14) were Native, male, of appropriate age, and non solvent abusing. The data from this study were therefore deemed as an appropriate for comparison on the BDI-II, the Digit Span, and the TONI-3.

Materials

A cover letter informing participants of the test purpose and procedure was provided (see Appendix A) to all participants. All participants were also provided with a consent form (see Appendix B). Participants were also entered into one $100 draw (per group) for their participation. All participants also received a $5 certificate to Tim Horton's coffee shop for their participation (Moland, 2004).

An interview form was used (see Appendix C) to obtain age, medication use, prior head injury, handedness, family history of disease, substance use (including coffee and cigarettes), solvent use, and chronicity data from solvent use group participants (Moland, 2004).

The choice of selecting tests that are not strongly language based, not IQ based, culture free, time-limited, and psychometrically sound led the author to select four tests which fit all criteria. To assess working memory, the writer used the Digit Span test from the WMS-III (Bowler et al., 2001; Wechsler, 1997). To assess fine motor skills, the writer used the Finger Tapping test (Bowler et al., 2001; Reitan & Wolfson, 1993). To assess levels of executive functioning, the writer used the Tower of London test (Culberton & Zillmer, 2005; Kolb & Wishaw, 2003; Lezak et al., 2004). To assess attention and concentration, the writer used Connor's Continuous Performance Test (Connors, 2000; Dick et al., 2002). Covariates were measures of intelligence, anxiety and depression. To assess anxiety, the author used the State-Trait Anxiety Inventory (Lezak, et al., 2004; Spielberger, Gorusch, Lushene, Vagg, & Jacobs, 1983), and to assess depression, the author used the Beck Depression Inventory-II (Beck, Brown & Steer, 1996; Moland, 2004). To assess intelligence, the author used the Test of Non-verbal Intelligence-3 (Brown, Sherbenou, & Johnsen, 1990; Moland, 2004).

Procedure

The author recruited 13 Native solvent abusers, aged 18 to 26 (M = 20.08, SD = 2.098) years old from Ka Na Chi Hih (KNCH) Specialized Solvent Abuse Treatment Centre, located in Thunder Bay, ON as primary research participants. One participant withdrew from the study, while the data from two more were withdrawn due to age issues. Written permission was provided by KNCH (see Appendix D). The relatively small number of experimental group participants represented the number of available clients available at KNCH that qualified for participation during the period of the study. Solvent group participants were recruited through KNCH staff. The solvent abuse group was interviewed prior to selection.

Potential control group participants were approached at a weekly cultural gathering held on Tuesday nights at Anishnawbe Mushkiki, located in Thunder Bay, ON. Written permission to recruit control participants was provided by Anishnawbe Mushkiki (see Appendix E). On the advice of members of the Aboriginal community, the study and its purpose were announced during the gathering, and potential participants were given the means to contact the writer by business card (see Appendix F).

For control participants, the author unsuccessfully attempted to recruit 20 age-and-ethnically matched non-solvent abusing Native participants. To set a context, experimental participants all disclosed that they were familiar with various tests and appeared to have broad experience with clinicians as a result of their addiction to solvents and subsequent trip to hospitals and/or psychiatrists and psychologists for assessment.

Potential Native control group participants (most of who were not "institutionalized") appeared to become strongly mistrustful of the author when informed that they were being asked to participate in a "neuropsychological research study". Many potential participants felt that they would be required to engage in medical procedures, physically demanding tests, or shock treatment despite clear explanation and demonstration of all tests by the author. Other potential participants disclosed that they completely distrusted psychological instruments and did not wish to disclose personal information or engage in these tests.

Due to the lack of success in recruiting a suitable control group, normative and non-solvent use clinical data for comparison had to be drawn from similar Native solvent abuse studies (e.g., Moland, 2004) as well as test manual norms (which were primarily non-Native).

Beauvais et al. (2002) reports that many solvent users also suffer from poly-substance abuse issues. Solvent users were interviewed to determine if they had both prior substance use and inhalant use chronicity. Participants were also asked to estimate weekly substance use levels. As identified solvent users in the city of Thunder Bay were very rare, solvent users were not disqualified for poly-substance abuse.

Each participant was provided a cover letter outlining the purpose and procedures involved in the study, and were required to provide their written, informed consent before participation. All participants were informed that they have the right to withdraw without penalty at any time during the study, or refuse to answer any question during the study, while still receiving full remuneration.

Participant confidentiality was maintained by removing names and specific identifying characteristics of KNCH participants from the study upon completion of the project. Participants were assigned an identifying number matched to a master list kept by the author.

Once a participant provided their informed consent to the study, they were then interviewed and assessed on each neuropsychological (the Finger Tapper, CPT, TOL and Spatial Span) and psychological test (the STAI, TONI-3 and BDI-II). Upon completion of the test battery, each participant received their $5 remuneration (Moland, 2004) with the opportunity to participate in the $100 draw at the end of the study. The estimated length of time to complete the battery was 90 minutes per participant.

Upon completion of the study, all participants were fully debriefed on the study and offered results at their request.

One aspect of the study not covered in the literature was the possible need for a translator. While an Ojibway or Cree speaking translator was not necessary during the interviews, all control participants identified English as their second language and required frequent clarification to comprehend the cover letter, procedures and test instructions.

All data from the study were securely stored at Lakehead University and will remain so for 5 years.

Analyses

Originally, the author intended to use the ANCOVA to examine overall test results as a primary means of analysis. Differences between Aboriginal controls, solvent abusers and norms were to be examined for differences between non-native norms and Aboriginal populations.

The lack of success in recruiting age and ethnically matched Native control participants severely limited the scope of analyses available to the author and performing an ANCOVA was no longer possible, nor was an examination of the relationship of the covariates to possible group differences in the independent variables. Consequently, all of the statistical comparisons presented were made between the experimental participant data and test manual normative data or normative data provided from similar studies, using t-tests to determine statistically significant differences. Potential weaknesses of the t-test are that it lacks sensitivity, and due to the small sample size, error rates are most likely inflated.

Demographic and substance abuse data

The pre-assessment interview (experimental group data only) collected data on several variables that the literature has suggested may have an impact upon the present study. These variables were intended to act as covariates. However, variables assessing TBI (Traumatic Brain Injury), family history of disease, medication use, substance abuse and frequency of substance use were removed from the analyses due to lack of specificity and inaccurate reporting of information from the participants. Due to the lack of a comparable control group, demographic data are presented in descriptive form only.

Age

Participants at KNCH ranged from 18 to 24 years of age ($\underline{N} = 10$, $\underline{M} = 20.08$, $\underline{SD} = 2.098$).

Handedness

Eighty percent of participants were primarily right handed (n = 8), and 20% of participants were left handed (n = 2).

Solvent Use

Participants were all primarily poly-solvent users, using two or more solvents over the course of their lifetime. One-hundred percent of solvent use participants used gasoline. Three participants (30%) also used propane. Four participants (40%) also used lighter fluid. In combination with these substances, one participant (10%) also used rubber cement, whiteout, nail polish remover, permanent marker, air freshener and lacquer over the course of their lifetime.

Age Started

All participants (N = 10) reported starting solvent use before 16 years of age (M = 10.40 yrs, SD = 3.596) with a minimum starting age of four years old (n = 1), and a maximum starting age of 15 years old (n = 1). On average, the participant group (n = 10) had abused solvents for 9.68 years.

Frequency of Solvent use

Thirty percent of participants (n = 3) reported abusing solvents daily during the course of their lifetime, with one participant (10%) reporting abusing solvents up to an estimated four times a week, two participants (20%) abusing solvents three times a week, two participants (20%) abusing twice a week, and two participants (20%) reporting abusing solvents once a week. All participants (100%) reported that they stopped abusing solvents at or under 12 months ago (N = 10, M = 6.2, SD = 4.185), with more then half the participants (n = 6) ending their solvent abuse more then 5 months ago.

Test Measures

Anxiety

Anxiety was assessed using the State-Trait Anxiety Inventory (STAI), Form Y (Spielberger et al., 1983). This test assesses both "state" (the current level of anxiety experienced by the participant) and "trait" (how the participant "generally" feels) anxiety. Both state and trait portions of the STAI-form Y-1 have 20 items that assess the participants current and long standing levels of anxiety. The author was primarily interested in the present levels of anxiety that participants were feeling during the testing period as a covariate, thus, only "state" data were analyzed and reported. Experimental data were compared to non-clinical male "college student" norms ($N = 324$, $M = 36.47$, $SD = 10.02$) contained within the STAI (see Table 1).

Nine participants completed the STAI ($N = 9$, $M = 42.2$, $SD = 8.27$), while one participant did not fully complete the questionnaire and STAI results were not reported. A t-test was conducted and results showed that participants were not significantly more anxious compared to test norms at the time the study was conducted, $t_{.05}(332) = 1.79$, $p > .05$.

Depression

Depression data from participants were compared to test, age and location matched data from a previous study on solvent abusers (Moland, 2004). One participant chose not to complete the DBI. The results show that experimental participants ($N = 9$, $M = 20.44$, $SD = 11.907$) were not significantly more depressed then controls ($N = 14$, $M = 12.14$, $SD = 7.48$), $t_{.05}(21) = 1.99$, $p > .05$, although the observed difference does approach significance (see Table 2). Both depression and anxiety were not significantly correlated with primary test measures.

Motor Skills

Finger Tapping Test

Experimental data were compared to age matched non-clinical norms (see Table 3) for both the dominant hand ($N = 45$, $M = 49.5$, $SD = 5.1$) and non-dominant hand ($N = 45$, $M = 45.6$, $SD = 5.1$) provided by the Compendium of Neuropsychological Tests: Administration, Forms and Commentary (Strauss, Sherman, & Spreen, 2006). Participants identified in the pre-assessment interview which hand was their dominant hand. Participant's performance (see Table 3) with the dominant hand ($N = 10$, $M = 50.36$, $SD = 3.461$) was not significantly different from test norms, $t_{.05}(53) = 1.50$, $p>.05$. Participant performance with the non-dominant ($N = 10$, $M = 45.38$, $SD = 4.91$) hand was also not statistically significant, $t_{.05}(53) = 1.796$, $p>.05$.

Attention/Concentration

Connor's Continuous Performance Test (CPT)

The CPT records a total of 12 different variables in its analyses. A CPT report provides the raw score for each variable as well as a T-score, percentile and a guideline for score performance. However, for research purposes the literature generally reports only five variables: number of omission errors; number of commission errors; response time (in milliseconds); response time standard error; and standard error variability (Connors, 2003). These results are usually represented in raw score form and means and standard deviations are recorded. Experimental data in this study were compared to non-clinical control data (see Table 4) from a study by Advokat, et al. (2007). Definition of each test score was drawn from the CPT manual (Connors, 2000)

Omissions

This score represents the number of omission errors. Omission errors result from the failure to respond to target letters (i.e., non-X's). Experimental participants (N = 10, M = 9.3, SD = 9.67) did not have significantly more omission errors than controls (N = 30, M = 5.0, SD = 8.6), $t_{.05}(38) = 1.699$, $p > .05$.

Commissions

This score represents the number of commission errors. Commission errors are made when the responses are given to non-targets (i.e., X's). Results show that the experimental group (N = 10, M = 24.7, SD = 3.591) made significantly more commission errors then controls (N = 30, M = 14.4, SD = 7.3), $t_{.05}(38) = 4.27$, $p < .001$.

Reaction Time

This score represents the overall hit reaction time in the average speed (in milliseconds) of correct responses for the entire test. Experimental participants (N = 10, M = 338.22, SD = 64.36) did not significantly differ from controls (N = 30, M = 341.5, SD = 52.1) in terms of overall reaction time to stimuli, $t_{.05}(38) = .159$, $p > .05$.

Reaction Time Standard Error

Standard error is a measure of response speed consistency that the participant displays over all signals. The higher the overall SE, the greater the inconsistency of the response speed to signals. Experimental participants (N = 10, M = 13.64, SD = 17.2) showed a significantly greater standard error in response speed from the control norm (N = 30, M = 6.2, SD = 1.9), $t_{.01}(38) = 3.504$, $p < .01$.

Variability

This score is a measure of response speed consistency that measures "within respondent" variability which represents the amount of variability the participant shows throughout the test in relation to their own overall standard error. Thus, the higher the variability of standard error, the greater the inconsistency in the response speed. Results show that experimental participants (N = 10, M = 13.64, SD = 17.208) did not show significantly different within respondent variability from control data (N = 30, M = 9.5, SD = 6.2), $t_{.05}(38) = .654$, $p > .05$.

Executive Functioning

Tower Of London Test (TOL)

The TOL measures seven variables in an attempt to come to a general 'range' of performance for executive functioning for each variable: total move score (a measurement of total moves over all test problems); total correct score (the total number of test problems solved at or under the correct number of moves); total time violations (when a participant does not complete a problem in under one minute, they have committed a time violation); total rule violations (when a participant moves two beads at once, or stacks more beads on a post that it was made to handle, then they have committed a rule violation); total initiation time (the total time over all test problems in seconds that a participant has taken to start solving a problem); total execution time (the total time in seconds that a participant has taken to solve all test problems); and total problem solving time (the sum of total initiation time and total execution time, in seconds). Experimental means and standard deviations (see Table 5) were compared to TOL test manual means and standard deviations for the appropriate age range. Results show only two significant differences, with experimental participants (N = 10, M = 36.10, SD = 29.46) scoring significantly higher in total moves required to complete all test problems, $t_{.01}(200) = 2.99$, $p > .01$ and scoring higher (N = 10, M = 331.2, SD = 256.594) in total execution time, $t_{.05}(200) = 2.02$, $p < .05$. While there is no "gold standard" in the TOL by which to develop one aggregate score of executive functioning, the overall results would suggest that executive functioning capacity was not adversely affected in the experimental participant population. Overall (across all variables), while participants appeared to have significant difficulties solving test problems, they appeared to carefully consider moves for longer periods of time, especially after incorrect bead movements.

Test of Non-verbal Intelligence (TONI-3)

Normative and clinical data were drawn from Moland's (2004) study on First Nation Adult offenders who have abused solvents. TONI-3 data were compared to Moland's (2004) control participant data (N = 14, M = 97.21, SD = 11.28) and participants were found to have significantly lower (N = 10, M = 77.9, SD = 3.542) non-verbal IQ then control norms, $t_{.05}(10) = 6.01$, $p < .001$ (see Table 4).

Digit Span

Experimental Digit Span data was compared to Moland's (2004) control participant data for forward (N = 14, M = 10, SD = 2) and backward (N = 14, M = 6.36, SD = 1.78) counts. Results show that participants (N = 10, M = 7.4, SD = 2.066) scored significantly lower then control norms in the forward count, $t_{.001}(22) = 6.29$, $p < .001$. Participants did not score significantly different worse than norms for backward count, $t_{.05}(22) = 1.15$, $p > .05$ (see table 7).

TONI-3 Correlations

Analyses of TONI data were correlated (one-tailed correlations) with test variables to determine any relationships. Results show that TONI data are correlated with CPT reaction time, $r(10) = -.763$, $p<.01$, CPT reaction time standard error, $r(10) = -.617$, $p<.05$, and CPT variability , $r(10) = -.599$, $p<.01$. These correlations indicate that non-verbal IQ may be implicated for at least one factor as to why solvent users appeared to have more difficulty cognitively processing signals from the CPT, which is implied by significant correlations with reaction time, reaction time standard error, and variability of within-subject speed. Digit span forward was also significantly correlated with the TONI, $r(10) = .568$, $p<.05$, but not digit span backward $r(10) = .500$, $p>.05$. TONI IQ was not significantly correlated with any other measures, thus suggesting that other significant test measures may be explained by other factors. Interestingly, this study's solvent use participants average TONI IQ was also not significantly different from Moland's (2004) Aboriginal solvent use group ($N = 28$, $M = 79.1$, $SD = 7.66$) data, $t.05(40) = 1.68$, $p>.05$ which was also primarily solvent using and fairly age matched. A relationship between low TONI IQ and solvent abuse seems to be apparent, yet the nature of this relationship requires further study.

Discussion

Unfortunately, the study is compromised due to a very small experimental group combined with a lack of a control group of age and location matched participants. The lack of a comparison group and the subsequent need to use norms from other studies has also severely limited the types of statistical analyses that are able to be performed on the data. The lack of a control group made it impossible to thoroughly examine such vital data as error variances and covariance effects. The study also could not control for the effects of age, drug use, head injuries, medication or frequencies and types or solvent use. Because of the severely limited numbers of identified solvent abusers in Thunder Bay, combined with the remoteness of Indian Reserves in northern Ontario where solvent abuse is common, the author was unable to correct these weaknesses of the study. Unfortunately, differences in test results may be due to factors beyond the study's control.

One of these factors is related to language. It is unknown how being a primary Native language speaker might have affected participant performance, or even if the test concepts translated across the English/Ojibway/Cree language barrier with a high degree of accuracy. All ($\underline{N}$ =10) participants asked for clarification of items on written instruments like the STAI and BDI or test instructions for the TOL. Some participants did not see the logic or need for such tests or felt some questions were "dumb". Was this due to a lack of understanding about test instructions, or a cultural barrier? Were participants who did not see the logic or need of tests responding to the best of their abilities? The literature shows that cultural differences can indeed impede understanding of test instructions or perhaps affect variables like reaction time to instruments (Brandt, 1984). Due to time constraints the author was unable to perform a qualitative analysis to further explore these possible implications.

The data did not appear to show consistent statistically significant deficits in the overall areas of motor functioning, executive functioning, attention/concentration or memory, although significant differences were found in sub-scores of some of tests. Of note are the statistically significant correlations of TONI IQ with scores in the CPT and

Digit Span tests, which imply a relationship with non-verbal IQ. Experimental TONI-3 data were also not significantly different from clinical data from Moland's (2004) study on First Nation solvent abusers. However, Moland's Aboriginal control data were significantly higher and in the normal TONI IQ range (N = 14, M = 97.21, SD =11.28). The relationship and direction between low TONI IQ and solvent abuse needs to be explored further before any conclusions can be made.

Directions for Future Research

The current literature has noted that research in the field of inhalant abuse is lacking (Bates et al., 1997; Beauvais 1997, 2002; Brouette & Anton, 2001; Gerasimov, Schiffer, Marstellar, Ferrieri, Alexoff, & Dewey, 2001; Howard et al., 1999; Kurtzman et al., 2001; Remington & Hoffman, 1984) and several questions still need to be addressed. Beauvais (1997, 2002) noted that the literature indicates a lack of progress in understanding in physical/neuropsychological effects, prevention, and treatment in solvent abuse. The data on physical/neuropsychological research are growing slowly, but there also exists a need to look at other areas of inhalant abuse, as addressed by Beauvais (1997).

In terms of prevention, Beauvais (1997) described several questions that need to be addressed in order to better understand solvent abuse: what is the "cultural meaning" of inhalants to inhalant abusers?; why does solvent abuse seems to occur in rapidly cycling epidemics?; what are the socio-cultural or other conditions that give rise to adult patterns of solvent abuse?; what psychosocial factors are associated with solvent abuse among youth and adults?; what are the most effective prevention messages to counter solvent abuse?; are there age specific factors that need to be considered?

Many inhalant abuse treatment directors have informally indicated that they perceived that there was a lack of data regarding inhalant abuse treatment. In fact, there only exists one known study by Reidel, Herbert, and Bird (1995) which addressed the effects and approaches to treatment. However, this study only assessed inhalant abuse treatment directors' perceptions and general knowledge about the field of solvent abuse rather than the perceptions of those in treatment.

While the primary objective of this study was to examine the effects of solvents upon Native male solvent abusers in Northwestern Ontario, a question about the cultural sensitivity of procedures and recruitment in regards to research with Native people was raised by the reactions of potential control participants. This study received permission from the Research Ethics Board of Lakehead University to recruit participants and conduct the current study using standard recruitment procedures, testing procedures, instruments and analyses. What was unexpected was the degree of resistance, reticence and strong mistrust faced by the author when approaching potential control participants and informing them that the author would like them to participate in a neuropsychological research study. Many potential participants expressed various negative perceptions about what the testing procedures would involve. Interestingly, these strongly negative perceptions remained even when the author provided demonstrations and explanations of the testing instruments and procedures.

To address the issue of cultural and language barriers to test performance, researchers interested in pursuing the area of Native solvent abuse may consider adding additional elements to their designs. Item analyses of test instruments like the STAI, BDI, and TONI will potentially yield valuable data in regards to where primary Native speaking participants are experiencing difficulties comprehending test items due to language and/or cultural differences.

While it cannot be directly confirmed by the study that the reactions expressed by potential Native participants were merely an aberration, a potential flaw in recruitment procedures, or a cultural phenomenon, the literature in the area of Indigenous research methodology suggests that there is already a strong sense of mistrust based on numerous unfortunate historical precedents between Aboriginal people and researchers (Smith, 1999) which may explain what the author experienced with potential control participants. The literature also suggests that in the case of North American Aboriginal people, an Indigenous research methodology must be developed for successful interaction and research to take place. While the literature does not yet provide a clearly definitive model for Indigenous research, Martin (2002) and Steinhauer (2002) provide five main features to an Indigenous research methodology:

1. Recognition of our world views, our knowledge and our realities and our realities as distinctive and vital to our existence and our survival. This serves as a research framework;
2. Honoring Aboriginal social mores as essential processes through which we live, learn and situate ourselves as Aboriginal people in our own lands and when in the lands of other Aboriginal people;
3. Emphasizing the social, historical and political contexts which shape our experiences, our lives, positions and futures;
4. Privileging the voices, experiences, and lives of Aboriginal people and lands;

5. Identifying and redressing issues of importance to us. (p.5)

According to Steinhauer (2002), Weber-Pillwax (1999) also suggests that those who are engaging in the process of developing an Indigenous research methodology must include a consideration of the following seven principles:

1. the interconnectedness of all living things,
2. the impact of motives and intentions on person and community,
3. the foundation of research as lived Indigenous experience,
4. the groundedness of theories in Indigenous epistemology,
5. the transformative nature of research,
6. the sacredness and the responsibility of maintaining personal and community integrity, and
7. the recognition of languages and cultures as living processes

Steinhauer (2002) suggests that in order to successfully apply research using an Indigenous methodology would also require a researcher to be aware of local customs and protocols, such as respect, reciprocity, and rationality. However, the literature also appears to suggest that the discussion on developing concrete methods of creating and applying a specific Indigenous research methodology are still ongoing. Researchers interested in adding to the new field of Indigenous research may consider including a qualitative component to their designs to contribute to these developments.

The particular potential control group participants that the author approached only became wary upon the mention of "research", which would seem provide some confirmation of the mistrust that Smith (1999) discussed. Given the importance of understanding such vital, yet poorly understood issues as solvent abuse in the North, future research must focus on further developing methodologies sensitive to Aboriginal peoples of Northern Ontario. This would provide a valuable and appropriate means of conducting research that is more culturally sensitive while yielding accurate and valuable data which will benefit Indigenous people.

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Appendix A

Neuropsychological Profile Project Cover Letter

Lakehead UNIVERSITY
Department of Psychology

Tel (807) 343-8441
Fax (807) 346-7734

Cover Letter

Dear potential participant:

I want to look for differences in neuropsychological performance between individuals who have abused solvents and individuals who have not used solvents as part of a research project to complete my M.Sc. of Applied Health Experimental Psychology at Lakehead University.

You will be asked to participate in 4 neuropsychological tests which will assess your executive functions, memory, motor skills, and concentration. You will also be asked to answer some questions about depression, anxiety, and cognitive performance, as well as some background information that may affect test performance. The procedure is safe and completely non-invasive, and involves no risk. The entire procedure will take about 60 minutes and will be conducted at

____ (location).

In return for your participation, you will receive a summary of your test results when the study has been completed. You will also receive a $5 Tim Horton's gift certificate upon finishing the session, and be entered into a $50 draw for your participation at the end of the study.

All information will remain confidential and securely stored at Lakehead University for five years, as required by Lakehead University policy.

As the investigator, it will be my role to collect all the data and review it on a computer. The testing will be carried out by me at Ka Na Chi Hih Specialized Solvent Abuse Treatment Centre and at Anishnawbe Mushkiki.

Dr. Charles Netley, a professor of Psychology at Lakehead University is supervising the project. He can be reached at 343-8486 if you have any questions or concerns. The Research Ethics Board may be contacted at 343-8283.

Sincerely,

Cameron Dokis,
cwdokis@lakeheadu.ca

955 Oliver Road Thunder Bay Ontario Canada P7B 5E1 www.lakeheadu.ca

Appendix B

Participant Consent Form

Lakehead
UNIVERSITY
Department of Psychology
Tel (807) 343-8441
Fax (807) 346-7734

Consent Form – Participant

1. I, ____________________________________, consent to take part in this study that will examine neuropsychological performance.

2. If I choose to participate, I will be asked to participate in tests assessing neuropsychological performance on memory, executive functions, fine motor functions, and concentration. I understand that I will also be asked to provide information on my basic demographics, a screen for depression, anxiety, and cognitive function.

3. I understand that all of my responses will be anonymous and confidential. After the study, my information will be coded to preserve anonymity and no identifying information will be released. The research information will be stored for five years by Dr. Netley at Lakehead University as per Lakehead University Policy.

4. I understand I am free to refuse to answer any question or discontinue my participation at any time for any reason, without explanation or penalty.

5. I understand that there are no known risks associated with participating in this research.

6. I will receive a $5 Tim Horton's gift certificate and be entered in a $50 draw for my participation.

My signature on this form indicates that I may participate in a study by Dr. Charles Netley and Cameron Dokis of Lakehead University on examining neuropsychological performance in individuals who have used solvents compared to individuals who have not used solvents.

I have received an explanation about the nature of the study and its purpose. I understand the following:

1. As a volunteer, I can withdraw at any time or refuse to answer any question.
2. There is no apparent danger of physical or psychological harm
3. The data I provided will remain confidential.
4. I will receive a summary of the project, upon request, upon completion of the project.

__________________________ __________________________

(signed) (Date)

____

(witness)

Appendix C

Demographic Information Questionnaire

Demographic Questions

1. Name/ID Number:______________________________
2. Age: ______________________________
3. Testing time: ______________________________
4. Date: ______________________________
5. Recent medication or drug use?: ______________________________
6. Have you ever had a significant brain injury?: ______________________________
7. Date of Injury?: ______________________________
8. Family history of disease?: (Y/N)______________________________
9. Right or left handed?: ______________________________
10. What solvents have you used before?: ______________________________

____

11. At what age did you start to use solvents?:______________________________
12. How often did you use solvents:?
    - o Daily
    - o Once a week
    - o Twice a week
    - o Three times a week
    - o Four times a week
    - o Five times a week
    - o Six or more times a week

13. When was the last time you used solvents:?

- Less then a month ago
- 1 month ago
- 2 months ago
- 3 months ago
- 4 months ago
- 5 months ago
- 6 months ago
- 7 months ago
- 8 months ago
- 9 months ago
- 10 months ago
- 11 months ago
- 12 or more months ago

14. What other drugs have you used before?: ________________________________

____

15. How often did you use drugs?:

- Once a week
- Twice a week
- Three times a week
- Four times a week
- Five or more times a week

16. When was the last time you used drugs?: ________________________________

____

Appendix D

Kan Na Chi Hih letter of Consent

KA-NA-CHI-HIH

Specialized Solvent Abuse Treatment Centre

RESIDENCE: 1700 Dease Street
Thunder Bay, Ontario P7C 5H4
Phone: (807) 623-5577 Fax: 623-5588

HEAD OFFICE: Suite 102-100 Anemki Drive
Fort William First Nation, Thunder Bay, Ontario P7J 1A5
Phone: (807) 626-1692 Fax: 626-1691

Ethics Committee
Lakehead University
955 Oliver Rd.
Thunder Bay, ON
P7B 5E1

May 13, 2008

Dear Research Ethic Committee Members:

We are pleased to notify the committee regarding our decision to allow Cameron Dokis to proceed with the research project involving our clients.

A Neuropsychological Profile of Northern Native Male Solvent Abusers.

The following will apply:

- Clients will be explained as to what the research involves and that participation is voluntary.
- Clients will have to sign agreement to participate with clause that they may withdraw at any time.
- Client's confidentiality must be protected as described in the code of ethics.
- Researcher will only disclose information related to research respecting client confidentiality.
- Client must sign release of information stating exactly what information will be released.

Yours truly,

Raija Vic
Treatment Coordinator

Appendix E

Anishnawbe Mushkiki letter of consent

ANISHNAWBE MUSHKIKI
Thunder Bay Aboriginal Community Health Centre
29 ROYSTON COURT, THUNDER BAY, ONTARIO P7A 4Y7
PH: (807) 343-4843 FAX: (807) 343-4728

Ethics Committee
Lakehead University
955 Oliver Road
Thunder bay, ON.
P7B 5E1

June 10, 2008

To whom it may concern:

This letter is to provide my consent to allow Mr. Cameron Dokis to recruit male Aboriginal participants, aged 18-26 years of age for his study, entitled: "A Neuropsychological Profile of Northern Male Solvent Abusers" at Anishnawbe Mushkiki, located at 29, Roston Court, Thunder Bay, ON. If there are any concerns, please feel free to contact me at 343-4843, ext. 224.

Best regards,

Bernice Dubec,
Executive Director.

Appendix F

Control participant recruitment card

Neuropsychological Profile Study

Hi, my name is Cameron Dokis, and I am looking to conduct a study to examine the differences between individuals who have used solvents in the past, and those who have not. The study will take about one hour and 15 minutes, is completely safe and non-invasive, and all responses will be completely confidential. In return for your participation, you will receive a Tim Horton's gift certificate and be entered into a $50 draw.

If you are a healthy Aboriginal male,
who is 18-26 years of age,
and are interested in participating,
please contact
Cameron Dokis at 251-0118
or by email at
cwdokis@lakeheadu.ca.

You may also contact Dr. Charles Netley at 343 8110

Table 1

Means (and standard deviations) comparing experimental group and control norms for the STAI (norms provided by Spielberger, et al., 1983)

Characteristic	Solvent users	Control
N	9	323
Age	20.8(2.098)	not given
STAI	42.2(8.270)	36.7(10.2)

Table 2

Means (and standard deviations) comparing experimental group and control norms for BDI-II (norms provided by Moland, 2004)

Characteristic	Solvent users	Control
N	9	14
Age	20.8(2.098)	28.86(7.46)
BDI-II	20.44(11.907)	12.14(4.48)

Table 3

Means (and standard deviations) comparing experimental group and control data norms for Finger Tapping Test (norms provided by Strauss, et al., 2006)

Characteristic	Solvent users	Control
N	10	45
Age (Years)	20.08(2.098)	20
Dominant hand	50.36(3.46)	49.5(5.1)
Non-dominant hand	45.38(4.91)	45.6(5.6)

Table 4

Means (and standard deviations) comparing experimental and control data norms for the Connor's Continuous Performance test (control data provided by Advokat, et al., 2007).

Characteristic	Solvent users	Control
N	10	30
Age	20.88(4.40)	13.48(2.39)
Omissions	9.30(9.67)	5.0(8.6)
Commissions**	24.7(3.591)	14.4(7.3)
Reaction Time	338.22(64.36)	341.5(52.1)
Reaction Time SE**	13.64(17.2)	6.2(1.9)
Variability	13.64(17.208)	9.5(6.2)

Note: N=40. *Significant at $p<.05$, ** at $p.<01$.

Table 5

Means (and standard deviations) comparing experimental group and normative data for Tower of London test (norms provided by Culbertson, et al., 2005)

Characteristic	Solvent users	Control
N	10	192
Age	20.80(4.40)	24.5
Total move**	36.9(29.42)	27.3(16.7)
Total correct	3.7(1.889)	4.7(2.4)
Rule violations	.3(.483)	.2(.7)
Time violations	1.20(2.486)	.05(.09)
Initiation time	54.6(47.96)	52.8(43.5)
Execution Time**	331.2(241.89)	195.2(92.0)

Note: N=55. *Significant at $\underline{p}<.05$, ** at $\underline{p}.<01$.

Table 6

Means (and standard deviations) comparing experimental and control data norms for TONI-3 (control data provided by Moland, 2004).

Characteristic	Solvent users	Control
N	10	14
Age	20.80(4.40)	28.86(7.46)
TONI I.Q.**	77.90(3.542)	97.21(11.28)

Note: N=24. *Significant at $p<.05$, ** at $p<.01$.

Table 7

Means (and standard deviations) comparing experimental and control data norms for Modified Digit Span test (control data provided by Moland, 2004).

Characteristic	Solvent users	Control
N	10	14
Age	20.80(4.40)	28.86(7.46)
Digit Span (forward)**	7.40(2.066)	10.00(2.00)
Digit Span (backward)	4.50(.972)	6.36(1.78)

Note: N=24. *Significant at p<.05, ** at p.<01.

Table 8

Correlations of the TONI-3 with test measures.

Test	*r*
STAI	r(10) = .179
BDI-II	r(9) = .064
Finger Tapper	
Right hand	r(10) = .420
Left hand	r(10) = .216
CPT	
Omissions	r(10) = -.295
Commissions	r(10) = .163
Reaction time**	r(10) = -.763
Reaction time SE*	r(10) = -.647
Variability*	r(10) = -.599

Note: *Significant at p<.05, ** at p.<01.

Table 8 (continued)

Correlations of the TONI-3 with test measures.

Test	*r*
TOL	
Total move	r(10) = .291
Total correct	r(10) = -.105
Rule violations	r(10) = -.110
Time violations	r(10) = .305
Initiation time	r(10) = .046
Execution time	r(10) = .350
Total problem solving time	r(10) = .339
Digit Span	
Forward*	r(10) = .568
Backward	r(10) = .500

Note: *Significant at $p<.05$, ** at $p.01$.