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A Smoking Cessation Program Using Vouchers with Individuals with Traumatic Brain Injury

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A Smoking Cessation Program Using Vouchers with Individuals with Traumatic Brain Injury

by

Thomas K. Erickson

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Arts Department of Child and Family Studies College of Behavioral and Community Sciences University of South Florida

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Abstract

This study examined the effects of a smoking cessation program using vouchers as reinforcers with individuals with traumatic brain injury and a history of substance abuse. The intervention was conducted at a residential facility that houses individuals with Traumatic Brain Injury (TBI). Vouchers were delivered contingent on reductions of carbon monoxide (CO) samples of 5 ppm or less across a shaping phase, and an abstinence induction phase. A standard pay phase was added at the end of the study to examine the effects of a standardized reinforcement scale with the abstinence criterion set at 8 ppm or less. Reductions in CO were not robust in the shaping and abstinence induction phase. The standard pay schedule showed some improvements in CO levels with less variability for two of the three participants.
Introduction

According to the CDC smoking is the leading cause of death in the U.S. From 1998 to 2008 smoking declined to 20.6%, which was a 3.5% reduction from the previous years (Center for Disease Control, 2009). Men in the United States have a smoking prevalence rate of 23.1% and women 18.3%. Smoking carries with it a number of health risks which include various types of cancer. It has been linked to kidney, laryngeal, lung, cervical, bladder, esophageal, pancreatic, and oral cancer (CDC, 2009). Along with these risks include heart disease, cerebrovascular atherosclerosis, and a number of respiratory diseases (CDC, 2009). Between 2000 and 2004, smoking resulted in 269,655 deaths among men and 173,940 deaths among women in the United States (Adhikarri, Khende, Malarcher, Pechacek, & Vong, 2009). Despite these risks, between 2007 and 2008 there was a modest increase in smoking which stunted the nationwide Healthy People 2010 objective of reducing the prevalence of cigarette smoking to < 12% among adults (CDC, 2009). And although adolescent smoking use declined from 1997 to 2003, the prevalence rate remained stable with 20% of high school students still smoking cigarettes.

With the many health risks associated with smoking, a number of cessation treatments have been tested showing positive effects with short and long term abstinence among adults (Khazall, Cornux, Bilancioni, & Zullino, 2006; Kornitzer, Boutsen, Dramaix, Thij, & Gustavsson, 1995; Oncken et al., 2006; Schneider et al., 1995; Schnoll et al., 2010; Stapleton et al., 1995). Such treatments have included medications such as nicotine replacement therapies (NRT) that incorporate the use of lozenges, nicotine
inhalers, nicotine nasal sprays, nicotine patches or nicotine gum to help reduce smoking (Aveyard, Johnson, Fillingham, Parsons, & Murphy, 2008; Cooney et al., 2009; Schneider et al., 1995; Shiffman et al., 2002; Sutherland & Stapleton, 1992). Some NRT products are designed to show an immediate effect by impacting the amount of craving an individual encounters. While others are designed to release a continuous supply of nicotine throughout a 24 hour period and provide a more gradual effect that has led to abstinence being verified at one year follow up (Shiffman et al., 2002).

Additional medications have included antidepressants such as bupropion and nortriptyline, which have shown long term abstinence (Fossati et al., 2007). Varenicline, a nicotine blocker, has shown to be effective with higher continuous abstinence rates in comparison to a bupropion and placebo group at 52 week follow-up (Jorensby et al., 2006). Topiramate, an anticonvulsant medication, has shown more gender specific effects in men with men four times more likely to quit when treated with Topiramate than men in the placebo group (Anthenelli, Blom, McElroy, & Keck, 2008).

Some other treatments have included combinations of NRT with components such as practitioner’s advice and educational material, and have demonstrated positive effects for abstinence (Russell, Merriman, Stapleton, & Taylor, 1983). This is further supported by later studies that have implemented combination approaches and also demonstrated positive effects (Buchkremer, Bents, Horstmann, Opitz, & Tolle, 1989; Puska et al., 1995; Russell, Merriman, Stapleton, & Taylor, 1983). By themselves, certain NRTs may be more effective in conjunction with behavioral support that includes counseling and advice from a nurse practitioner (Leischow, Ranger-Moore, Muramoto, & Mathews, 2004). Buchkremer et al. (1989) implemented a combination approach with a
behavioral component that included a deposit contract designed to assure attendance in small group training sessions and showed efficacy with reductions in smoking.

A number of studies have included contingency management programs using money and have yielded positive results as well. Rand, Stitzer, Bigelow, and Mead (1989) implemented a combination approach that included contingency management in conjunction with frequent monitoring in a between-group design at a worksite delivering payment contingent on lower levels of CO. This resulted in a delay in relapse that was significantly different than the placebo and the noncontingent group (Rand et al., 1989).

In another study Stitzer, Rand, Bigelow and Mead (1986) introduced a contingency management intervention that utilized a sliding scale for money earned contingent on reductions in CO level. In the final two weeks of the study participants had the opportunity to earn $12 a day if they were completely abstinent and provided breath samples three times a day. Results demonstrated that most of the participants were willing to attempt abstinence during the last two weeks and that 80.5% were breathing < 8 ppm in CO demonstrating a significant reduction from pre-study readings (Stitzer et al., 1986). In a more recent study done by Reynolds, Dallery, Schroff, Patak, and Leraas (2008), researchers monitored four adolescents for smoking abstinence and found that all participants achieved prolonged abstinence when money was delivered contingent on CO levels < 5 ppm.

In other instances vouchers have been shown to be effective. Dunn, Sigmon, Thomas, Heil, and Higgins (2008) found a voucher based contingency management program to be effective in curbing smoking with methadone-maintained individuals. They also found a greater percentage of abstinent samples were provided with the
contingent group than the noncontingent control group (Dunn et al., 2008). Other novel approaches have included the use of drawings as well as the use of deposit contracts. Alessi, Petry, and Urso (2008) implemented a contingency management intervention with residents that involved the earning of draws in a raffle drawing with each negative CO reading. Results showed decreases in cigarettes smoked and reduced levels in CO with residents entering a substance abuse program (Alessi et al., 2008). Dallery, Meredith, and Glenn (2008) used deposit contracts that were demonstrated to be feasible in delivering reinforcement for abstinence.

Approximately 200,000 individuals with mental health illness die annually of tobacco related disease. For people with mental illness and a history of substance abuse, nicotine addiction is generally much more severe than in the general public (Schroeder & Morris, 2010). Additionally, 77%-93% of individuals in substance abuse clinics use tobacco products (Schroeder & Morris, 2010). Individuals with mental illness/substance use disorder also have a tendency to die 25 years earlier than the general population as a result of smoking and previous existing conditions (Schroeder & Morris, 2010). In addition to the health consequences, smoking places a financial toll on individuals with mental illness and substance abuse problems by impacting the way money is managed. Approximately 27% spend their money on smoking (Schroeder & Morris, 2010). Part of becoming more independent involves having the ability to manage money wisely. Without money management skills, integration back into the community becomes more difficult.

With populations with mental illness/substance abuse, the success of smoking cessation may be predicted by symptoms of comorbid diagnosis of depression. Niaura et
al. (2001) in one study examined pre-treatment symptoms of depression and the time to relapse to see if symptoms could predict the time to relapse. Researchers concluded that minimal symptoms of depression, described as pre-treatment mood, were enough to predict the survival of quit attempts. But lifetime history of depression did not (Niaura et al., 2001). Treatments for individuals with mental illness have included many of the FDA approved medications that are typically used by the general population (Schroeder & Morris, 2010). Because individuals with mental illness or substance dependence often have more severe nicotine addictions, individuals also require more intensive treatment that may include higher doses and longer durations of treatment, and potentially more combinations of interventions that are included in a highly individualized treatment plan (Schroeder & Morris, 2010). Despite the impact smoking has on these individuals, tobacco control with this population has been insufficient and requires further research (Schroeder & Morris, 2010).

Furthermore most research on smoking cessation has focused on interventions with typically developing adults. Much of the research on smoking also focuses on surveys determining variables predating smoking prevalence rather than interventions (Fagan, Brook, Rubenstone, & Zhang, 2005; Shiffman, Brockwell, Pillitteri, & Gitchell, 2008; Slomkowski, Rende, Novak, Lloyd-Richardson, & Niaura, 2004). No known research has focused on adult smokers with traumatic brain injury (TBI) who may also be dually diagnosed with psychiatric illness and a history of substance abuse. Further research for this population is needed considering that many individuals with comorbid substance use disorder are also addicted to nicotine. Individuals with TBI often have other diagnoses including Post Traumatic Stress Disorder (PTSD) where symptoms might
include intense fear and anxiety, and insomnia (Lew et al., 2008; Parcell et al., 2006). In one study insomnia was reported in 80% of participants with TBI (Parcell et al., 2006). Among individuals with TBI, substance use disorder is found to be more severe and many also experience higher rates of depression, and anxiety with increases in suicide attempts (Felde, Westermeyer, & Thuras, 2006). Many prescribed medications for smoking cessation have side-effects that may resemble symptoms associated with comorbidity. For example bupropion, which is generally prescribed as an antidepressant and has been approved for use in smoking cessation, has been known to cause reactions such as sleeplessness, panic attacks, depression, irritability, and seizures which are common among individuals with TBI (“Side effects”, 2010). Nortriptyline is another common antidepressant medication that shares some of the same side-effects that include changes in mood, suicidal ideations, trouble sleeping with the addition of heart pounding (“Side effects”, 2010). These types of effects can lead to greater difficulties with independence and general well-being and also impact the outcome of any treatment. In cases in which prescribed medications can not be used, alternatives could include nicotine replacement therapies such as nicotine gum or nicotine patches which have been demonstrated to be effective and even more effective as combination treatments (Puska et al., 1995). However, these treatments also have side-effects such as skin irritation, mouth and throat soreness, nausea, vomiting, and coughing. More serious side-effects may also include heart palpitations and chest pains along with insomnia (Mills, Lockhart, Wilson, & Ebbert, 2010). Even if side-effects were controlled for individuals with TBI, the use of nicotine replacement therapies may be contraindicated if individuals have preexisting medical conditions (“Side-effects”, 2010).
Other options are needed for individuals with TBI. Contingency management programs have been effective in reducing CO levels in individuals who smoke without the potential harm associated with medications. As described earlier, many studies have examined the use of vouchers, lottery tickets, and raffle drawings and in many cases these have been shown to be effective for smoking cessation (Alessi et al., 2008; Dunn et al., 2008; Neese, 2009). This study extends previous research on smoking cessation studies that have used vouchers as reinforcers and also incorporates other behavioral components that have been used to decrease smoking such as frequent monitoring, self-monitoring, and vouchers. The main purpose of this study was to examine the efficacy of using vouchers in a smoking cessation intervention with individuals with TBI and a history of smoking.
Method

Participants

Three participants, 1 female and 2 male with traumatic brain injury (TBI) and with a history of at least 1 year of smoking participated in the study. Amanda was a 36-year-old Caucasian female who was a left leg amputee which was the result of an automobile accident. Amanda was diagnosed with bipolar disorder, chronic anemia, and TBI. Her past diagnoses have included substance use disorder. Amanda was undergoing treatment for pain that she was experiencing in her phantom limb and had difficulty walking with her prosthetic. She spent most of her time ambulating using her wheelchair. Amanda reportedly had smoked for about 20 years starting at the age of 15 and had attempted quitting at least once. In the past Amanda had used the patch and Chantix - a prescribed medication that blocks the nicotine receptors of neurons. Amanda reportedly smoked approximately 22 cigarettes a day. Harry was a 45-year-old Asian American male diagnosed with a TBI, substance use disorder and type II diabetes. His TBI was sustained from an automobile accident. As a result he had residual deficits to his short term memory, concentration, and dysphasia. His drug use had included alcohol, opiates, cocaine and marijuana. Harry reportedly had never attempted quitting smoking and never used any nicotine replacement therapy. Harry reportedly smoked about 10 cigarettes a day and had smoked for 27 years. Mark was a 34-year-old Caucasian male who sustained a TBI after falling from a wall while on active duty. His past diagnoses had included bipolar disorder and substance use disorder. His drug use included opioids,
cocaine, marijuana, alcohol, and heroin. In the past Mark had made quit attempts at least 4 times and had used the patch as part of his nicotine replacement therapy. Mark reportedly smoked 16-20 cigarettes a day and had smoked for 22 years. The residential facility, in which all three participants resided, assessed functioning level using the Rehabilitations Institute of Chicago Functional Assessment Scale (RIC-FAS). Based off of the RIC-FAS, participants had a minimum of mild to moderate impairment and a rating of 4-5 on the memory scale. Individuals who have a rating of 4 require minimal prompting, and they recognize and remember 75-90% of the time. Participants who score a 5 require prompting only under stressful conditions, but no more than 10% of the time. Participants also had a minimum baseline CO level between 10 and 15 parts per million (ppm) and were not currently part of a smoking cessation program.

**Setting**

The setting was at a residential facility that housed 20 residents with TBI. In the residential facility there were approximately 200 employees with 8-10 caretakers assigned to each shift. Many of the residents were part of a work hardening program in which they worked at the residential housing facility earning money doing odd jobs which included grounds keeping, cleaning, and stuffing brochures. As a part of their program residents undergo inpatient treatment which includes cognitive therapy, counseling, physical training, and behavioral services. Behavioral services are implemented as part of a comprehensive program designed to reduce problem behaviors that may include verbal outbursts, elopement, drug seeking, and physical aggression. Additionally behavioral services are provided to facilitate the acquisition of skills for independence with the eventual goal for residents to be able to live on their own. Two of
the participants Amanda and Mark lived in apartments with roommates on the residential campus. Harry lived in a group home with one other client not participating in the study.

**Interview**

Prior to the start of intervention, each participant underwent a brief counseling session provided by the board certified behavior analyst at the facility via a power point presentation format that covered setting a quit date, tips on gaining support from friends and family, planning for challenges, and removing triggers to smoking in the environment using the *Clearing the Air: Quit Smoking Today* booklet (attached to appendices). At the conclusion of the counseling session, motivation for quitting was assessed using the University of Rhode Island Change Assessment Long Form (URICA) (Appendix 1) (University of Rhode Island Cancer Prevention Research [URICA], 1991). The addition of a counseling session with the booklet and the assessment for motivation was based off of an earlier study by Glenn and Dallery (2007). Demographic information was gathered through a review of the participants’ file. Information that was gathered included gender, age, current diagnoses, race, history of smoking, age of first cigarette, and current medical conditions.

Withdrawal, craving, and nicotine dependence can be important factors for long term abstinence and relapse and were assessed using different assessment scales. Nicotine dependence was assessed during baseline using the Fagerstrom Test for Nicotine Dependence (Appendix 2) to assure dependence at the start of the study (Fagerstrom, Heatherton, & Kozlowski, 1991). Withdrawal severity is a predictor of relapse and was tracked throughout the study. Withdrawal was assessed at the beginning and end of baseline conditions, at the end of the shaping phase, at the end of the
abi


dience induction phase, and at the end of the standard pay phases using the
Minnesota Withdrawal Scale Revised (MWSR) (Appendix 3) (Hughes & Hatsukami,
2008). Craving severity is also important for predicting long term abstinence and was
included on the scale as part of the total score (MWSR).

**CO Monitoring**

Carbon monoxide (CO) was measured using the Bedfont Micro-Smokerlyzer. The CO monitor was tested for validity and reliability by having a non-participant non-smoker exhale into the monitor twice before the start of baseline and once per week throughout the study. The two readings for the non-smoker were compared to each other to determine reliability. The two readings for the smoker were also compared to each other to determine the reliability of the readings. A comparison of readings between smoker and non-smoker was conducted to determine validity. If the smoker’s reading was higher than the non-smoker’s reading for both exhalations then this would indicate instrument validity. To get an accurate reading the participant inhaled and held their breath as the device counted down from 15 s. During the last three seconds the device beeped briefly for the first two seconds and beeped one continuous tone for the third second. At the end of the beep the participant placed their mouth onto the cardboard mouth piece attached to a plastic D-piece on the front of the CO monitor and exhaled into the device continuously. After the participant completely exhaled into the device, a reading was delivered in parts per million (ppm) on the display located on the front of the monitor.

Participants provided 4 CO readings each day separated by at least 5 hrs and not to exceed 8 hrs in between readings (Reynolds et al., 2008). This requirement was
included because the half-life of CO is 4 to 5 hrs. After 5 hrs trace amounts of CO can be detected at up to 8 hrs. One CO sample was given in the morning between 8 am and 9 am. The second CO sample was given in the afternoon between 12 pm and 2 pm. The third CO sample was taken early evening between 5 pm and 7 pm. And the last CO sample was taken prior to each participant going to bed. For participant 1 her last sample was taken at 9 pm. For participant 2 and 3 their samples were taken between 10 pm and 11 pm before they went to bed.

**Staff Training**

A task-analysis for the CO monitor is located in Appendix 4. Prior to the study, staff members and research assistants were trained to use the CO monitor by practicing on themselves with the trainer. The use of the CO monitor was modeled by the trainer before assistants and staff members practiced on themselves. Staff members and research assistants were graded on the completion of the steps in the task analysis and required to retest until 100% had been achieved. Research assistants and staff members were trained on data documentation which included the CO level, the amount of money a participant earned per CO reading and the serial number of each of the vouchers. Assessment tools (i.e. the URICA, MWSR, and Fagerstrom) were administered by the researcher and the BCBA at the facility. Research assistants and staff members all scored 100% after training.
**Experimental Design**

The study used a multiple baseline design across participants with an ABCADA format, which included a baseline (A), shaping condition with an increasing pay scale (B), abstinence induction condition (C) and a standard pay scale (D).

**Baseline**

Throughout all phases of the study, staff members were only allowed to smoke in areas out of sight of the participants. Incidentally a company wide non-smoking policy was also put into place for all employees. In baseline, participants in the study were allowed to continue smoking as they normally would. There were no consequences delivered for smoking cigarettes. CO levels were taken 4 times a day as described previously.

**Shaping**

Vouchers had values assigned to them with the amount displayed on the front. To help reduce the risk of participants falsifying the values of the vouchers, the vouchers each had their own serial number. For their first sample participants were given a voucher for a CO sample lower than their baseline mean. For each additional sample a voucher was delivered if their CO sample was less than their previous sample. Participants’ initial CO level below baseline mean resulted in a voucher worth $2.00. Each successive reduction resulted in a .25 increase until CO levels stabilized at or below 5 ppm at which time vouchers were no longer delivered for successive reductions (Reynolds et al., 2008). For example the initial CO sample was $2.00. The second CO
sample was $2.25. The third CO sample was $2.50. The fourth sample was $2.75. This continued until the participant reached $5.75. Increases in CO levels before reaching 5 ppm, resulted in the voucher amount resetting to the initial amount of $2.00 (Dunn et al., 2008; Glenn & Dallery, 2007; Reynolds et al., 2008). The participants had the potential of earning up to $62.00 during the shaping procedure. After an increase in CO, participants had the opportunity to reinstate the voucher amount with 3 negative CO readings (less than or equal to 5ppm) (Dunn et al., 2008; Reynolds et al., 2008).

Daily goals for reductions were based off of each participants’ average baseline CO level and were established across four days so that on the fourth day the CO level would be less than or equal to 5 ppm. Goals for each day were established by reducing the baseline mean for each participant by 25% across four days. Bonuses were assigned for achieving the predetermined goals within the specified time period. For achieving the first goal the participant was able to earn $5. This amount increased in increments of $5 with the accomplishment of each goal across the 4 days. For this portion of the reinforcement contingency the participant had the potential of earning up to $50 vouchers for reaching all of the goals. Participants were not able to earn bonuses more than once. For example upon earning a bonus, the participant could not provide a sample with a higher CO level then reduce the CO level again to earn the same bonus.

The purpose of this reinforcement schedule was to increase the likelihood of reductions in CO occurring within the specified period of time. Without this contingency, it was possible that participants could still earn vouchers in reductions in CO, but still not achieve any of the predetermined goals.
Additionally participants were provided feedback on their progress by the research assistants and staff members administering the CO monitor. Feedback included the provision of praise and congratulatory remarks if the participant reduced their CO levels or corrective feedback if they did not reduce their CO levels. After the delivery of a CO sample, participants were shown the CO reading and reminded of the criteria they needed to meet in order to receive the bonus vouchers. Graphical feedback including current performance, total earnings, and total available earnings was delivered twice a day, once prior to the morning sample and once prior to the early evening sample.

**Abstinence Induction**

At the conclusion of the shaping phase the abstinence induction phase began. Participants were given vouchers for providing a CO sample equal to or less than 5 ppm. Voucher values during this phase equaled the last amount they were earning during the shaping phase minus the bonus amounts. The induction phase lasted 10 days. This phase was based upon an earlier study by Dallery et al. (2008). Because the most a participant could earn per reduction in CO sample during the shaping phase was $5.75, during the abstinence induction phase participants had the opportunity to earn up to $230.00 total if they ended the shaping phase at $5.75. During the abstinence induction phase graphical feedback was faded to once a day in the morning.

**Return to Baseline**

As an evaluation of maintenance effects, following the abstinence induction phase participants returned to the baseline condition. During this time participants were allowed to continue smoking as they normally would. There were no consequences delivered for smoking cigarettes.
**Standard Pay Schedule**

As a result of a lack of intervention success and maintenance, the standard pay schedule condition was added to evaluate the differences between an increasing scale of reinforcement (shaping) and standard pay scale (abstinence induction and standard pay condition with higher voucher value). This condition was similar to the abstinence induction condition in that a flat amount was delivered contingent on the participant achieving abstinence criterion. Additionally the abstinence criterion was changed to 8 ppm or less. During the standard pay condition the graphical feedback was given once a day in the morning or early afternoon.

**Inter-Observer Agreement**

A task analysis on the use of the CO monitor was used. Research assistants collected inter-observer agreement (IOA) for 42% of the sessions for each participant across all conditions to monitor the appropriate use of the CO monitor and the measure of CO. Inter-observer agreement was calculated by dividing the number of agreements by 10 (total number of steps in the task analysis). An agreement was defined as the step from the task analysis in which two observers recorded the step being followed correctly. A disagreement was the extent to which both observers recorded differences in the step being followed (i.e., one observer scored that the step was completed correctly while the other observer recorded that the step was not completed correctly). The level of CO on the monitor was recorded by two observers. Both observers needed to record the exact number in ppm to be in agreement. IOA was 100% for the observed CO measure and 100% for the use of the CO monitor.
Results

Across all three participants high variability was identified during baseline and throughout the intervention (Fig 1). Upon the introduction of the shaping condition for Amanda there was a gradual reduction in her CO levels. For Amanda, a decreasing trend occurred beginning from the shaping condition and continuing to the first 6 samples of the abstinence induction phase where sharp spikes in her CO level began to appear with levels of 22 ppm, 20 ppm, and 18 ppm. With a return to baseline, for Amanda CO variability was less than the shaping and abstinence induction phase. Her performance continued along an increasing trend and response variability returned to higher levels as the standard pay condition was introduced.

During the introduction of the shaping condition for Harry a sharp decline in his CO level was identified while Mark continued to show stability during his baseline CO levels. Harry’s CO levels began to lose stability once the abstinence induction condition was introduced. There was also an increasing trend with high variability around level of responding beginning to approximate his baseline variability, with increases appearing more gradual than Mark’s performance during the abstinence induction condition. When Harry returned to baseline his CO levels continued to show similar levels to the abstinence induction phase. For Harry the standard pay schedule demonstrated reductions in CO levels but began to increase with the return to baseline.

Upon the introduction of the shaping condition for Mark his CO levels gradually reduced. Mark’s CO reductions continued until the beginning of the
abstinence induction condition in which increases in CO levels occurred for all three participants. With the introduction of the abstinence induction condition Mark’s first CO sample immediately increased to a level consistent with his baseline samples. This continued with less variability than his baseline samples with his highest reading being 17 ppm in comparison to his highest reading during baseline being 22 ppm. Mark’s return to baseline resulted in a reduction in variability which continued into the standard pay condition.

Scores from the URICA (Table 2) for Mark indicated his readiness to change fell between the contemplation and the action stages with readiness to change being highest with the action stage with a score of 32. His score for the contemplation stage was 31. Lowest scores were 17 for the pre-contemplation stage and 27 for the maintenance stage. Amanda’s highest score was in the contemplation stage with 33. Her next highest was in the maintenance stage with 26 followed with action stage with 25 and pre-contemplation with 11. Harry’s scores, similar to Amanda, were highest in the contemplation stage with 31 which were followed by 27, 25, and 7 for the maintenance, action, and pre-contemplation stages. Participants together earned a total of $346 in the study. Participants were all able to earn their $50 bonuses. Amanda earned a total of $103.75. Harry earned a total of $153.00. And Mark earned $89.25 (See Table 3 for details on earnings during each phase).

Craving scores for Mark started off at 4 during baseline then reduced to 2 in the remaining conditions. For Amanda, her craving score started off at 4 during baseline then reduced to 3 during the shaping phase. Her scores further reduced to 2 during the abstinence induction phase and the baseline phase. During the standard pay phase, her
score returned to 3 and stayed there during the return to baseline. Harry’s craving score started off at 2 during the initial baseline then increased to 3 during the shaping phase. His highest score of 4 occurred during the abstinence induction condition after which it reduced to 3 during baseline and the standard pay phases. During baseline his scores returned to 2 and remained there.

Items 1-9 were summed for withdrawal scores for all participants. For Mark his score was 8 during baseline, which increased to 11 during the shaping phase and reduced to 9 during the abstinence induction phase. During his second baseline his score increased to 16 then returned to 9 in his standard pay phase. Amanda’s initial baseline score was 20. Her scores reduced slightly to 16 during the shaping phase then returned to 20 during the abstinence induction phase. Following the abstinence induction phase was the second baseline in which her score reduced to 12. During the standard pay condition her withdrawal score increased to 22 and rose even further to 25 during the final baseline phase. Harry’s score during the initial baseline was 20. His score reduced to 8 during the shaping phase then rose again to 16 during the abstinence induction phase. A return to baseline showed a slight reduction in withdrawal with a score of 15 and a further reduction during the standard pay phase with a score of 12. During his final baseline his withdrawal score rose back to 17. Fagerstrom scores for Mark, Amanda, and Harry were 3, 3, and 1.

Out of a total of 182 samples, Mark was able to provide 92% of the samples missing 13. Out of a possible 174 samples, Amanda provided 94% of the samples missing 9. Out of 180 total possible samples, Harry provided samples for 93% of them, missing 11.
Discussion

The purpose of the study was to extend research on smoking cessation programs using voucher reinforcers for achieving reductions in smoking. Research typically included a shaping condition and an abstinence induction condition. Schedules of reinforcements usually involved the delivery of vouchers along an increasing scale or a standard pay scale. In some studies the standard pay scale was used in the shaping phase and in other studies the standard pay scale was used in the abstinence induction phase. This study used an increasing scale as part of the shaping phase and a flat rate scale as part of the abstinence induction phase. Research using this methodology has focused on typical adults and adolescents that smoke. This study focused on a population of TBI clients at a residential facility. The participants in this study all reached 5 ppm or less, however, overall never consistently maintained the abstinence criteria. Amanda and Mark both showed CO reductions during the shaping phase. Looking at their last phases and comparing it with their initial baseline phases further reductions were observed. For Mark a clear reduction in variability was identified in his last phase only after the criteria for abstinence changed to 8 ppm. Amanda’s lower levels however appeared to be more of a continuation of reductions observed in her second baseline indicating the need for better experimental control. Harry also showed reductions once the criteria changed to 8 ppm. CO levels for him during the standard pay phase began to approximate his shaping phase. The standard pay phase for Harry should have been continued for a longer period.
of time. Doing so would have given a better understanding of whether or not a reinforcer contingency could produce reductions similar to Harry’s shaping phase.

Individuals with TBI, as a result of experiencing their injury, often exhibit a number of complications related to psychiatric disorder. With depression, for example, many experience sadness, irritability, fatigue, loss of sleep, psychomotor retardation, difficulty concentrating and memory dysfunction (Seel et al., 2003). It is a possibility that some of these symptoms could have altered the effectiveness of the smoking cessation intervention. Cognitive impairment is often times an outcome to TBI which may impact a person’s overall functioning (Schretlen & Shapiro, 2003). TBI patients often experience difficulty multitasking and so experience cognitive overwhelming which has been described to cause irritability ranging from mild to severe (Lux, 2007). Mood disturbances are common with TBI clients. Amanda, for example, who was currently diagnosed with bipolar disorder, for the first half of the study engaged in a number of verbal outbursts almost daily. Mark in the past was also diagnosed with bipolar disorder and during the study exhibited some mild outbursts. Whether or not this was a residual symptom of his previous diagnoses is not known. Response efforts for cognitive tasks are high with individuals with TBI and so may have impacted participants’ abilities to manage their smoking by following the tips presented during the initial counseling session and performance feedbacks. Moreover impairments in executive functioning which involve planning, monitoring, and self-correction may have impacted participants’ abilities to maintain these skills if they were actually being practiced (Lux, 2007). Taken together, deficits in executive functioning, mood disorder and response effort may have
contributed to the high variability that was observed throughout the study and the failure for maintenance of CO reductions during the abstinence induction and baseline phases.

During times participants relapsed, they were provided with advice such as delaying their first cigarette of the day to afternoon hours, smoking only half of a cigarette or leaving the pack of cigarettes inside and staying away from other smokers. It was also recommended that they review the power point packet that was given to them in their initial counseling session going over tips for quitting. Amanda and Mark did mention smoking only half a cigarette. Mark also mentioned that he usually smoked after eating breakfast and attempted to delay his cigarette to afternoon hours. For Mark and Amanda, delaying their first cigarette may explain the reduction in variability in their second baseline. The extent the advice was used and helped participants overall in reducing their smoking however is not known. For Harry during the shaping phase it should be mentioned that it was discovered that he used the nicotine patch throughout the shaping phase which may explain the CO reductions at the start of the shaping phase.

Study samples were taken four times a day with the first sample taken between 8 am and 9 am. High variability was identified with all participants throughout all the conditions. Early samples tended to be much lower than later samples mainly as a result of participants waking up. As the day progressed, with CO having a half-life of 4-5 hours, levels may have increased partly as a result of carry over effects. However the number of cigarettes that are smoked across time versus the number of cigarettes smoked at one time may have different effects on CO level 4-5 hours later and should be examined more closely taking into account this possibility.
Studies that have examined the use of vouchers took samples one to two times a day (Dallery & Glenn, 2005). Other studies have taken samples three times a day. Participants in such cases would still have the opportunity to smoke abundantly in the early part of the day prior to their first sample and 5-6 hours later may be able to provide a sample that shows a reduction in CO levels. To avoid this, sampling times originally were to be taken at 8 am, 1 pm, 6 pm and 11 pm. However, this changed to a somewhat random schedule once we tried to accommodate the changing program schedules. This could possibly explain some of the variability. With the semi-random nature of the sampling times one could argue that this may have prevented participants from “taking advantage” of the system. For example if participants knew that a sample time was coming up they may be able to time their last cigarette so that their CO level was less than their previous reading. Because the sampling times were somewhat unpredictable this may have reduced the likelihood of participants contacting the reinforcement contingency and contributed to the variability that was identified throughout the study.

Motivation was assessed using the University of Rhode Island Change Assessment Scale (URICA) which assesses readiness to change along four stages pre-contemplation, contemplation, action, and maintenance, and was developed by researchers without a behavior analytic background (Henderson, Saules, & Galen, 2004). Motivation may have been better addressed using a functional approach that identifies controlling variables to smoking. Little research has been conducted that has incorporated the use of functional assessments for smoking. Dallery, Glenn, and Raiff (2007) developed the University of Florida Functional Assessment Scale for Smoking (UFFAS) which is a 45 item questionnaire in which the participant rates the frequency of
reasons for smoking along a continuum from never to always and also rates the degree to which they agree with their response from strongly disagree to strongly agree. The questionnaire provides questions that address controlling variables within a behavior analytic paradigm. Understanding the controlling variables better could have provided much more individualized tips for quitting and may have been a more effective approach for individuals with TBI. Cole and Bonem (2000) incorporated a functional assessment with two undergraduate students and developed individualized self-management strategies that led to significant reductions in exhaled CO levels with both participants.

The participants in the current study often times were unable to contact reinforcement because they did not provide a lower sample of CO. In many cases participants were close to achieving their goal and achieving the abstinence criteria of 5 ppm or less and thus never received reinforcement. It was not until the abstinence criteria changed to 8 ppm that consistent reductions were observed for and Mark. Giving a margin of freedom between 5 ppm and 8 ppm could have lead to reduced variability during the shaping and abstinence induction phases. One additional thing to consider is that all participants had a history of substance abuse disorder. Harry was the only participant currently attending AA meetings even though the option was still available for Mark and Amanda. The extent of their nicotine dependency and history of drug use may be determining factors for the effectiveness of contingency management.

For participants that fail to contact the reinforcement contingency because of these factors percentile schedules may be more effective by increasing the likelihood of reinforcement for gradations of improvement. Shaping procedures that have incorporated the use of percentile schedules in which vouchers are delivered contingent
on the participant providing a CO sample less than the last 3-7 lowest previous samples have shown positive outcomes. Percentile schedules are designed so the participant will contact a minimum level of reinforcement for CO reductions. This is a contrast from other studies which have provided vouchers for specific goals or having a reduction. Percentile schedules provide a CO window in which a participant will receive reinforcement. Lamb, Morral, Kirby, Iguchi, and Galbicka (2004) used percentile schedules with hard to treat individuals in three conditions: 30th, 50th, and 70th percentile and found that greater reductions were observed with participants in the 70th percentile.

However, if contingency management is ineffective because the value of the money fails to compete with the reinforcing value of nicotine, a functional approach identifying controlling stimuli may be needed. Mark reportedly may not have needed the money because of his current income, but mentioned he still wanted to quit. For either possibility, it is apparent that a more individualized plan that addresses the reinforcer differences of participants and allows for participants to contact the reinforcer contingency with minimal response effort is needed. Future research should examine the use of percentile schedules as a shaping method and incorporate individualized reinforcers using a functional approach. Research that incorporates the gathering of multiple samples a day should establish random times for taking samples to minimize the likelihood of participants circumventing the intervention. Lastly, research should solicit the combined effort of all relevant staff members to ensure samples are not missed.
Figure 1. Multiple baseline design across participants showing reductions during the shaping phase, relapses in the abstinence induction phase, and improvements for Harry and Mark during the standard pay phase.
Figure 2: Craving scores as they are tracked across conditions.
Figure 3: Total withdrawal scores across phases with items 1-9 summed on the MNWS.
### Table 1

**University of Rhode Island Change Assessment Scores**

<table>
<thead>
<tr>
<th></th>
<th>Precontemplation</th>
<th>Contemplation</th>
<th>Action</th>
<th>Maintenance</th>
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<td>33</td>
<td>25</td>
<td>26</td>
</tr>
<tr>
<td>Harry</td>
<td>7</td>
<td>31</td>
<td>25</td>
<td>27</td>
</tr>
<tr>
<td>Mark</td>
<td>17</td>
<td>31</td>
<td>32</td>
<td>27</td>
</tr>
</tbody>
</table>

*Note:* Scores from the URICA indicating readiness to change.

* Continuous scores (C+A+M-PC)

### Table 2

**Participant Earnings**

<table>
<thead>
<tr>
<th></th>
<th>Shaping</th>
<th>AB/IN</th>
<th>Standard Pay</th>
<th>Bonuses</th>
<th>Total</th>
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</thead>
<tbody>
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<td>$20.00</td>
<td>$50.00</td>
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<td>$103.75</td>
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<tr>
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<td>$33.00</td>
<td>$45.00</td>
<td>$50.00</td>
<td>$153.00</td>
</tr>
</tbody>
</table>

*Note:* Earnings across conditions and per participant
References


Appendices
Appendix A
Instructions for Measuring CO Levels

1) Press and hold the on/off button located on the side of the monitor until the display becomes active then release the button.

2) Make sure to not cover the vents on the back of the device with your hand.

3) Insert a D-piece into the instrument and fit a new cardboard mouth piece.

4) Touch the icon of the person holding the monitor to begin the breath test.

5) This begins the count down. As the display counts down to zero, the participant should inhale their breath deeply until the count reaches zero.

6) During the last 3 seconds, an audio beep will sound.

7) When the count reaches zero, the participant should begin to exhale into the mouthpiece slowly, aiming to empty their lungs into the machine until the ppm rises and holds at the highest level.

8) Remove and dispose of the cardboard mouth piece slowly.

9) Remove the D-piece to allow fresh air to purge the sensor then place back.

10) Show and document the correct reading.