INTERNET-BASED GROUP CONTINGENCY MANAGEMENT TO PROMOTE ABSTINENCE FROM CIGARETTE SMOKING

By

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To Mildred Hurlburt
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In contingency management (CM) interventions, monetary incentives are contingent on evidence of drug abstinence. Typically, incentives (e.g., “vouchers”) are contingent on individual performance. In Experiment 1, we programmed vouchers contingent on group performance and evaluated an Internet-based group CM intervention to promote smoking cessation. Thirteen participants were divided into 5 teams ($n = 2-3$ per team). Each participant submitted video recordings of breath carbon monoxide (CO) measures twice daily via the Internet. Teammates could monitor each other’s progress and communicate through an online peer support forum. During a 10-day Abstinence Induction condition, vouchers available on concurrently arranged independent and interdependent group contingencies were awarded to participants for CO samples indicative of abstinence (i.e., negative samples). Less than 1% of CO samples submitted during a baseline control condition were negative, compared to 57% submitted during Abstinence Induction. Experiment 2 isolated the effects of the monetary and social components of group CM. Thirty-two participants were divided into teams ($n = 3$ per team) and submitted breath CO measures twice daily during three 5-day within-subject treatment conditions. During the interdependent contingency
condition, participants earned vouchers each time they and their teammates submitted negative samples. During the independent contingency condition, participants earned vouchers each time they submitted negative samples, regardless of their teammates’ performance. During the no vouchers condition, no monetary incentives were contingent on abstinence. Half of the participants \( (n = 16) \) could communicate with their teammates through an online discussion forum. Forum access did not improve primary treatment outcomes. Significantly more negative samples were submitted when vouchers were contingent on individual performance (56%) or team performance (53%) relative to when no vouchers were available (35%; \( F = 6.9, p = 0.002 \)). Differences in the acceptability and cost of independent and interdependent contingencies are discussed.
CHAPTER 1
INTRODUCTION

Cigarette smoking is the leading cause of preventable morbidity and mortality in the United States, resulting in 443,000 deaths each year and costing $193 billion in annual health-related economic losses (US Department of Health and Human Services, 2004). Although 70% of smokers report a desire to quit, less than 7% are successful each year despite the availability of an increasing number of over-the-counter and prescription pharmacotherapies (Fiore et al., 2008; Schwartz, 1992). Thus, several researchers have argued that more intensive behavioral interventions are needed to curb the smoking epidemic (Fiore et al.; Sigmon, Lamb, & Dallery, 2008; Stitzer, 1999). Contingency management (CM) is one such intervention.

CM interventions typically deliver monetary incentives to substance users contingent on objective evidence of drug abstinence (see Higgins, Silverman, & Heil, 2008 for a review). This incentive-based treatment strategy emerged from the field of operant psychology (i.e., behavior analysis). Thus, researchers and practitioners who utilize this treatment approach, rely on a conceptually systematic framework consisting of traditional operant learning theory (Skinner, 1938, 1953, 1957) and more contemporary theories of choice that emerged from this paradigm, including delay discounting (Mazur, 1987) and behavioral economic theories (Hursh, 1984). CM capitalizes on the fundamental observation that drug use, like any other operant behavior, is influenced by the consequences it produces (Bigelow & Silverman, 1999; Griffiths, Bigelow, & Henningfield, 1980; Schuster & Thompson, 1969). Thus, when using CM, knowledge gleaned from a vast literature of laboratory and clinical research
on operant behavior can be applied to the treatment of drug use (Higgins, Budney, & Bickel, 1994).

Operant theory predicts that as long as incentives are available in sufficient magnitude and delivered on a schedule incompatible with drug use, they can be used to promote abstinence from any abused substance (Roll, Higgins, & Badger, 1996). In many CM interventions designed to promote abstinence from cigarette smoking, incentives exchangeable for goods or services are delivered to smokers contingent on biochemical verification of smoking reduction or cessation. Breath carbon monoxide (CO) is often used for verification of abstinence because it is a relatively immediate and acute measure of smoking status. This method of CM has been shown to promote smoking cessation in a number of studies (e.g., Alessi, Badger, & Higgins, 2004; Dallery, Glenn, & Raiff, 2007; Dunn et al., 2008; Higgins et al., 2004; Roll & Higgins, 2000; Roll et al., 1996; Tidey, O’Neill, & Higgins, 2002). Moreover, CM has been shown to promote abstinence from cocaine, opiates, alcohol, marijuana, and polydrug use (Lussier, Heil, Mongeon, Badger, & Higgins, 2006; Stitzer & Petry, 2006). In fact, an extensive literature consisting of empirical reports spanning several decades as well as independent reviews of the substance abuse treatment literature suggest that CM is one of the most efficacious treatments available for drug dependence (Dutra et al., 2008; McGovern & Carroll, 2003; Prendergast, Podus, Finney, Greenwell, & Roll, 2006).

Despite robust evidence attesting to the efficacy of CM as a substance abuse treatment, this behavioral intervention is used by community-based treatment providers only 11-25% of the time (Benishek, Kirby, Dugosh, & Padovano, 2010; McGovern, Fox, Xie, & Drake, 2004). One possible barrier to dissemination is response effort. Frequent
assessment of substance use is an important feature of CM programs, requiring considerable effort from both patients and practitioners. In the case of cigarette smoking, breath CO samples must be collected at least twice daily to accurately assess smoking status. This frequent schedule of assessment is necessary due to the short half-life of breath CO (i.e., about 3-6 hours; Benowitz et al., 2002; Deller, Stenz, Forstner, & Konrad, 1992; Joumard, Chiron, Vidon, Maurin, & Rouzioux, 1981) and to minimize delays between reinforcement and alternative non-drug behavior (Bigelow & Silverman, 1999). However, routine clinic visits might not be feasible for many patients due to distance, lack of transportation, clinic hours, or other practical constraints.

To overcome these obstacles, Dallery and colleagues developed an Internet-based CM program to promote smoking cessation (Dallery & Glenn, 2005; Dallery, Glenn, & Raiff, 2007; Dallery, Meredith, & Glenn, 2008; Reynolds, Dallery, Shroff, Patak, & Leraas, 2008; Stoops et al., 2009). Participants submitted video breath CO measures twice daily via user-friendly Internet technology, and abstinence was reinforced with vouchers exchangeable for goods from various Internet vendors. The Internet-based system successfully overcame distance as a barrier—even promoting abstinence among smokers living in rural Appalachia, Kentucky (Stoops et al.).

Although the Internet-based treatment model allowed researchers to circumvent several barriers to implementing CM in an outpatient setting, this model did not address other potential limitations associated with incentive-based treatment. For example, several authors have argued that incompatibility between CM and standard care is a substantial barrier to dissemination (Hartzler, Lash, & Roll, 2012; Roll, Madden, Rawson, & Petry, 2009). Although CM is typically evaluated under controlled conditions
when it is delivered to individual substance users, many substance abuse treatment programs rely on group-oriented therapies, including the 12-step approach (Benishek, et al., 2010). Thus, integrating CM with group-centered treatment may help promote dissemination. Indeed, several researchers have recently begun investigating methods for integrating CM into group therapy (Petry, Weinstock, & Alessi, 2011; Petry, Weinstock, Alessi, Lewis, & Diekhuas, 2010). One strategy is to program monetary incentives contingent on group therapy attendance (Alessi, Hanson, Wieners, & Petry, 2007; Ledgerwood, Alessi, Hanson, Godley, & Petry, 2008). Another promising strategy is to integrate monetary group contingencies into the incentive schedules used to promote drug abstinence (Kirby, Kerwin, Carpendo, Rosenwasser, & Gardner, 2008).

Several types of group contingencies have been described in the applied behavior analysis literature (Cooper, Heron, & Heward, 2007; Litow & Pumroy, 1975). Independent group contingencies are arranged when programmed consequences are contingent on individual performance, but the contingencies are applied simultaneously to all members of a group. Dependent and Interdependent group contingencies are those in which “the behavior of one or more group member determines the consequences received by at least one other group member” (Speltz, Shimamura, & McReynolds, 1982, p. 533). One advantage of these contingencies is that they may promote social support such as cooperation or abstinence-contingent praise (Gresham & Gresham, 1982; Williamson, Williamson, Watkins, & Hughes, 1992). Some evidence suggests that social incentives such as these may promote smoking cessation (Baha & Le Faou, 2010; Chen, White, & Pandina, 2001; Christakis & Fowler, 2008; Cohen & Lichtenstein, 1990; Hennrikus et al., 2010; Ji et al., 2005; Mermelstein, Cohen,
Lichtenstein, Baer, & Kamarck, 1983; Møller, Pedersen, Villebro, & Nørgaard, 2003; Westmaas, Wild, & Ferrence, 2002). Moreover, research indicates that practitioners are more willing to adopt treatments that use social incentives over those that use tangible incentives (Kirby, Benishek, Dugosh, & Kerwin, 2006).

The purpose of Experiment 1 was to develop and test an Internet-based group CM program to promote smoking cessation. We integrated independent and interdependent group contingencies and an online peer support forum into an existing Internet-based intervention (Stoops et al., 2009). This experiment demonstrated the feasibility, acceptability, and preliminary efficacy of Internet-based group CM. However, data from this experiment could not be used to assess the independent effects of social support and monetary group contingencies on smoking cessation. Thus, Experiment 2 was conducted to isolate the effects of these variables on cigarette smoking.
Participants

Participants were 13 healthy smokers (4 Female) recruited from Gainesville, FL and surrounding communities through print media and word of mouth. Qualified applicants were between 18 and 60 years of age, had Internet access from their home, smoked ≥ 10 cigarettes per day, presented with a breath CO ≥ 10 ppm at intake, reported a minimum 2-year smoking history, and expressed a desire to quit smoking (i.e., answered affirmatively to the question, “Do you want to quit smoking?”; Perkins, Stitzer, & Lerman, 2006).

Interested applicants were screened over the phone for basic qualifying criteria such as having home Internet access and being a current smoker. Qualified applicants were scheduled for an in-person intake session. During intake, applicants provided informed consent and completed several questionnaires, including a psychosocial history survey which contained questions related to demographics, smoking history, drug use, psychological and physical health, and the Fagerström Test for Nicotine Dependence (FTND). The FTND is a 6-item questionnaire that assesses nicotine dependence with a scale ranging from 0-10 (higher scores representing greater dependence; Fagerström & Schneider, 1989). Urine samples were collected during intake and analyzed for the presence of cocaine, benzodiazepines, and opiates. Applicants were excluded from participating in the study if they showed evidence of current alcohol dependence or drug use, smoked marijuana more than twice per month, or reported a history of medical or psychiatric illness that, in our judgment, would
interfere with study participation. Women were disqualified if they were pregnant or breastfeeding. The University of Florida Institutional Review Board approved all study procedures.

A total of 15 participants were recruited. These participants were divided into small groups or “teams” (n = 2-3). Three teams were comprised of 3 participants. However, because 1 participant could not be contacted prior to the set-up procedure, and another participant withdrew from the study during baseline (citing cancellation of her Internet service provider as the reason for her withdrawal), two teams completed the study with only 2 participants each. Only data for the 13 participants (4 female) who completed the study are included in the Results. Individual participant characteristics are presented in Table 2-1.

Participants were assigned to their teams based on the order in which they qualified to participate in the study. According to self-report data collected at Set-up, none of the participants knew each other prior to study commencement. However, if a participant knew someone else who was participating in the study, a policy was in place to assign those participants to different teams. There were a number of reasons that only unfamiliar participants were assigned to the same team. First, familiar participants could potentially provide each other with social support outside of the online Mōtif8™ Group Support Forum; thus, researchers would be unable to collect data on such interactions if they occurred. Second, social interactions could possibly turn aggressive outside of the online forum; therefore, it was important to take extra precautions to protect participants’ anonymity and confidentiality. Third, familiarity with teammates could be an important independent variable that should be investigated in future studies.
Participants assigned to the same team were required to begin the study on the same day; thus, teammates could not begin participating until a group of 3 qualified applicants was ready to participate. Consequently, relatively small team sizes were employed to minimize the delay between study qualification and the onset of treatment.

**Materials**

Carbon monoxide monitors (Bedfont piCO+ Smokerlyzer®) were loaned to each participant. Webcams (Creative Live!® Cam Optia) and laptops (Asus® Eee PC) were also loaned to those participants who needed them; however, most participants used their own webcams and/or computers. For security purposes, copies of participants’ driver’s licenses were obtained, and participants were asked to sign an off-campus property contract stating that they would return the equipment. All equipment was returned.

**Set-up**

Before the intervention began, researchers set up the necessary equipment in participants’ residences and demonstrated how to use the software, including how to submit a video CO sample and how to post a comment on the online peer support forum. Participants were then required to practice both of these tasks in the presence of a researcher. Participants were also provided with the National Cancer Institute’s booklet, Clearing the Air (a guide to quitting smoking; [http://www.smokefree.gov/pubs/Clearing-The-Air_acc.pdf](http://www.smokefree.gov/pubs/Clearing-The-Air_acc.pdf)), and an instruction manual that included a detailed description of all study procedures. Participants were required to pass a quiz demonstrating that they read and understood all study procedures (Silverman, Chutuape, Bigelow, & Stitzer, 1999).
Mōtiv8™ and CO Monitoring Procedure

Participants were asked to submit video samples of breath CO measurements twice daily (minimum 8 h inter-sample interval). Mōtiv8 Systems™, a web-based application, enabled collection of the videos. Participants logged into the secure Mōtiv8™ website using the unique usernames and passwords that were assigned to each of them at set-up. After logging in, the website directed participants to a personalized homepage. From this homepage, participants could access several features of the website, including their account history which listed any incentives earned or spent during the study, a link to an online peer support forum through which they could communicate with teammates, a quantitative progress graph (a graphical representation of CO levels submitted over the course of the study), a link to teammates’ quantitative progress graphs, and a “Post Video” button that was active only if participants had not yet submitted two videos that day and if 8 hr had passed since the last video submission.

When participants were ready to submit a sample, they clicked on the “Post Video” button and followed the simple step-by-step, on-screen instructions. After turning on the CO monitor and webcam, participants were instructed to complete the following steps: 1) take a deep breath, 2) activate the “countdown” feature of the CO monitor, 3) hold breath for 15 s, 4) exhale into the monitor loud enough for the audible hiss to be detected by the microphone, and 5) show the digital display of the final CO level to the webcam. Participants would then manually enter the CO measurement into the website using the computer keyboard. Although participants were instructed to follow this series of steps to ensure that accurate CO measurement was obtained, the procedure was relatively quick and easy; that is, it took less than 2 m to complete, and most
participants learned the steps after only one or two practice submissions. A software feature allowed playback of the videos so participants could review the content. Once participants were satisfied with their videos, they could click the “Post” button. The website immediately directed them to a screen that thanked them for submitting the sample and, when appropriate, informed them of any incentives earned for submitting the sample. Participants were then directed back to their homepage which included an updated quantitative progress graph and account history. Participants were notified during set-up that attempts to falsify a sample were easily detected and would lead to dismissal from the study.

**Online Peer Support Forum**

From their homepages, participants could click a link that would direct them to the Mōtiv8™ Group Support Forum. Here they could post comments or read comments posted by their teammates or by the forum moderator (participants were unable to view or reply to the comments made by participants assigned to other teams). Each post could be viewed by every member of the team and the forum moderator. Participants were instructed to use their usernames, not their real names, on the forum. Participants also received the following guidelines for communicating via the online peer support forum: “Make sure your posts are supportive in nature. Posts that are discouraging or offensive will not be allowed. Keep in mind you want to help encourage other group members to quit smoking. You should congratulate them when they make progress toward this goal!” Posts that were considered negative by the moderator were removed from the discussion thread (only one comment met the criteria for a negative post, Table 2-2).
The moderator posted comments on the forum approximately twice per experimental condition. These posts were similar across teams and often included reminders of condition changes or smoking cessation tips and strategies recommended by the Clearing the Air booklet (i.e., “informational support” [Cohen, 2004]) and praise for meeting treatment goals (i.e., “emotional support” [Cohen]).

Participants also had access to their teammates’ quantitative progress graphs through their Mōtiv8™ homepage. This feature allowed participants to see when their teammates met their goals, so they could provide them with appropriate social consequences through the forum (e.g., abstinence-contingent praise).

**Experimental Design and Conditions**

A within-subject, non-concurrent multiple baseline design was used to evaluate performance during three conditions. Baseline (A) was followed by two treatment conditions: tapering (B) and abstinence induction (C). The introduction of the first treatment condition occurred after different baseline durations across teams. That is, one team experienced a 2-day baseline, another team experienced a 3-day baseline, and so on, up to 6 days. This arrangement specifies a multiple baseline design. The power of the multiple baseline design is derived from demonstrating that behavior change occurs when, and only when, the intervention is directed at a particular individual or team (Barlow, Nock, & Hersen, 2009). Thus, if the intervention is efficacious, the design will show that the change in the independent variable, and not some other factor, resulted in the change in the dependent variable relative to baseline. The influence of other factors such as history or self-monitoring can be ruled out by replicating the effect across multiple individuals or teams with differing baseline durations.
A nonconcurrent design was chosen to minimize the delay participants experienced between study qualification and participation. Requiring all teams to begin the intervention simultaneously would have substantially increased the delay between the participant application process and the onset of treatment. Therefore, not all teams began the intervention at the same time; rather, each team began as soon as 3 applicants qualified and were ready to participate.

Baseline (A)

This condition lasted between 2 and 6 days across teams. No incentives were available during baseline; however, participants had access to all other features of the intervention (i.e., Internet-based monitoring, teammates' quantitative progress graphs, the Mōtiv8™ Group Support Forum, the Clearing the Air booklet, etc.).

Tapering (B)

During this 4-day condition, monetary incentives (i.e., electronic “vouchers” exchangeable for goods) were contingent on specified reductions in breath CO (Dallery et al., 2007). The reductions were determined as follows. First, the average baseline CO was calculated for each participant. Then, progressively lower CO values were calculated such that over eight samples, the last tapering criterion (i.e., goal) was 4 ppm (the abstinence threshold used in the current study; Javors et al. 2005). An independent group contingency was arranged such that each participant who submitted a CO sample less than or equal to his/her tapering goal earned a $1.50 voucher. In addition, an interdependent group contingency was arranged such that each participant earned a $1.50 team bonus voucher if and only if every member of the team met their respective tapering goal for the scheduled sample. Two concurrently arranged contingencies, such as these, specify a mixed contingency arrangement.
Abstinence induction (C)

During abstinence induction, the final 10 days of the intervention, an independent contingency was arranged such that participants earned vouchers on an escalating schedule of reinforcement (Roll et al., 1996) contingent on submission of breath CO samples indicative of abstinence. Participants earned a $1.50 voucher for the first CO sample $\leq 4$ ppm (i.e., negative sample). Each consecutive negative sample resulted in a $.25 increase in voucher value. In other words, the first negative sample resulted in a $1.50$ voucher, the second resulted in a $1.75$ voucher, the third resulted in a $2.00$ voucher, and so on. If a participant missed a sample submission or submitted a positive sample, the value of the voucher contingent on the next negative sample was reset to the initial amount (i.e., $1.50$; Roll & Higgins, 2000). The voucher magnitude then returned to the highest previous level following two consecutive negative sample submissions. An interdependent group contingency was concurrently arranged such that each time every member of a team submitted a negative sample, they all received a $3.00$ team bonus voucher.

Exit Interview

An exit interview was conducted with each participant within 1 week following study completion. Researchers collected equipment, and participants completed several questionnaires, including a behavioral change inventory and a treatment acceptability questionnaire. Participants also completed the Group Environment Questionnaire (GEQ), a 5-item questionnaire with a 9-point Likert scale modified from an instrument developed by Estabrooks and Carron (1999) to assess group cohesion (higher scores representing greater cohesion among group members). Finally, participants completed a questionnaire documenting any communication with group members outside the
online peer support forum. There were no reported instances of external communication between participants.

Researchers discussed voucher earnings and purchases with participants at the exit interview. During Set-up, participants were instructed to notify researchers if they wished to make a purchase with their vouchers during the study; however, none of the participants made any purchases until after they completed the study. Items were purchased from online vendors (e.g., Amazon.com®) and gift cards were purchased from local businesses (e.g., Best Buy®). Participants could not purchase firearms, alcohol, or tobacco products with their vouchers.

**Data Analysis**

A one-way repeated measures analysis of variance (ANOVA) was calculated on the percentage of breath CO measures ≤ 4 ppm (negative samples) with condition (baseline, tapering, and abstinence induction) as a factor. The mean percentage of negative samples was calculated for each condition, with missing samples considered positive. Planned pairwise comparisons of the mean percentage of negative CO samples were then made with the Bonferroni procedure between baseline and tapering, baseline and abstinence induction, and tapering and abstinence induction.

Pearson product-moment correlations were calculated to detect correlations between breath CO measures and potential predictors of treatment success, including: age, income, FTND score, CO at intake, years smoked, and average number of cigarettes smoked per day prior to intake. Correlations were also calculated to detect relationships between breath CO measures and GEQ score. In addition, the data were analyzed for correlations between breath CO measures and various variables related to quantity and quality of support forum posts, including: the number of posts created by
an individual’s teammates, the number of posts created by his/her entire team (i.e., including his/her own posts), the percentage of posts rated as positive that were created by an individual’s teammates, and the percentage of posts rated as positive that were created by his/her team. Finally, correlations were calculated to detect relationships between GEQ score and quality and quantity of support forum posts.

Support forum posts were rated as positive, negative, or neutral based on a scale developed by Speltz et al. (1982). Positive posts were defined as compliments; statements of friendship, concern, congratulations, gratitude, or encouragement; statements of excitement about quitting; and/or requests or offers for assistance or instruction. Neutral posts were defined as posts that reflect general discussion and/or nondirected posts. Negative posts were defined as name-calling or swearing at peers, ridiculing a peer's lack of progress, threats of physical aggression, posts that reflect disgust or disapproval, and/or posts intended to antagonize or frighten peers. A single post often included multiple comments. If a post contained both positive and neutral comments, the post was rated as positive. If a post contained a negative comment and positive and/or neutral comments, the post was rated as negative. Two independent observers rated all forum posts. Interobserver agreement (IOA) was calculated by subtracting the number of disagreements from the total number of posts, dividing this number by the total number of posts, and multiplying by 100.

**Results**

**CO Data**

There was a significant effect of condition on breath CO ($F = 25.77; p < 0.001$). Figure 2-1 shows the CO data for each participant. Reductions in CO were reliably observed across participants during tapering and abstinence induction relative to
baseline. Ten participants (C30, M39, K43, K59, B60, J25, K27, E33, D63, and S45) demonstrated some period of continuous abstinence (≥ 2 consecutive days) during abstinence induction. Four of these participants (C30, M39, K27, and S45) demonstrated ≥ 5 days of continuous abstinence during the 10-day abstinence induction condition (these 4 participants also reported smoking 0 cigarettes during the previous 7 days on a behavioral change inventory administered during the exit interview). M48 showed substantial reductions in breath CO, but no period of continuous abstinence. E66 showed initial reductions in CO during tapering and at the onset of abstinence induction, but immediately thereafter returned to near baseline CO levels and repeatedly missed sample submissions. The intervention had little effect on T47’s CO who, like E66, also missed several sample submissions during abstinence induction.

Figure 2-2 shows that less than 1% of CO samples that were submitted during baseline were negative; whereas, 57% of samples that were submitted during abstinence induction were negative (missing samples were considered positive). Bonferroni’s planned comparisons revealed a significant increase in the percentage of negative CO samples in abstinence induction relative to baseline and relative to tapering. These comparisons did not, however, reveal a significant difference in the percentage of negative CO samples between baseline and tapering conditions.

Pearson product-moment correlations revealed no significant relationships between percentage of negative CO samples submitted during abstinence induction and any of the potential predictor variables we tested.

**Contingent Reinforcement Earned**

Participants who submitted breath CO samples twice per day for 14 days during the tapering and abstinence induction conditions had 28 opportunities to earn vouchers.
On average, participants met the independent contingency of reinforcement on 60% of these occasions and the interdependent contingency on only 29% of these occasions. During abstinence induction, participants met the interdependent contingency requirement on 46% of negative sample submissions. In other words, although 100% of negative samples submitted during abstinence induction resulted in a voucher, the majority of these submissions did not result in a team bonus voucher. If participants met the independent and interdependent contingency criteria on each available opportunity, they could earn $161.50 each over the course of the study. Participants earned an average of $58.38 each ($SD = 39.36). Thus, the average daily cost in vouchers was $4.17 per participant during the 14-day treatment. Eleven of 13 participants purchased gift cards from local businesses with their vouchers. The remaining 2 participants elected to have specific items (e.g., electronics, tools, etc.) shipped to them from online vendors.

Support Forum Data

Over the course of the study, 128 posts were made by participants on the online peer support forum ($M = 9.8$, $SD = 5.7$). Sixty-five percent of posts were rated as positive, 34% were rated as neutral, and less than 1% were rated as negative (IOA = 87%). Table 2-2 shows the percentage of positive, neutral, and negative posts, the number of each type of post recorded during the study, and several samples of participants’ posts taken from the Mōtiv8™ Group Support Forum.

A modest correlation was found between the percentage of negative CO samples submitted during abstinence induction and the percentage of team support forum posts during the same condition that were rated as positive ($r = .696$, $p = .008$). This relationship was no longer observed, however, when participants’ own forum posts were
removed from analysis. That is, there was no significant correlation between the percentage of negative CO samples submitted by a participant during abstinence induction and the percentage of his/her teammates’ support forum posts that were rated as positive ($r = .503, p = .08$). No other relationships were observed between the quantity or quality of forum posts and CO.

**Treatment Acceptability Data**

Table 2-3 shows data collected from the treatment acceptability questionnaire. The Internet-based intervention was rated as easy to use ($M = 82.7, SD = 17.9$) and convenient ($M = 77.9, SD = 14.5$). On average, participants rated the quantitative progress graph as the most favorable treatment component ($M = 86.6, SD = 19.7$), and the moderated online peer support forum as the least favorable component ($M = 54.3, SD = 24.7$). Participants’ ratings of how much they liked earning vouchers based on their teams’ performance ($M = 76.9, SD = 22$) were not significantly different than their ratings of how much they liked earning vouchers based only on individual performance ($M = 83.3, SD = 17.2; F = 0.965; p = 0.35$).

**GEQ Score**

Mean GEQ score was 5.7 ($SD = 1.8$), representing, on average, moderate group cohesion across teams. No correlations were observed between GEQ scores and forum posts or between GEQ scores and CO.

**Discussion**

The results of Experiment 1 suggest that combining group contingencies and online peer support with Internet-based CM to promote abstinence from cigarette smoking is a feasible treatment strategy. Reliable reductions in breath CO were observed across participants during treatment conditions relative to baseline, and 10 out
of 13 participants demonstrated some sustained period of abstinence during the 10-day abstinence induction condition.

Figure 2-1 shows that reductions in breath CO were a function of the experimenter-arranged contingencies and not some other variable (e.g., history or self monitoring). When vouchers were contingent on CO samples ≤ 4 ppm at the end of tapering and during abstinence induction, the majority of participants began submitting negative CO samples. Despite each team experiencing variable baseline durations, 9 of the 12 participants who submitted at least one negative sample (C30, M39, K43, M48, K59, B60, K27, E33, and E66) submitted the first one on the last day of tapering or on the first day of abstinence induction. Thus, the multiple baseline design not only allowed us to evaluate the feasibility of the intervention, it also allowed us to demonstrate preliminary efficacy.

The results of the study also indicate that group CM is an acceptable form of treatment. On average, participants reported liking all of the treatment components, including the interdependent contingency (Table 2-3). In fact, participants reported that they liked earning vouchers contingent on their teams’ performance \((M = 76.9, \ SD = 22)\) almost as much as they liked earning vouchers independent of their teams’ performance \((M = 83.3, \ SD = 17.2)\). This was somewhat unexpected given that vouchers contingent on team performance were earned far less frequently than those contingent on individual performance. Yet, despite only limited contact with the interdependent contingency, participants reported that the overall intervention was fair \((M = 85.9, \ SD = 14.2)\).
Not all of the treatment components were rated quite as favorably as the vouchers. Participants rated the online peer support forum as the least favorable ($M = 54.3$, $SD = 24.7$) and least helpful ($M = 56.6$, $SD = 22.1$) treatment component (Table 2-3). According to responses to open-ended questions on the treatment acceptability questionnaire, the most common objection to the forum was a lack of participation by teammates. Although most participants posted comments on the forum regularly, they did so relatively infrequently. The mean number of posts per participant was $9.8$ ($SD = 5.7$) over the course of the intervention (i.e., roughly one post every other day). As might be expected, participants who used the forum more frequently (i.e., $\geq 9$ posts, the median number of forum posts), rated the forum as more favorable ($M = 66.5$, $SD = 17.6$) and more helpful ($M = 66.9$, $SD = 18$) than did others.

Social exchanges on the support forum were quite positive. In fact, $65\%$ of posts were rated as positive. This finding is of particular interest given the criticism that group contingencies have the potential to promote undesirable or negative behavior among participants (e.g., threats or aggression; Romeo, 1998). In the current study, however, only one instance of negative behavior was observed—J25 posted a negative comment on the support forum directed at his teammate, E33. Notably, this post was unrelated to the interdependent contingency arrangement. In other words, the negative post was not evoked by E33’s failure to meet the interdependent contingency requirement. Rather, E33’s lack of forum participation evoked the negative response (Table 2-2). In fact, E33 was demonstrating a period of continuous abstinence at the time J25 posted the negative comment.
The results of Experiment 1 suggest that Internet-based group CM is not only feasible and acceptable, but convenient as well. Although researchers were based at the University of Florida Smoking Laboratory and Clinic in Gainesville, Florida, several participants lived in surrounding North Central Florida communities and/or traveled in and outside the state while participating in the study. For example, C30 and K27 each lived 68 kilometers from the clinic (Table 2-1). During the study, both of these participants spent several days in Orlando, Florida (> 200 kilometers southeast of Gainesville), and S45 spent a week in Athens, Georgia (> 500 kilometers north of Gainesville). However, because treatment was delivered via the Internet, smokers who lived considerable distances from the clinic were able to participate, and treatment was not interrupted by travel.

One major limitation of Experiment 1 is that the results cannot be used to dissociate the effects of independent and interdependent group contingencies on smoking cessation. The mixed contingency that was arranged by researchers in Experiment 1 is advantageous, because it combines the benefits of both independent and interdependent contingencies of reinforcement. That is, the independent group contingency ensures precise correspondence between abstinence and experimenter-delivered consequences, while the interdependent group contingency may promote collateral social behavior. This mixed contingency, however, does not permit us to identify the relative advantages of the independent and interdependent contingencies. Indeed, the outcomes observed in Experiment 1 may have been a function of the independent contingency alone. An independent group contingency is similar to an individual contingency of reinforcement, and Internet-based CM programs that employ
only individual contingencies have already been demonstrated efficacious (e.g., Dallery et al. 2007). Thus, one aim of Experiment 2 was to determine the effects of interdependent group contingencies alone on smoking cessation.

Another aim of Experiment 2 was to determine the effects of social support on smoking cessation. Although the positive social exchanges observed in Experiment 1 suggest that smokers are willing to use an online discussion forum to support one another during their quit attempts, the effects of this support on smoking cessation remain unclear. Few relationships were observed between measures of social support and abstinence in Experiment 1. It is possible that such relationships were not detected because the effects of the monetary contingencies masked the effects of other variables on smoking cessation. Thus, social and monetary contingencies were isolated in Experiment 2.
Table 2-1. Participant characteristics.

<table>
<thead>
<tr>
<th>Team</th>
<th>ID</th>
<th>Sex</th>
<th>Age</th>
<th>Race/ethnicity</th>
<th>Education</th>
<th>Weekly income</th>
<th>Cigs/day</th>
<th>CO</th>
<th>FTND</th>
<th>Kilometers from clinic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>C30</td>
<td>F</td>
<td>50</td>
<td>White</td>
<td>Some college</td>
<td>$501-600</td>
<td>18</td>
<td>23</td>
<td>4</td>
<td>64</td>
</tr>
<tr>
<td>1</td>
<td>M39</td>
<td>M</td>
<td>49</td>
<td>White</td>
<td>College graduate</td>
<td>$501-600</td>
<td>28</td>
<td>23</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>1</td>
<td>K43</td>
<td>M</td>
<td>22</td>
<td>Asian</td>
<td>Graduate school</td>
<td>&lt;$100</td>
<td>18</td>
<td>12</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>M48</td>
<td>M</td>
<td>21</td>
<td>Hispanic</td>
<td>Some college</td>
<td>$100-200</td>
<td>20</td>
<td>34</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>K59</td>
<td>F</td>
<td>20</td>
<td>White</td>
<td>Some college</td>
<td>$201-300</td>
<td>20</td>
<td>11</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>B60</td>
<td>M</td>
<td>29</td>
<td>White</td>
<td>Graduate school</td>
<td>$401-500</td>
<td>20</td>
<td>21</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>J25</td>
<td>M</td>
<td>37</td>
<td>White</td>
<td>Some college</td>
<td>&lt;$100</td>
<td>12</td>
<td>20</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>K27</td>
<td>M</td>
<td>27</td>
<td>White</td>
<td>Some college</td>
<td>$100-200</td>
<td>10</td>
<td>19</td>
<td>3</td>
<td>64</td>
</tr>
<tr>
<td>3</td>
<td>E33</td>
<td>M</td>
<td>24</td>
<td>White</td>
<td>Some college</td>
<td>$301-400</td>
<td>12</td>
<td>19</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>D63</td>
<td>F</td>
<td>50</td>
<td>White</td>
<td>Some college</td>
<td>$501-600</td>
<td>10</td>
<td>14</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>E66</td>
<td>F</td>
<td>19</td>
<td>White</td>
<td>Some college</td>
<td>$100-200</td>
<td>20</td>
<td>13</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>T47</td>
<td>M</td>
<td>38</td>
<td>White</td>
<td>GED</td>
<td>&lt;$100</td>
<td>40</td>
<td>45</td>
<td>5</td>
<td>38</td>
</tr>
<tr>
<td>5</td>
<td>S45</td>
<td>M</td>
<td>45</td>
<td>Black</td>
<td>Some college</td>
<td>$100-200</td>
<td>12</td>
<td>15</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>

Note: ID = participant identification code. CO = breath carbon monoxide level at intake (ppm). FTND = Fagerström Test for Nicotine Dependence score. Kilometers from clinic = distance from participant’s residence to University of Florida Smoking Laboratory and Clinic, Gainesville, FL.
Table 2-2. Forum Posts.

<table>
<thead>
<tr>
<th>Rating</th>
<th>Quantity</th>
<th>% Total</th>
<th>Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>95</td>
<td>65%</td>
<td>K27: &quot;J25, I see you are back on track so far… keep it up!&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>M39: &quot;Let's make some money!&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>M48: &quot;Wow K59, you are doing really well!&quot;</td>
</tr>
<tr>
<td>Neutral</td>
<td>32</td>
<td>34%</td>
<td>T47: &quot;Hello all.&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>E66: &quot;I've been doing a little better, not by much though, I've got to get very motivated.&quot;</td>
</tr>
<tr>
<td>Negative</td>
<td>1</td>
<td>1%</td>
<td>J25: &quot;Hey E33, thanks for sharing! You could join us or at least let us know what's working for you. We are supposed to be in this together, yet you remain an outsider, some teammate you are.&quot;</td>
</tr>
</tbody>
</table>
Table 2-3. Treatment acceptability.

<table>
<thead>
<tr>
<th>Question</th>
<th>Anchor = 0</th>
<th>Anchor = 100</th>
<th>$M$</th>
<th>$SD$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overall intervention</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How <em>easy to use</em> was the internet program that you completed?</td>
<td>not easy to use</td>
<td>very easy to use</td>
<td>82.7</td>
<td>17.9</td>
</tr>
<tr>
<td>How <em>helpful</em> was the internet program in your quit attempt?</td>
<td>not helpful</td>
<td>very helpful</td>
<td>74.5</td>
<td>16.3</td>
</tr>
<tr>
<td>How <em>convenient</em> was the internet program that you completed?</td>
<td>not convenient</td>
<td>very convenient</td>
<td>77.9</td>
<td>14.5</td>
</tr>
<tr>
<td>How <em>effective</em> was the internet program that you completed?</td>
<td>not effective</td>
<td>very effective</td>
<td>76.2</td>
<td>21</td>
</tr>
<tr>
<td>How <em>fair</em> was the internet program that you completed?</td>
<td>not at all</td>
<td>very fair</td>
<td>85.9</td>
<td>14.2</td>
</tr>
<tr>
<td><strong>CO monitor</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How much did you <em>like</em> using the CO meter to monitor your progress?</td>
<td>not at all</td>
<td>a great deal</td>
<td>76.9</td>
<td>19.7</td>
</tr>
<tr>
<td><strong>Quantitative progress graph</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How much did you <em>like</em> seeing your progress on the graph?</td>
<td>not at all</td>
<td>a great deal</td>
<td>86.6</td>
<td>19.7</td>
</tr>
<tr>
<td><strong>Vouchers</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How much did you <em>like</em> earning vouchers based on your team’s performance?</td>
<td>not at all</td>
<td>a great deal</td>
<td>76.9</td>
<td>22</td>
</tr>
<tr>
<td>How much did you <em>like</em> earning vouchers based on only your performance?</td>
<td>not at all</td>
<td>a great deal</td>
<td>83.3</td>
<td>17.2</td>
</tr>
<tr>
<td>How <em>helpful</em> was earning vouchers based on your team’s performance?</td>
<td>not helpful</td>
<td>very helpful</td>
<td>70.5</td>
<td>18.5</td>
</tr>
<tr>
<td>How <em>helpful</em> was earning vouchers based on only your performance?</td>
<td>not helpful</td>
<td>very helpful</td>
<td>79.2</td>
<td>18.4</td>
</tr>
<tr>
<td><strong>Online support forum</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How <em>easy to use</em> was the discussion forum?</td>
<td>not easy to use</td>
<td>very easy to use</td>
<td>84.8</td>
<td>18.5</td>
</tr>
<tr>
<td>How much did you <em>like</em> using the discussion forum?</td>
<td>not at all</td>
<td>a great deal</td>
<td>54.3</td>
<td>24.7</td>
</tr>
<tr>
<td>How <em>helpful</em> was the discussion forum in your quit attempt?</td>
<td>not helpful</td>
<td>very helpful</td>
<td>56.6</td>
<td>22.1</td>
</tr>
<tr>
<td><strong>Clearing the Air</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How much of the Clearing the Air guide to quitting smoking did you <em>read</em>?</td>
<td>none of it</td>
<td>all of it</td>
<td>69.5</td>
<td>29.9</td>
</tr>
<tr>
<td>How much did you <em>like</em> the Clearing the Air guide to quitting smoking?</td>
<td>not at all</td>
<td>a great deal</td>
<td>66.8</td>
<td>26.5</td>
</tr>
<tr>
<td>How <em>helpful</em> was the Clearing the Air guide that you used?</td>
<td>not helpful</td>
<td>very helpful</td>
<td>60.2</td>
<td>29.5</td>
</tr>
</tbody>
</table>

*Note: $M$ = mean, $SD$ = standard deviation.*
Figure 2-1. Within-subject breath CO level (ppm). Dashed vertical lines represent changes in experimental condition. Dashed horizontal lines represent the abstinence criterion (4 ppm). Baseline duration increases across teams from left to right (i.e., Team 1 experienced a 2-day baseline, Team 2 experienced a 3-day baseline, and so on). Note the different scale on the y-axis for participant T47.
Figure 2-2. Percentage of samples negative for breath CO. Circles represent individual participants' percentages of negative breath CO (i.e., CO ≤ 4 ppm). Bars represent the mean for all participants (N = 13) during each condition.
CHAPTER 3
EXPERIMENT 2

Experiment 1 demonstrated the feasibility, acceptability and preliminary efficacy of Internet-based group CM to promote abstinence from cigarette smoking. The purpose of Experiment 2 was to dissociate the monetary and social contingencies of group CM to determine the effects of each of these treatment components on smoking cessation. The effects of monetary group contingencies on smoking cessation were examined within participants, and the effects of online peer support were examined between participants.

Methods

Participants

Participants were 32 healthy smokers (14 Female) recruited from Gainesville, FL and surrounding communities through print media, radio announcements, television advertisements, and word of mouth. The same screening methods and inclusion criteria used in Experiment 1 were used in Experiment 2 (see Experiment 1 Participants). Thus, participants smoked ≥ 10 cigarettes per day, reported a minimum 2-year smoking history, and expressed a desire to quit smoking. In addition, participants completed the Need to Belong (NTB) scale during intake (Leary, Kelly, Cottrell, & Schreindorfer, 2005; Mellor, Stokes, Firth, Hayashi, & Cummins, 2008). This 10-item questionnaire with 5-point Likert scale assessed participants’ need to belong to social groups and was collected prior to study participation so researchers could later evaluate whether the measure was predictive of smoking cessation, forum use, or group cohesion. Participant characteristics are displayed in Table 3-1. The University of Florida Institutional Review Board approved all study procedures.
The purpose of this study was to isolate the effects of several treatment components on promoting only brief periods of abstinence. Therefore, we did not perform an intention to treat analysis. Forty-two participants were recruited. These participants were assigned to small teams ($n = 3$) using the same methods as those used in the first experiment (see *Experiment 1 Participants*). Two participants from different teams withdrew, altering the experimenter-arranged contingencies for two teams. The loss of 1 or 2 participants from a team consisting of only 3 participants represents a substantial change in the response criterion for the group contingency arranged during the interdependent contingency condition (see *Experiment 2 Within-subject treatment conditions*). Thus, reductions in team size were expected to impact the remaining teams’ performance during this condition (Shapiro & Goldberg, 1990). Therefore, data from 2 participants who withdrew from the study (and data from their respective teams) were excluded from final data analyses. In addition, 4 participants (each from different teams) submitted less than 50% of scheduled sample submissions. Due to these participants' noncompliance with study procedures and irregular contact with experiment-arranged contingencies, their data were excluded from final data analyses. However, data from these participants’ respective teams were included in analyses because the missing samples did not alter the experimenter-arranged contingencies for the remaining teammates. Thus, data collected from 32 participants are analyzed in the *Experiment 2 Results*.

**Materials**

Participants were loaned the same equipment used in the first experiment (see *Experiment 1 Methods*).
Set-up

Set-up procedures were the same as those used in Experiment 1 (see Experiment 1 Set-up). In addition, researchers collected a breath CO measure from each participant at this time point.

Treatment conditions began on Mondays. Thus, researchers set up participants on Thursdays and Fridays of the preceding week. Researchers informed participants on the Friday before the onset of the first condition which contingency arrangement they would experience during the first week of the study (see Experiment 2 Within-subject treatment condition). Similarly, on subsequent Fridays during the intervention, participants were informed which within-subject treatment condition they would experience the following week.

Mōtiv8™ and CO Monitoring Procedure

Participants were instructed to submit video samples of breath CO measurements twice daily (minimum 8 h inter-sample interval). However, participants were only able to submit videos Monday through Friday. Participants had access to all features of the website during the weekend except the "Post Video" button (see Experiment 1 Mōtiv8™ and CO monitoring procedure), which was inactive on Saturdays and Sundays.

Experimental Design

We used a 2x3 factorial design. Access to a moderated online discussion forum was the between-subject factor and contingency arrangement was the within-subject factor.
**Between-Subject Treatment Conditions**

Teams were randomly assigned to one of two groups. Six teams \((n = 16; 7\) Females) were given access to the Mōtiv8™ Group Support Forum. Six teams \((n = 16; 7\) Females) were not given access to this online discussion forum.

**Forum access.**

Participants with forum access could click on a link located on their Mōtiv8™ homepage that directed them to the Mōtiv8™ Group Support Forum (see *Experiment 1 Online peer support forum* for a description of this feature). Participants received the same guidelines for communicating via the online peer support forum as participants received in Experiment 1.

The forum moderator posted approximately five comments on the forum per within-subject treatment condition (Monday through Friday). Twice per week, these comments included informational support (Cohen, 2004) based on recommendations provided by the authors of the Clearing the Air booklet (e.g., "Stay away from places where smoking is allowed."). The moderator also posted emotional support (Cohen) when participants met treatment goals (e.g., "Good job meeting your CO goal!").

**No forum access.**

Participants without forum access could not communicate with their teammates. These participants received the same informational support received by participants with forum access. However, participants without forum access received this support in the form of administrative messages posted directly onto participants' Mōtiv8™ homepages. These participants did not receive the experimenter-delivered emotional support that participants with forum access received.
Within-Subject Treatment Conditions

Participants were exposed to three treatment conditions: (1) no vouchers, (2) independent contingency, and (3) interdependent contingency. Each condition lasted 5 days (Monday through Friday). Participants could not post videos during the weekend. Thus, participants were exposed to 2 days with no monetary contingencies between each within-subject treatment condition. The order in which participants were exposed to these conditions was counterbalanced across teams, such that every possible sequence of conditions was used once among participants with forum access and once among participants without forum access.

During every within-subject condition, participants were instructed to quit smoking and meet the 4 ppm breath CO abstinence goal. In addition, during each condition, those participants with forum access could communicate with their teammates.

No vouchers.

No monetary contingency was arranged during this condition. However, all participants had access to other features of the intervention (e.g., Internet-based monitoring and the Clearing the Air booklet).

Independent contingency.

During the independent contingency condition, participants earned vouchers on an escalating schedule of reinforcement (Roll et al., 1996) contingent on submission of breath CO samples indicative of abstinence (i.e., ≤ 4 ppm; Javors et al., 2005). Participants earned a $3.00 voucher for the first CO sample ≤ 4 ppm (i.e., negative sample). Each consecutive negative sample submission resulted in a $.25 increase in voucher value. In addition, participants received a $5.00 bonus voucher contingent on three consecutive negative sample submissions. Thus, the first negative sample
resulted in a $3.00 voucher, the second resulted in $3.25, the third resulted in $8.50 (i.e., $3.50 + $5.00), the fourth resulted in $3.75, and so on. A reset contingency (Roll & Higgins, 2000) was also arranged such that when a participant failed to submit a sample or submitted a positive sample, then that participant did not receive a voucher, and the value of the voucher contingent on the next negative sample was reset to the initial amount (i.e., $3.00). Following three consecutive negative sample submissions, the voucher magnitude then returned to the highest previous level. Participants could earn $56.25 in vouchers if they submitted all scheduled samples and were continuously abstinent throughout the independent contingency condition.

**Interdependent contingency**

During the interdependent group contingency condition, vouchers were available on the same escalating schedule of reinforcement with reset contingency that was used in the independent contingency condition except for one major difference—the vouchers in this condition were contingent on group, rather than individual, performance. If every member on a team submitted a negative sample, they each received a voucher. If one teammate failed to submit a sample or submitted a positive sample, no one on the team received a voucher even if the other members of the team submitted negative samples. Participants could earn $56.25 in vouchers if they and their teammates submitted all scheduled samples and were continuously abstinent throughout the interdependent contingency condition. During this condition, participants also had access to their teammates’ quantitative progress graphs through their Mōтивó™ homepage. Thus, they were able to see when their teammates submitted positive and negative breath CO measures.
Exit Interview

An exit interview was conducted with participants within 1 week following study completion (see Experiment 1 Exit interview for details). Only participants with access to the Mōtiv8™ Group Support Forum completed the GEQ. There were no reported instances of external communication between participants. All participants were compensated with $50 in vouchers for completing the study.

Data Analysis

Participant characteristics

Mann-Whitney U tests were used to compare characteristics between participants with access to the Mōtiv8™ Group Support Forum and those without access to the forum. There were no significant differences in demographic measures or other participant characteristics between the two groups of participants.

Primary outcome measures

Visual and statistical analyses revealed no significant effect of the between-subject factor, forum access, on breath CO measures nor any interactions between forum access and the within-subject factor, contingency arrangement. Thus, data from both groups of participants were combined, and one-way repeated measures ANOVAs were calculated on two primary outcome measures (the percentage of negative CO samples and the most consecutive negative CO samples) with contingency arrangement (no vouchers, independent contingency, and interdependent contingency) as a factor. Missing samples were considered positive. Planned pairwise comparisons of the mean percentage of negative CO samples and consecutive negative CO samples were then made with the Bonferroni procedure between no vouchers and independent
contingency conditions, no vouchers and interdependent contingency conditions, and independent and interdependent contingency conditions.

Pearson product-moment correlations were calculated to detect correlations between breath CO measures and potential predictors of treatment success, including: age, income, FTND score, NTB score, breath CO level at intake, and average number of cigarettes smoked per day prior to intake. Correlations were also calculated to detect relationships between breath CO and GEQ score. In addition, the data were analyzed for correlations between breath CO measures and quantitative and qualitative measures of support forum posts.

Secondary measures

Pearson product-moment correlations were calculated to detect relationships between GEQ score and NTB score, and between both of these measures and quantitative measures of Mōtiv8™ Group Support Forum posts. Quantity of support forum posts created by participants with forum access were compared between within-subject treatment conditions using a Friedman repeated measures ANOVA on ranks. Pairwise comparisons of the differences in ranks were then made with the Tukey procedure between no vouchers and independent contingency conditions, no vouchers and interdependent contingency conditions, and independent and interdependent contingency conditions. Support forum posts were also rated for quality (i.e., positive, negative, or neutral) by two independent observers (see Experiment 1 Data analysis for details). The percentage of posts rated as positive was compared between within-subject treatment conditions using a one-way repeated measures ANOVA. In addition, the cost in vouchers for each participant was calculated and compared across independent and interdependent contingency conditions using a Wilcoxon signed rank test.
test. Finally, we used t tests to compare mean responses (range 0-100 on a visual analog scale) to each treatment acceptability question across groups (i.e., participants with forum access and those without forum access) and one-way repeated measures ANOVAs to compare responses by all participants to questions regarding independent and interdependent contingency acceptability.

**Results**

**CO Data**

At Set-up, the average breath CO level for all participants was 25 ppm (SD = 13.4). At this time point, 3-4 days prior to study commencement, only 1 of 32 participants submitted a negative sample (i.e., 1% of samples were negative prior to the onset of experimental conditions). During the 3-week intervention, the average breath CO for all participants was 7 ppm (SD = 6.8), and 48% of samples were negative.

Regardless of whether participants had access to the Mōtiv8™ Group Support Forum, they submitted approximately the same percentage of negative CO samples (Table 3-1). A two-way repeated measures ANOVA revealed no difference in the mean percentage of negative samples submitted between participants with and without forum access (F = 0, p = 1). Moreover, there was no significant interaction effects detected between forum access and the within-subject factor, contingency arrangement, on the percentage of negative sample submissions (F = .19, p = .82).

Figure 3-1 shows the percentage of negative CO samples for all participants (those with and without forum access) as a function of contingency arrangement. Across within-subject treatment conditions, participants submitted more negative samples when vouchers were available than when no vouchers were available. Data for all participants were combined and analyzed using a one-way repeated measures
ANOVA, and comparisons between contingency arrangements revealed a significant difference between mean percentages of negative CO samples submitted during the no vouchers ($M = 34.7, SD = 38.9$) and independent contingency conditions ($M = 55.6, SD = 41.5; t = 3.43, p = .003$) and between the no vouchers and interdependent contingency conditions ($M = 52.8, SD = 39.4; t = 2.97, p = .01$), but no difference between the independent and interdependent contingency conditions ($t = .46, p = 1$).

Figure 3-1 shows substantial variability in the percentages of negative samples submitted by participants. Visual analysis of the within-subject CO data revealed several patterns of responding across treatment conditions. Seventeen participants submitted negative breath CO samples more reliably during one or both monetary contingency conditions relative to the no vouchers condition, 7 participants submitted few or no negative samples during any treatment condition, and 8 participants submitted negative samples regularly throughout all three treatment conditions. The 8 participants who submitted negative samples reliably during the no vouchers condition experienced this condition during the second or third week of the intervention. Figure 3-2 shows that all three within-subject treatment conditions promoted abstinence among some participants during the second and third weeks of the 3 week intervention. That is, during all three treatment conditions, some participants submitted 50% or more negative samples during the second or third week of the intervention. Moreover, several participants submitted 50% or more negative samples during the first week of the intervention when the independent and interdependent contingency conditions were in effect. However, no participant who was exposed to the no vouchers condition first in the sequence of
within-subject treatment conditions submitted 50% or more negative samples during this condition.

Figure 3-3 shows the highest number of consecutive negative samples submitted by each participant (those with and without forum access) during each treatment condition. Participants submitted more consecutive negative samples when vouchers were available than when no vouchers were available. Twice as many participants were continuously abstinent for 3 days during the independent and interdependent contingency conditions relative to the no vouchers condition. A one-way repeated measures ANOVA revealed a significant effect of contingency arrangement on the most consecutive negative samples submitted by each participant ($F = 6.07, p = .004$). Comparisons revealed a significant difference in the most consecutive negative sample submissions between the no vouchers condition ($M = 2.8, SD = 3.6$) and independent contingency condition ($M = 4.9, SD = 4.2; t = 3.3, p = .005$) and between the no vouchers condition and interdependent contingency condition ($M = 4.5, SD = 4; t = 2.62, p = .03$), but no difference between the independent and interdependent contingency conditions ($t = .68, p = 1$).

No significant correlations were detected between breath CO measures and the predictor variables we tested

**Contingent Reinforcement Earned**

Participants earned significantly more vouchers during the independent contingency condition ($M = $28.85, $SD = 23.73$) than they earned during the interdependent contingency condition ($M = $6.47, $SD = 12.10; W = 334, p < .001$) despite similar treatment outcomes during each condition.
Support Forum Data

The 16 participants who had access to the Mōtiv8™ Group Support Forum posted 119 comments during all three within-subject treatment conditions ($M = 7.4$, $SD = 5.4$). Eighty-nine percent of the posts were rated as positive, 11% were rated as neutral, and no posts were rated as negative (IOA = 90%). Participants made 33 posts (85% positive) during the no vouchers condition, 37 posts (86% positive) during the independent contingency condition, and 49 posts (94% positive) during the interdependent contingency condition. The forum moderator made approximately the same number of posts per condition: 33 posts (97% positive; 1 post was rated as neutral) during the no vouchers condition, 35 posts (100% positive) during the independent contingency condition, and 34 posts (100% positive) during the interdependent contingency condition.

A Friedman repeated measures ANOVA on ranks revealed a significant difference in the number of participants’ support forum posts as a function of within-subject treatment condition ($\chi^2 = 7.56, p = 0.23$). Comparisons indicated that participants posted significantly more comments during the interdependent contingency condition ($M = 3.1$, $SD = 2.6$) relative to the no vouchers condition ($M = 2.1$, $SD = 2$; $q = 3.5$, $p < .05$). In fact, 12 out of 16 participants posted more comments during the interdependent contingency condition relative to the no vouchers condition. Only 7 participants posted more comments during the independent contingency condition ($M = 2.3$, $SD = 1.9$) relative to the no vouchers condition, and the number of posts per participant was not significantly different between these two conditions ($q = 2.5$, $p > .05$). Although 10 participants posted more comments during the interdependent contingency condition relative to the independent contingency condition, the number of posts per participant
was not significantly higher during the interdependent contingency condition relative to the independent contingency condition ($q = 2.5$, $p > .05$).

The mean percentage of positive posts per participant was not significantly different between treatment conditions ($F = .77$, $SD = .47$). No significant correlations were detected between quantity or quality of support forum posts and breath CO measures.

**Treatment Acceptability Data**

Participants with access to the Mōtiv8™ Group Support Forum reported that they “liked” using the forum ($M = 80.8$, $SD = 20.1$) and that it was “helpful” in their quit attempt ($M = 71$, $SD = 22.4$). Participants reported that they liked earning vouchers based on individual performance ($M = 77.7$, $SD = 25.8$) significantly more than they liked earning vouchers based on team performance ($M = 56.1$, $SD = 32.6$; $t = 3.02$, $p = .005$). Participants also reported that earning vouchers based on individual performance was significantly more helpful ($M = 73.7$, $SD = 26.5$) than earning vouchers based on team performance ($M = 50.5$, $SD = 33$; $t = 2.8$, $p = .009$); moreover, this was the only acceptability measure that was significantly different between participants with forum access and those without forum access. Participants with forum access reported that the interdependent contingency was more helpful in their quit attempt ($M = 64$, $SD = 25.3$) than participants without forum access ($M = 36.9$, $SD = 35.3$; $t = 2.5$, $p = .018$).

**GEQ and NTB Measures**

Mean GEQ score for participants with access to the Mōtiv8™ Group Support Forum was 5.7 ($SD = 1.7$), representing, on average, moderate group cohesion across teams. Mean NTB score for all participants was 2.6 ($SD = .6$), representing, on average, low to moderate need to belong to social groups. NTB scores were similar among
participants with forum access ($M = 2.7$, $SD = .7$) and without forum access ($M = 2.5$, $SD = .6$; $t = 1.16$, $p = .255$). No significant correlations were detected between NTB scores and GEQ scores or between either of these measures and breath CO measures, quantity or quality of support forum posts, or treatment acceptability measures.

**Discussion**

The results of Experiment 2 show that Internet-based group CM can be used to promote brief abstinence from cigarette smoking. Only one participant submitted a negative breath CO sample during Set-up. Thus, 1% of samples were negative prior to treatment conditions. The percentage of negative samples increased to 48% during the intervention. Abstinence-contingent monetary incentives increased negative sample submissions relative to a condition with no incentives, but access to the Mōtiv8™ Group Support Forum did not improve primary outcome measures.

Thirty-five percent of samples were negative during the no vouchers condition. This finding suggests that, in the absence of incentives, goal-setting and instructions to quit smoking combined with several other features of the Internet-based intervention (e.g., self-monitoring and feedback) are enough to promote smoking cessation among some participants. Adding monetary incentives to these treatment components increased the percentage of negative sample submissions to 56% during the independent contingency condition and 53% during the interdependent contingency condition. Thus, interdependent contingencies alone can be used to promote smoking cessation. To our knowledge, this is the first study to demonstrate that interdependent group contingencies of reinforcement can be used to promote abstinence from any abused substance.
The results also suggest that interdependent contingencies may promote collateral social behavior. Participants with forum access posted more comments on the forum during this condition than during any other within-subject treatment condition. Moreover, the comments were remarkably positive during this condition—94% of the posts were rated as positive by independent observers. However, this emergent social behavior did not appear to improve primary treatment outcomes. Thus, future research is needed to investigate methods for enhancing the value of social incentives (e.g., by assigning participants from pre-existing social networks to the same team).

Cost-effectiveness is another potential advantage of interdependent group contingencies. Although, the percentage of negative samples submitted by participants was similar across independent and interdependent contingency arrangements, the cost in vouchers was four times higher during the independent contingency condition ($M = 28.85, SD = 23.73$) relative to the interdependent contingency condition ($M = 6.47, SD = 12.10$). These results suggest that interdependent contingencies may be more affordable than independent contingencies. However, it remains unclear if the outcomes observed in the current study were a function of voucher magnitude, contingency arrangement, or both. It is possible that lower magnitude vouchers comparable to the amount which was earned during the interdependent contingency condition could have promoted the same treatment outcomes if available on an independent schedule of reinforcement. Thus, future research is needed to compare independent and interdependent contingency arrangements with incentives of various magnitudes.

Despite the potential practical advantages of interdependent group contingencies, treatment acceptability data indicate that these contingencies are much less preferred
than independent contingencies. Participants liked earning vouchers based on individual performance much more than they liked earning vouchers based on team performance. Moreover, those participants without access to the Mōtiv8™ Group Support Forum and, therefore, unable to communicate with their teammates, did not find the interdependent contingency helpful in their quit attempt.

The results of Experiment 2 should be interpreted with caution. One major limitation of this experiment is the small sample size. Only 32 smokers completed the study. Moreover, only half \( n = 16 \) had access to the Mōtiv8™ Group Support Forum. Thus, future studies should investigate whether findings from the current study generalize to larger samples of smokers. Another major limitation of Experiment 2 is one of the inclusion criterion used in recruitment. Only smokers who reported a desire to quit smoking were invited to participate. Although this sample of smokers represents a clinically relevant population (i.e., treatment-seeking smokers; Perkins et al., 2006), confounding motivating factors may have attributed to treatment outcomes (e.g., some smokers may have had a stronger desire to quit than others). Indeed, such factors may be responsible for the variability in breath CO measures observed between participants. Although none of the potential predictor variables we examined correlated with treatment outcomes (e.g., FTND score, NTB score, breath CO at intake), it is possible that motivation to quit may have contributed to treatment success. Thus, to get a clearer picture of the effects of the independent variables we examined on smoking cessation, future studies should recruit smokers who report no desire to quit smoking.
Table 3-1. Participant characteristics.

<table>
<thead>
<tr>
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<th>No Forum ((n = 16))</th>
<th>Forum ((n = 16))</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(M)</td>
<td>(SD)</td>
</tr>
<tr>
<td>Sex (% Male)</td>
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<td>-</td>
</tr>
<tr>
<td>Age</td>
<td>39.6</td>
<td>14</td>
</tr>
<tr>
<td>Race (% White)</td>
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</tr>
<tr>
<td>Education (Median)</td>
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</tr>
<tr>
<td>Weekly Income (Median)</td>
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<td>-</td>
</tr>
<tr>
<td>Cigarettes per day</td>
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<td>10.3</td>
</tr>
<tr>
<td>CO (ppm) at Intake</td>
<td>27.1</td>
<td>15</td>
</tr>
<tr>
<td>NTB score</td>
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<td>0.6</td>
</tr>
<tr>
<td>FTND score</td>
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<td>2</td>
</tr>
</tbody>
</table>

Table 3-2. Percentage of negative samples.

<table>
<thead>
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<th>Forum ((n=16))</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(M)</td>
<td>(SD)</td>
</tr>
<tr>
<td>No Vouchers</td>
<td>36</td>
<td>44</td>
</tr>
<tr>
<td>Independent Contingency</td>
<td>56</td>
<td>43</td>
</tr>
<tr>
<td>Interdependent Contingency</td>
<td>51</td>
<td>41</td>
</tr>
</tbody>
</table>
Figure 3-1. Percentage of negative samples across conditions. Percentage of samples negative for breath CO (i.e., CO $\leq$ 4 ppm) submitted by all participants ($N = 32$) with and without forum access presented as a function of within-subject treatment condition. Circles represent percentages for each participant. Bars represent mean percentages for all participants.

Figure 3-2. Percentage of negative samples across weeks in treatment. Percentage of negative samples submitted by all participants ($N = 32$) presented as a function of time in treatment. Each circle represents the percentage of negative samples for one participant. Each panel represents a different within-subject treatment condition. Thus, in the “No Vouchers” panel, the data above “Week 1” represent the percentage of negative samples submitted during the no vouchers condition for each participant who experienced this condition during the first week of the 3-week intervention.
Figure 3-3. Consecutive negative samples. The most consecutive negative samples submitted by all participants ($N = 32$) across within-subject treatment condition. Circles represent the highest number of consecutive negative samples by each participant during (maximum of 10 samples or 5 days of continuous abstinence). Bars represent mean percentages for all participants. Any data point falling on or above the dashed horizontal line indicates that the participant was continuously abstinent for 3 or more days.
CHAPTER 4
GENERAL DISCUSSION

To our knowledge, the current study is the first to use group CM to promote abstinence from cigarette smoking. Although the findings are preliminary, they are nonetheless encouraging. They suggest that Internet-based group CM is a feasible and acceptable smoking intervention. Moreover, the intervention may provide researchers with an advantageous treatment model for investigating the effects of social support on drug abstinence.

Previous research suggests that social support may promote smoking cessation (Baha & Le Faou, 2010; Chen, White, & Pandina, 2001; Christakis & Fowler, 2008; Cohen & Lichtenstein, 1990; Hennrikus et al., 2010; Ji et al., 2005; Mermelstein, Cohen, Lichtenstein, Baer, & Kamarck, 1983; Møller, Pedersen, Villebro, & Nørgaard, 2003; Westmaas, Wild, & Ferrence, 2002). Thus, understanding what dimensions of social support are necessary to influence behavior change would allow researchers and practitioners to apply this knowledge to the treatment of drug dependence. The moderated online support forum is ideal for initial investigations into the influence of social support on behavior change because it affords researchers the ability to investigate social interactions while minimizing or eliminating undesirable behavior among participants, preserving their anonymity, and protecting their confidentiality. The Internet-based intervention also allows all social interactions to be recorded for descriptive analyses. In many previous studies in which the effects of group contingencies on behavior change were investigated, researchers were only able to collect data on emergent social behavior via self-report (e.g., Williamson et al. 1992) or during a brief window when participants were in the presence of trained observers, tape
recorders, or video recorders (e.g., Speltz et al. 1982). In the current study however, a complete record of all social exchanges was obtained. Thus, we were able to find that Internet-based group CM promotes social support. Moreover, a descriptive analysis revealed that this collateral behavior was remarkably positive. However, we were unable to determine the function of the support forum posts. In other words, the current study did not evaluate whether tips and advice from successful quitters functioned as prompts to help others quit smoking, or whether abstinence-contingent praise functioned as reinforcers for smoking cessation. In future studies however, an online forum could permit researchers or “confederates” to experimentally manipulate quality and quantity of social interactions to identify functional relationships between social behavior and abstinence and to learn which dimensions of social support promote target behavior change. Empirical investigations such as these are needed to advance researchers’ understanding of the role social support plays in drug abstinence.

It is unclear which variables contributed to infrequent forum participation in the current study. Participants’ responses to open-ended questions on the treatment acceptability questionnaire indicated that anonymity may have decreased the value of social incentives. For example, one participant from Experiment 2, V461, noted that his least favorite part of the intervention was that he was given “no chance to put a face to the name of [his] teammates.” Other participants suggested that having more teammates or allowing real-time communication via “chat rooms” would improve the social component of the intervention. Future studies should therefore investigate ways to facilitate communication, perhaps by allowing teammates to meet one another; enlarging team size; stratifying teams based on common characteristics; providing
incentives contingent on forum participation; or using a forum moderator who is also an
ex-smoker, group therapist, or counselor. This latter method would allow researchers to
integrate psychosocial therapy into the online peer support forum.

Although participants did not use the forum frequently, several reported that it was
their favorite feature of the intervention. Indeed, participants in Experiment 2 rated this
feature much more highly than participants in Experiment 1 ($M = 81$, $SD = 20$ versus $M$
$= 54$, $SD = 25$, respectively). The difference in acceptability ratings between participants
in each experiment did not appear to be related to group cohesion. Participants in
Experiment 2 had the same average GEQ score as participants in Experiment 1 ($M =$
$5.7$, $SD = 1.7$ versus $M = 5.7$, $SD = 1.8$, respectively). However, the different
acceptability ratings may have been due to differences observed in the quality of
support forum posts. Although the majority of posts were rated as positive in Experiment
1 (65%), even more were rated as positive in Experiment 2 (89%). The increase in the
percentage of positive posts across experiments may have been related to the increase
in the quantity and quality of moderator posts in Experiment 2. That is, the moderator’s
behavior may have served as a model which was imitated by participants. Thus, future
research is needed to examine the influence of moderator behavior on participants’
social behavior.

The results of this study suggest that group CM may represent a more cost-
effective alternative to traditional CM. In Experiment 2, similar treatment effects were
observed across independent and interdependent contingency arrangements. However,
the amount of vouchers awarded to participants was significantly lower during the
interdependent contingency condition than during the independent contingency
condition. Strict interdependent contingencies like the one used in Experiment 2 are likely inappropriate for clinical application. As the acceptability data collected in Experiment 2 indicate, the response requirement is likely to frustrate some patients when they meet their treatment goals and their teammates do not. However, a mixed contingency arrangement like the one used in Experiment 1 may be more acceptable to patients and practitioners, while still promoting social support. Presumably, a mixed contingency such as this would be more affordable than individual contingencies of reinforcement. Participants in Experiment 1 earned relatively few of the interdependent vouchers; yet, many still abstained from smoking. Future studies should compare mixed group contingency arrangements with individual or independent contingencies to determine whether group contingencies can help lower costs or enhance traditional CM treatment outcomes.

The value of social and monetary group contingencies may even be enhanced if researchers preserve participants’ access to peer support after financial incentives are withdrawn. Maintaining this social component as well as other features of the Internet-based intervention while transitioning to interdependent contingency arrangements over the course of an intervention or gradually thinning out monetary incentives may result in a low-cost method to increase treatment duration and long-term maintenance of treatment gains. As the results of Experiment 2 suggest, self-monitoring, feedback, goal-setting, and other features of the Internet-based group CM intervention may not be enough to initiate smoking cessation, but these treatment components may be sufficient for sustaining abstinence once it is established with incentives.
In sum, Internet-based group CM represents a promising strategy for treating cigarette smoking. Moreover, it is an ideal treatment model for systematically investigating the effects of social contingencies on behavior change. Future investigations of the effects of this intervention on smoking cessation will allow researchers to learn more about the role social support plays in promoting drug abstinence.
LIST OF REFERENCES


BIOGRAPHICAL SKETCH

Steven Meredith graduated as a valedictorian from the University of Florida in 2005 with a B.S. in Psychology. Following graduation, he continued his education at the University of Florida Department of Psychology with a concentration in Behavior Analysis. As a graduate student he conducted basic behavioral pharmacology research and earned an M.S. in Psychology in 2009. He subsequently focused his research efforts on applied behavioral pharmacology. He earned several academic and research awards as a graduate student, including the American Psychological Association Dissertation Research Award, the E.F. Malagodi Jr. Memorial Scholarship, the Society for the Advancement of Behavior Analysis Doctoral Dissertation Grant, and the B.F. Skinner Foundation Research Award. He earned his Ph.D. in August 2012, after which he continued to conduct research in behavior analysis and behavioral pharmacology as a National Institute of Health postdoctoral fellow at the Johns Hopkins University School of Medicine.