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Internet-based group contingency management to promote abstinence from cigarette smoking: A feasibility study

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Abstract

Background—In contingency management (CM) interventions, monetary consequences are contingent on evidence of drug abstinence. Typically, these consequences are contingent on individual performance. Consequences contingent on group performance may promote social support (e.g., praise).

Methods—Thus, to combine social support with the monetary incentives of CM, we integrated independent and interdependent group contingencies of reinforcement into an Internet-based intervention to promote smoking abstinence. Breath carbon monoxide (CO) measures were compared between treatment conditions and a baseline control condition. Thirteen participants were divided into 5 groups or “teams” ($n = 2–3$ per team). Each participant submitted video recordings of CO measurement twice daily via the Internet. Teammates could monitor each other’s progress and communicate with one another through an online peer support forum. During a 4-day tapering condition, vouchers exchangeable for goods were contingent on gradual reductions in breath CO. During a 10-day abstinence induction condition, vouchers were contingent on abstinence ($\text{CO} \leq 4$ ppm). In both treatment conditions, concurrent independent and interdependent group contingencies were arranged (i.e., a mixed contingency arrangement).

Results—Less than 1% of CO samples submitted during baseline were ≤ 4 ppm, compared to 57% submitted during abstinence induction. Sixty-five percent of participants’ comments on the online peer support forum were rated as positive by independent observers. Participants rated the intervention favorably on a treatment acceptability questionnaire.

Conclusion—The results suggest that the intervention is feasible and acceptable for promoting abstinence from cigarette smoking.

Keywords

Smoking; Cigarette; Internet; Group; Contingency management; Incentives

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Conflict of interest

The authors declare no conflicts of interests.

Contributors: Meredith and Dallery designed the study and wrote the protocol. Grabinski developed the software used in the study. Meredith collected and analyzed the data. Meredith and Dallery wrote the manuscript. All authors contributed to and have approved the final manuscript.

1. Introduction

Contingency management (CM) is an efficacious method for promoting abstinence from a variety of abused substances, including illicit drugs, alcohol, and tobacco (Higgins et al., 2008). In many CM interventions designed to promote abstinence from cigarette smoking, vouchers 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 because it is a relatively immediate and acute measure of smoking status. This method of CM has been shown reliably to promote abstinence from cigarette smoking (Alessi et al., 2004; Dallery et al., 2007; Dunn et al., 2008; Higgins et al., 2004; Roll and Higgins, 2000; Roll et al., 1996; Tidey et al., 2002).

An important feature of many CM interventions is rigorous monitoring of breath CO. Monitoring must be both frequent and sustained for several reasons. First, because breath CO has a half-life of about 3–6 h (Benowitz et al., 2002; Deller et al., 1992; Joumard et al., 1981), samples must be collected at least twice daily to accurately assess smoking status. Second, learning theories based on extensive empirical evidence predict that frequent and immediate reinforcement for alternative non-drug behavior is needed to promote abstinence (Bigelow and Silverman, 1999); thus, to utilize effective schedules of reinforcement, CO must be measured on a frequent basis. Third, research suggests that continuous abstinence for at least 2 weeks during the initial stages of a quit attempt is an important predictor of long term treatment success (Frosch et al., 2002; Kenford et al., 1994). Clinicians should therefore attempt to promote abstinence for a minimum of 2 weeks.

Requiring clinic visits to collect CO samples frequently over a sustained period, however, involves considerable response effort. Further, twice daily visits would not be feasible for many clients due to distance, lack of transportation, disability, clinic hours, and other practical constraints. To overcome these obstacles, Dallery and colleagues developed an Internet-based CM program to promote smoking cessation (Dallery and Glenn, 2005; Dallery et al., 2007, 2008; Reynolds et al., 2008; Stoops et al., 2009). Participants submitted video CO samples 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., 2009). Some smokers who participated in the program did not quit, however, or relapsed following withdrawal of the voucher-based contingencies (e.g., see Dallery et al., 2007). Thus, enhancements are warranted to improve the efficacy of the intervention.

One promising strategy is to incorporate group contingencies into the Internet-based CM model. Although the majority of CM interventions use individual contingencies of reinforcement, in which each individual receives consequences contingent on his or her own behavior, three types of group contingencies have also been described in the literature: independent, dependent, and interdependent (Cooper et al., 2007; Litow and Pumroy, 1975). An independent group contingency is arranged when the contingency is applied simultaneously to all members of a group, but the consequences are contingent on individual performance. Thus, in both individual and independent contingency arrangements, consequences are delivered independent of the performance of others. Dependent and interdependent group contingencies, however, are arranged such that “the behavior of one or more group members determines the consequences received by at least one other group member” (Speltz et al., 1982, p. 533). Kirby et al. (2008) found that an interdependent-group-contingency-based CM intervention is feasible for promoting desirable behavior change among cocaine-dependent methadone maintenance patients. Research on the effects of group contingencies on various other forms of behavior change has shown the strategy is

as effective as individual contingencies of reinforcement (Drabman et al., 1974; Herman and Tramontana, 1971) or more effective (Long and Williams, 1973; Speltz et al., 1982).

One advantage group contingencies have over individual contingencies is that they promote social interactions such as praise and cooperation (Gresham and Gresham, 1982; Williamson et al., 1992)—social support that could play an important role in desirable behavior change (Cooper et al., 2007). Indeed, research suggests that cigarette smoking is influenced by an individual's social interactions (Baha and Le Faou, 2010; Chen et al., 2001; Christakis and Fowler, 2008; Ji et al., 2005; Mermelstein et al., 1986; Møller et al., 2003; Westmaas et al., 2002). For example, of over 13,000 smokers registered in the French national smoking cessation database between 2006 and 2007 who answered the question, “Why would you like to stop smoking?” the only self-reported motivating factor that predicted abstinence at 1 month follow-up was “motivated or pressured by others” (Baha and Le Faou, 2010). Although more smokers cited “health concerns” and “cost of smoking” as motivating factors, neither of these or any other self-reported motivating factor predicted abstinence. Similarly, other research suggests that smokers are more likely to quit if members of their social network discourage smoking (Ji et al., 2005) or if their partners encourage abstinence (Cohen and Lichtenstein, 1990; Mermelstein et al., 1983). Given these findings, it follows that researchers should be able to decrease smoking by structuring an environment that promotes social interactions which discourage smoking and/or encourage cessation. Although group contingencies are ideally suited for this aim, to our knowledge, no previous research has evaluated the feasibility of a group-contingency-based smoking intervention.

The purpose of the current study was to develop an Internet-based group CM program to promote smoking cessation and to evaluate the feasibility, acceptability, and preliminary efficacy of the intervention. We integrated group contingencies and an online peer support forum into an existing Internet-based CM program (Stoops et al., 2009). In addition to the financial incentives that are typically associated with CM, we hoped to harness another powerful source of influence over behavior change—social support.

2. Methods

2.1. Participants

Participants were healthy smokers recruited locally 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?”).

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 six-item questionnaire that assesses nicotine dependence with a scale ranging from 0 to 10 (higher scores representing greater dependence; Fagerström and 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 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 Mōtiv8™ 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. Although few researchers have examined group or team size as an independent variable in group-contingency-based interventions, Shapiro and Goldberg (1990) found no differences in target behavior change when group sizes were 4 versus 8 individuals.

2.2. 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.

2.3. 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-Airacc.pdf>), and an instruction manual that included a detailed description of all study procedures. This manual included 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!” Participants were

also asked not to use their real names in the forum. They were provided with usernames to protect their confidentiality. Participants were required to pass a quiz demonstrating that they read and understood all study procedures (Silverman et al., 1999).

2.4. Mōtiv8™ and CO monitoring procedure

Participants were asked to submit video samples of breath CO measurements twice daily (minimum 8 hr 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 vouchers 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 h 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 min to complete, and most participants learned the steps after only one or two practice submissions. A software feature allowed playback of the video 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 vouchers earned for submitting the sample. Participants were then directed back to their homepage which included an updated quantitative progress graph and voucher account history. Participants were notified during setup that attempts to falsify a sample were easily detected and would lead to dismissal from the study.

2.5. 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. Each post could be viewed by every member of the team and the moderator. Posts that were considered negative by the moderator were removed from the discussion thread (only one comment met the criteria for a negative post, see Table 2). The moderator posted two to three comments per condition. These posts were similar across teams and often included reminders of condition changes or references to the Clearing the Air booklet. Participants also had access to their teammates' quantitative progress graphs through their Mōtiv8™ homepage. Thus, they were able to see when their teammates met their goals and provide them with appropriate social consequences on the forum when those goals were met.

2.6. Experimental design and conditions

2.6.1. Non-concurrent multiple baseline design—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 et al., 2009; Weisz and Kazdin, 2010). 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.

2.6.2. Baseline (A)—This condition lasted between 2 and 6 days across teams. No vouchers 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.).

2.6.3. Tapering (B)—During this 4-day condition, vouchers 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. Additionally, 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 a given sample. Two concurrently arranged contingencies, such as these, specify a mixed contingency arrangement.

2.6.4. 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 ≤ 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 and 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.

2.7. Exit interview

An exit interview was conducted with each participant within 1 week following study completion. Researchers collected equipment and asked participants to complete 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 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.

2.8. Data analysis

A one-way repeated measures analysis of variance (ANOVA) was calculated on the percentage of negative CO 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 the percentage of negative CO samples submitted during abstinence induction 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 percentage of negative CO samples and GEQ score. Additionally, the data were analyzed for correlations between percentage of negative CO samples 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 total by the total number of posts, and multiplying by 100.

3. Results

3.1. CO data

There was a significant effect of condition on breath CO ($F_{(2,12)} = 25.77$; $p < 0.001$). Fig. 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.

Fig. 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 that were examined.

3.2. 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.

3.3. Support forum data

Over the course of the study, 128 posts were made by participants on the online peer support forum (M number of posts per participant = 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 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 significant relationships were observed between the quantity or quality of forum posts and CO.

3.4. Treatment acceptability data

Table 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 ($M = 83.3$, $SD = 17.2$; $F_{(1,12)} = 0.965$; $p = 0.35$).

3.5. 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.

4. Discussion

The results show 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. Out of 13 participants who completed the study, 10 demonstrated some sustained period of abstinence during the 10-day abstinence induction condition. Fig. 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 examine preliminary efficacy.

One major limitation of the study, however, is that we cannot dissociate the effects of the independent and interdependent group contingencies on abstinence. The mixed contingency arrangement employed in the current study 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 promotes emergent social support. This mixed contingency, however, does not permit us to identify the relative advantages of the independent and interdependent contingencies. It is possible the outcomes observed in the current study were a function of the independent contingency alone. In independent group contingency is similar to an individual contingency of reinforcement (aside from the group context in which the independent contingency is administered), and Internet-based CM programs that employ only individual contingencies have already been demonstrated efficacious (Dallery et al., 2007). Future studies should therefore compare the effects of various group, individual, and mixed contingency arrangements to determine which strategy is most effective for promoting abstinence.

The results of the study indicate that group CM is an acceptable form of treatment. On average, participants reported liking all of the treatment components, including the interdependent contingency (see Table 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 (see Table 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., ≥ 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. Unfortunately, it is unclear which variables contributed to infrequent participation on the support forum. Future studies should therefore investigate ways to facilitate communication, perhaps by increasing the frequency of moderator posts; enlarging team size; stratifying teams based on common characteristics; arranging social or monetary contingencies for forum participation; or utilizing a forum moderator who is also an ex-smoker, group therapist, or counselor. The latter method would allow researchers to integrate psychosocial therapy into the online peer support forum.

Although participants used the forum somewhat infrequently, their exchanges were quite positive. Indeed, 65% of posts met our definition for a positive post. 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. Interestingly, the post was unrelated to the interdependent contingency. J25's teammate, E33 posted only one comment over the course of the intervention. It was E33's lack of forum participation that evoked the negative response by J25 (see quote in Table 2), not his inability to emit the target behavior and

prevent his teammates from earning a team bonus voucher. In fact, E33 was demonstrating a period of continuous abstinence at the time J25 posted the negative comment.

The predominantly positive social exchanges observed in the current study suggest that smokers are willing to use an online discussion forum to support one another during their quit attempts. Yet, effects of this support on abstinence remain unclear because few relationships were observed between social support and abstinence. It is possible that such relationships were not detected because the effects of the monetary contingencies masked the effects of other variables on smoking. Alternatively, it is possible that our inability to detect such relationships was due to another major limitation of the study—the small sample size. We analyzed the data for relationships between treatment outcome and variables that previous, larger *N* studies have shown to be predictors of abstinence (e.g., FTND score and age; Courvoisier and Etter, 2010; Frosch et al., 2002). However, we found no significant relationships between abstinence and any of these variables. Thus, future studies investigating correlations between characteristics of social support and smoking cessation should employ larger samples.

In addition to conducting correlational studies to uncover relationships between social support and abstinence, researchers could conduct a number of empirical investigations using Internet-based group CM. For example, access to the support forum could be allowed or denied depending on condition or group assignment. The online forum could also permit researchers to experimentally manipulate quality and quantity of social interactions to determine which dimensions of social behavior influence abstinence. Empirical investigations such as these are needed to advance researchers' understanding of the relationship between social support and abstinence. Moreover, some authors have argued that conceptual models must be specified and tested to fully understand this relationship (Westmaas et al., 2010). If this assumption is true, then Internet-based group CM may be considered a theoretically advantageous treatment model because it was developed based on an operant framework—a framework that includes testable models of how social and verbal behavior influences target behavior change (Skinner, 1957).

Internet-based group CM is practically advantageous as well. The moderated online forum is ideal for initial investigations into the influence of social support on behavior change because it affords researchers the ability to investigate social behavior while better preserving a participant's anonymity, protecting his/her confidentiality, and minimizing negative social behavior. The Internet-based intervention also allows all social interactions to be recorded. In 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 (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. The Internet is also a convenient method for delivering treatment across substantial distance. Although the clinic used in the current study was located in Gainesville, Florida, several participants lived in the surrounding North Central Florida region and/or traveled in and outside the state while participating in the study. For example, C30 and K27 each lived 68 km from the clinic (Table 1). During the study, both of these participants spent several days in Orlando, Florida (>200 km southeast of Gainesville), and S45 spent a week in Athens, Georgia (>500 km 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.

Regardless of whether treatment is delivered via the Internet, group CM may offer other advantages as well. For example, group CM may help lower treatment costs. Participants in

the current study earned relatively few of the available vouchers; yet, many still abstained from smoking and rated the intervention favorably. Furthermore, the value of the intervention could be enhanced if researchers preserve participants' access to peer support following removal of the monetary contingencies. Doing so could result in a low-cost method to increase treatment duration and long-term maintenance of treatment gains. Group CM may also increase dissemination of incentive-based interventions. Although traditional CM has been shown to promote abstinence from a number of substances across a variety of populations, the intervention is underutilized by community-based treatment providers (Bride et al., 2010; Kirby et al., 2006; McGovern et al., 2004) due, in part, to objections related to cost, compatibility with standard care, and negative attitudes toward incentive-based interventions (Alessi et al., 2007; Bride et al., 2010; Kirby et al., 2006, 2008; Petry et al., 2010; Roll et al., 2009; Stitzer, 2006). However, a CM intervention that employs group contingencies and peer support would presumably be more compatible with traditional group-therapy-based substance abuse treatment methodology and more acceptable to practitioners. Future studies should therefore compare the cost-effectiveness of group CM and traditional CM as well as evaluate practitioners' attitudes regarding the acceptability of both treatment strategies.

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 that may provide researchers with a theoretically and practically advantageous treatment model for investigating the effects of social support on abstinence.

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Fig. 1.

Individual participant ($N = 13$) data showing breath CO level (ppm) for each sample across all study conditions. Dashed vertical lines represent condition change lines (A = baseline, B = tapering, and C = abstinence induction). Dashed horizontal lines represent the abstinence criterion used during abstinence induction (4 ppm); therefore, data points at or below this line are indicative of abstinence. Baseline duration increases from 2 to 6 days across teams from left to right (i.e., Team 1 experienced a 2-day baseline, Team 2 experienced a 3-day baseline, etc.). Note the different scale on the y-axis for T47.

Fig. 2.

Mean percentage of negative breath CO samples ($\text{CO} \leq 4$ ppm). Each bar represents the mean for all participants ($N = 13$) during each condition. Circles represent individual participant means during each condition.

Table 1

Participant characteristics.

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

Note: ID = participant identification code. CO = breath carbon monoxide level at intake (ppm). Kilometers from clinic = distance from participant's residence to University of Florida Smoking Lab and Clinic, Gainesville, FL.

Table 2

Forum posts.

Rating	Quantity	% Total	Samples
Positive	95	65%	K27 “J25, I see you are back on track so far... keep it up!”
			M39 “Let’s make some money!”
			M48 “Wow K59, you are doing really well!”
Neutral	32	43%	T47 “Hello all.”
			E66 “I’ve been doing a little better, not by much though, I’ve got to get very motivated.”
Negative	1	1%	J25 “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.”

Table 3

Treatment acceptability.

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

Note: mean = average response to each question on a visual analog scale. SD = standard deviation.