Effects of Sensory and Behavioral Substitutes Following an Experimentally Induced Stressor among Abstinent Smokeless Tobacco Users

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Despite the well-known health risks associated with smokeless tobacco use, much is unresolved with respect to effective treatment for use of this substance. The present study examined the impact of a nicotine-free smokeless tobacco substitute and confectionary chewing gum on craving, withdrawal, and anxiety among 24 smokeless tobacco users following 24 hours of nicotine abstinence and a laboratory stressor. Although chewing gum did not impact withdrawal, craving, or anxiety compared to a no-product control condition, smokeless tobacco substitute administration resulted in a reduction of withdrawal and craving levels compared to the control condition following 24 hours of abstinence. Furthermore, significantly lower levels of craving and withdrawal were observed in both smokeless tobacco and smokeless tobacco substitute conditions compared to the control condition following the stressor. These data suggest that use of a smokeless tobacco substitute may be an effective aid in helping individuals wishing to quit, especially when managing stressors. (Am J Addict 2010;19:128–135)

INTRODUCTION

Smokeless tobacco use continues to be a serious problem. Recent data indicate that over seven million individuals aged 12 and older reported using a smokeless tobacco product in the past month.1 Of these individuals, the highest rates of smokeless tobacco use were observed among individuals 18–25 years old (5.1%),1 which is alarming given that the initiation of smokeless tobacco use at a younger age increases the likelihood of progression to more frequent use.2,3 In addition to the development of nicotine dependence, chronic smokeless tobacco use is associated with various health hazards, including leukoplakia, gingivitis, oral cancer, and an elevated risk for cardiovascular disease.4,5

Although the health effects of smokeless tobacco use are well known, treatment protocols for smokeless tobacco users have only produced modest effects with respect to long-term (ie, 6 months or longer) abstinence (23–38%).6–9 While several reasons may account for these modest treatment effects, two possibilities include the suboptimal utilization of behavioral and sensory alternatives and an inattention to the role of stress on relapse. This is noteworthy given that behavioral and sensory aspects may be as (or even more) important in reinforcing tobacco use as the pharmacological properties.10 The present study investigated two readily available products that have been shown to help in lessening the severity of nicotine withdrawal symptoms, a herbal, non-nicotine mint snuff substitute, and confectionary chewing gum.

Beyond the pharmacological properties of nicotine, sensory and behavioral factors appear to play a significant role in the maintenance of tobacco use among smokeless tobacco users. In fact, an investigation of smokeless tobacco users who abruptly quit found that more than three-quarters of the participants surveyed used chewing gum or other substitutes (eg, sunflower seeds) during their quit attempt.11 Despite these available survey data, few empirical studies have closely examined the utility of behavioral alternatives in helping individuals better manage their symptoms of nicotine withdrawal. One such alternative that has shown promise among cigarette smokers is confectionary chewing gum. Specifically, Cohen and colleagues have repeatedly demonstrated that the use of chewing gum during periods of brief nicotine abstinence can be helpful in...
lessening the severity of nicotine withdrawal symptoms.\textsuperscript{12,13} To date, it is unclear why chewing gum may help, but it may be related to the fact that chewing gum has been found to increase subjective states of relaxation and reduce tension levels.\textsuperscript{14}

Another alternative that has been examined among smokeless tobacco users is a herbal, non-nicotine mint snuff substitute that allows for an investigation of the conditioned cues inherent to smokeless tobacco. Specifically, use of a smokeless tobacco substitute was shown to substantially reduce average daily smokeless tobacco consumption.\textsuperscript{15} Additionally, there have been several studies indicating that the behavioral and sensory cues related to smokeless tobacco (eg, smokeless tobacco substitute properties of smell, taste, handling a tin, etc.) were as effective at decreasing urges\textsuperscript{16,17} as well as symptoms of withdrawal (ie, frustration and irritability)\textsuperscript{17} as smokeless tobacco itself. Similarly, Hatsukami and colleagues\textsuperscript{6} found that although smokeless tobacco substitute did not significantly increase the treatment effect when paired with nicotine patch, smokeless tobacco substitute use resulted in a significant reduction in craving and withdrawal symptoms. These results were partially supported in a study by McChargue et al.\textsuperscript{18} showing that use of a smokeless tobacco substitute was found to significantly decrease symptoms of withdrawal, but not craving compared to a placebo control.

As mentioned earlier, the role of stress on relapse to smokeless tobacco has also been largely ignored, receiving considerably less attention than what is observed in the smoking literature. This is surprising given the strong connection between stress and relapse. For example, initial lapses related to stress have been shown to lead to relapse more quickly compared to initial lapses due to other consequences (ie, eating or drinking)\textsuperscript{19} and are associated with a lower likelihood of returning to abstinence\textsuperscript{20} among smokers. Pre-clinical trials indicate that ST users reported a significant increase in urge to use smokeless tobacco following exposure to a laboratory stressor.\textsuperscript{15} Nonetheless, additional research is needed to examine the extent to which administration of sensory and behavioral substitutes impact craving, withdrawal, and anxiety levels following a stressor.

Taken together, it appears that much is unresolved with respect to the treatment of smokeless tobacco use. One area of research that may improve upon existing smokeless tobacco treatment protocols is the examination of sensory and behavioral substitutes on variables that are known to be related to successful tobacco cessation, such as withdrawal, craving, and anxiety. The purpose of the present study was to compare the effects of sensory and behavioral substitutes after brief abstinence and following a laboratory stressor among young adult smokeless tobacco users. More specifically, the primary aim of the present study was to examine the utility of a nicotine-free, herbal, smokeless tobacco substitute (BACCOFF\textsuperscript{TM}; Ralston, Inc., Selma, AL) versus confectionary chewing gum in reducing subjective nicotine withdrawal, craving, and anxiety following 24-hour abstinence. The secondary aim was to investigate the impact that these substitutes had on subjective levels of withdrawal, craving, and anxiety after a laboratory-induced stressor. Specifically, it was hypothesized that smokeless tobacco administration would produce the greatest reduction in withdrawal, craving, and anxiety, followed by the smokeless tobacco substitute, confectionary chewing gum, and no-product control conditions, respectively. The extent to which the smokeless tobacco substitute and chewing gum mimic topographical aspects of smokeless tobacco use without nicotine allows for an assessment of the effects of nicotine versus the effects of behavioral and sensory properties.

\textbf{METHODS}

\textbf{Participants}

Twenty-six male undergraduate students who reported current smokeless tobacco use participated in this study. Two participants’ data were excluded from the final analyses due to not adhering to the experimental protocol (ie, following completion of the study, these participants reported use of smokeless tobacco during the abstinence period). Of the remaining 24 participants, all self-identified as Caucasian, and reported an average age of 19.12 years (SD = 1.75). Participants noted using an average of 2.63 (SD = 1.23) tins of smokeless tobacco per week, and reported an average smokeless tobacco history of 3.50 years (SD = 2.11). Regarding the smokeless tobacco usage patterns of the participants, the majority (n = 11) reported keeping a fresh dip in their mouth for longer than 30 minutes, while 10 participants reported keeping a fresh dip in their mouth for 20–30 minutes, and the remaining three participants reported keeping a fresh dip in their mouth for 10–19 minutes. According to the SMTDQ results, the majority of participants tended to dip for 14.5 or less hours per day (n = 15), while several (n = 8) reported keeping it in their mouths for 14.5–15.5 hours, and the remaining participant reported dipping for 15.5 hours or more per day.

Eligible participants consumed at least one tin of smokeless tobacco per week for the past 6 months. Exclusionary criteria included: (1) regular use of another form of nicotine (eg, more than five cigarettes per week for at least 6 months), (2) a recent (eg, within the past 6 months) attempt to quit or decrease smokeless tobacco use, or (3) current use of psychotropic medication. Thirty-eight participants who indicated smokeless tobacco use were screened. Participants who were screened but not asked to participate in the remainder of the study were excluded for a variety of reasons including, not using enough smokeless tobacco per week to qualify (n = 4), use of a flavored smokeless tobacco product that could not be approximated by the smokeless tobacco substitute (n = 1), current use of antidepressant medication (n = 1), not interested in participating in the...
current study \((n = 3)\), and having made a recent smokeless tobacco cessation attempt \((n = 3)\). Participants were offered course credit in exchange for taking part in this study that was approved by the Institutional Review Board at Texas Tech University.

Materials

Smokeless Tobacco Dependence Questionnaire (SMTDQ)\(^{27}\)

The SMTDQ is a 10-item self-report questionnaire modified from the Fagerström Test of Nicotine Dependence (FTND)\(^{22}\) for use with smokeless tobacco users. Scores on this measure range from 4 to 19 with greater scores indicating higher levels of nicotine dependence. Among 100 smokeless tobacco users who averaged 11 dips per day \((SD = 5.3)\), the SMTDQ total score had a high correlation \((r = .47, p < .0001)\) with salivary cotinine levels and a mean level of dependence of 6.75 \((SD = 1.76)\).\(^{21}\) The sample from the current study reported average total SMTDQ score of 11.13 \((SD = 2.56)\).

Questionnaire of Smokeless Tobacco Urges-Brief (QSTU-Brief)\(^{25}\)

The QSTU-Brief is a modification of the Questionnaire of Smoking Urges-Brief (QSU-Brief) for use among smokeless tobacco users (ie, same item wording except for the word “dip” being inserted where cigarette or smoking appeared). This 10-item measure is rated on a 7-point scale with anchor points of “strongly disagree” and “strongly agree.” The QSU-Brief was found to have high reliability \((\alpha = .97)\) as a general measure of craving and correlates strongly \((r = .51)\) with the overall score on the 32-item version of the QSU.\(^{28}\) Baseline data for the current study indicated a mean of 35.21 \((SD = 11.52)\) during ad lib smokeless tobacco use.

Minnesota Nicotine Withdrawal Scale (MNWS)\(^{25}\)

The MNWS is a measure originally developed for cigarette smokers, which has been adapted for smokeless tobacco users. Significant differences in total withdrawal score have been found between abstinent and non-abstinent smokeless tobacco users with a similar withdrawal symptom checklist.\(^{26}\) Instructions for use of the MNWS indicate that the number of items and response options are variable leaving specific items and response options up to the individual researcher.\(^{27}\) Thus, seven withdrawal items were used in the current study with a 5-point response set. Baseline data for the current study indicated a mean of 8.71 \((SD = 6.72)\) during ad lib smokeless tobacco use.

Anxiety Visual Analog Scale (VAS)

Participants rated their current level of anxiety from 0 to 100 using a VAS. Participants were instructed to place a slash mark on a 100-mm long line with anchor points of “0—No Anxiety” and “100—Maximum Anxiety.” The placement of the slash mark was subsequently measured, indicating the score. A similar VAS has been used to examine affect and stress levels in smokeless tobacco users.\(^{16}\)

Baseline data for the current study indicated a mean of 35.44 \((SD = 23.24)\) during ad lib smokeless tobacco use.

Smokeless Tobacco Substitute

BACCOFF\textsuperscript{TM} (Ralston, Inc., Selma, AL), a herbal, non-nicotine smokeless tobacco substitute, was used in the present study. Flavors and cut of tobacco were matched to participant’s reported preference of smokeless tobacco brand and flavor (ie, wintergreen, mint, or straight). The ingredients of BACCOFF\textsuperscript{TM} include a mixture of various tea leaves, sugar, salt, natural and artificial flavors, USP glycerine, and sodium benzoate. BACCOFF\textsuperscript{TM} has been shown to reduce withdrawal levels among smokeless tobacco users.\(^{18}\)

Confectionary Chewing Gum

In order to standardize the effects of flavor, all participants received the same type of confectionary chewing gum throughout the study. Participants received Wrigley’s Extra\textsuperscript{®} Spearmint flavored chewing gum.

Procedure

Baseline Session

Initially eligible assenting participants were scheduled via phone interview for their baseline session. This initial session consisted of completing an informed consent document and obtaining baseline measurements on the SMTDQ, QSTU-Brief, MNWS, and Anxiety VAS. Carbon monoxide levels were also obtained via a BreathCO monitor (model 2900, Vitalograph Inc., Lenexa, KS) in order to screen out individuals who were concurrent cigarette smokers. In order to match the smokeless tobacco substitute to the preferred brand flavor, participants provided the name of their preferred smokeless tobacco brand. Additionally, participants provided a saliva sample and were informed that they would be asked to provide a sample each day of the experimental protocol. It was further explained that the samples collected would be assayed for cotinine in order to provide biological evidence of abstinence. However, due to cost, the saliva samples were not actually assayed. Previous research indicates that such bogus pipeline procedures increase the reliability of self-reported tobacco abstinence from 17 to 100%.\(^{28–30}\)

Participants were asked to abstain from using any tobacco products for the 24 hours prior to each of their four scheduled experimental sessions, which were scheduled approximately 1 week apart. Additionally, participants were asked to refrain from: (1) caffeine use 2 hours before the beginning of each experimental session, as caffeine consumption may elevate anxiety ratings and (2) consuming alcohol the night before each session, in order to assist in remaining abstinent from smokeless tobacco. All
participants were contacted by phone at least 24 hours before each session and were reminded of these criteria. Additionally, participants were encouraged to reschedule their experimental session without penalty if they were not able to maintain abstinence for the full 24-hour period.

**Experimental Sessions**

The same procedure was implemented for each of the experimental sessions with the only exception being the product used (ie, smokeless tobacco, smokeless tobacco substitute [BACCOFF™], confectionary chewing gum, or nothing [no-product control]). Use of these products was counterbalanced across participants in order to minimize order effects. Furthermore, to minimize expectancy effects from perceived tobacco use, both the smokeless tobacco and the smokeless tobacco substitute were put in identical unlabeled tins in an attempt to keep participants blind to condition. The following questionnaires were given at all four time points: QSTU-Brief, Anxiety VAS, and MNWS. Time 1 (T1) measurements were collected (ie, three questionnaires noted above, saliva cotinine, and carbon monoxide) 5 minutes after the participant entered the lab, allowing for a brief relaxation period. If a participant’s carbon monoxide rating exceeded 10 parts per million (ppm) they were asked to reschedule the experimental session for a subsequent day, as this suggests recent exposure to or use of cigarettes. Depending on experimental condition, participants were asked (or not asked in the case of the control and chewing gum condition) to take a “normal” sized dip of either smokeless tobacco or smokeless tobacco substitute and then relax in a reclining chair for 15 minutes. Participants in the chewing gum condition were asked to chew a piece of gum for 15 minutes. This time frame was utilized to allow nicotine levels to rise in the bloodstream.

After participants removed smokeless tobacco, smokeless tobacco substitute, or chewing gum Time 2 (T2) measurements were collected. Following T2 measurements, a mental arithmetic task, shown to induce anxiety in previous studies, was administered. For this task, participants were given a three-digit number (which changed in each of the four experimental sessions) and were asked to count backward by 13 for five 1-minute trials. Participants were instructed to answer aloud and work as rapidly as possible during each trial. If a mistake was made, participants were told to return to the originally designated number and count backwards from the beginning. After the mental arithmetic task, Time 3 (T3) measurements were taken. Participants then watched a video, which was chosen for its emotionally neutral subject matter and was similar in content to nature videos used in previous studies and relaxed for 30 minutes before Time 4 (T4) measures were taken. Participants either scheduled their next experimental day or were debriefed if it was the final experimental session. As part of the debriefing process participants were asked how strongly they believed that the biochemical verification assessed their tobacco use as well as whether they had actually remained abstinent for each of the 24-hour periods.

**Analytical Plan**

The present study was a $4 \times 4$ (Condition $\times$ Time) within-subjects design, in which each participant served as their own control. Analyses were conducted taking a stepwise approach. Following several preliminary analyses (see below), three repeated-measure analyses of variance (ANOVAs) were conducted for each of the dependent variables (ie, craving, withdrawal, and anxiety). Planned follow-up tests (one-way repeated measure ANOVAs) examined the differences between products at each of the four time points. If there was a significant difference ($p < .05$) between the types of product, then multiple comparisons (eg, smokeless tobacco vs. smokeless tobacco substitute; smokeless tobacco vs. control; smokeless tobacco vs. chewing gum; etc.) within each time point were conducted using a Tukey-Kramer test. Mean ($M$), standard deviation (SD), and the corresponding $p$-value are reported below.

**RESULTS**

**Preliminary Analyses**

Initially, two preliminary analyses were conducted to determine whether (1) participants experienced a significant increase in withdrawal levels from baseline to Time 1 and (2) there was a significant increase in anxiety after the laboratory-induced stressor by comparing scores from Time 2 to Time 3 during the no-product control condition. Paired-sample t-tests indicated a significant increase in withdrawal symptoms after 24 hours of abstinence ($t(23) = -2.37, p = .026$) as well as increases in anxiety levels ($t(23) = -2.09, p = .048$) after the stressful task was administered.

Given that the QSTU-Brief was adapted for smokeless tobacco users for the present study, the reliability of this instrument was examined during ad lib smokeless tobacco use and following overnight abstinence by Cronbach’s alpha. Results indicated that QSTU-Brief was a reliable measure of craving at baseline (Cronbach’s $\alpha = .88$), and immediately following brief abstinence (Cronbach’s $\alpha = .97$). Results of the debriefing question that asked participants to rate on a scale of 0 (do not believe at all) to 10 (extremely) how strongly they believed that saliva samples were analyzed for nicotine content, indicated that on average, participants believed rather strongly that this would occur ($M = 7.29; SD = 2.56$), lending support to the bogus pipeline procedure.

**Primary Analyses**

**Overall Repeated Measure ANOVAs**

Significant Condition $\times$ Time interactions were found for withdrawal ($F(9, 207) = 3.83, p = .001$), craving...
Brief Abstinence Effects

Prior to product administration significant differences were not anticipated within product condition for any of the dependent variables following 24 hours of abstinence, given that there were no differences across experimental days at this point. The length of smokeless tobacco use (i.e., number of years of use) was examined to determine if there was a significant association between the length of smokeless tobacco use and craving, withdrawal, and anxiety levels following 24 hours of abstinence. Results of this analysis indicated that there was a significant effect of number of years of smokeless tobacco use on withdrawal \( (p = .03) \) and anxiety \( (p = .03) \). Therefore, the number of years of smokeless tobacco use was included as a covariate in the analyses examining brief abstinence effects for withdrawal and anxiety. Results indicated that there was not a significant difference among the four product administration conditions for withdrawal or anxiety levels following 24 hours of abstinence after controlling for number of years of use of smokeless tobacco. Although a significant difference was observed among product conditions for craving level following brief abstinence \( [F(3, 23) = 3.56, p = .03] \) for the overall ANOVA, Tukey’s follow-up tests did not indicate significant differences between these conditions prior to product administration.

Product Administration Effects

One-way repeated measure ANOVAs were significant for withdrawal, \( [F(3, 23) = 19.52, p = .0001] \), craving, \( [F(3, 23) = 19.61, p = .0001] \), and anxiety, \( [F(3, 23) = 7.36, p = .001] \) following product administration. The administration of smokeless tobacco showed significantly lower levels of craving, withdrawal, and anxiety compared to the no-product control and chewing gum conditions \( (p's < .01) \). Smokeless tobacco administration also showed significantly lower levels of anxiety \( (p = .049) \) and craving \( (p = .009) \) compared to the smokeless tobacco substitute. However, withdrawal scores were not significantly different across the smokeless tobacco \( (M = 6.67; SD = 4.59) \) and smokeless tobacco substitute \( (M = 9.42; SD = 5.67) \) conditions. Significant differences were also not observed between the smokeless tobacco substitute, chewing gum and no-product control conditions for anxiety. However, administration of the smokeless tobacco substitute led to significantly lower withdrawal \( (p's < .01) \) and craving \( (p's < .05) \) scores compared to the chewing gum and no-product control conditions. Finally, contrary to what was expected, no significant differences were observed between the no-product control and chewing gum conditions for any of the three dependent variables.

Post-Stressor Effects

One-way repeated measure ANOVAs were significant for craving \( [F(3, 23) = 21.89, p = .0001] \), withdrawal \( [F(3, 23) = 13.03, p = .0001] \), and anxiety \( [F(3, 23) = 5.01, p =
.008) post-stressor. Following the stressor, the smokeless tobacco condition showed significantly lower levels of anxiety compared to the chewing gum (p = .041) and no-product control conditions (p = .005). Further, the smokeless tobacco condition also showed significantly lower ratings of both craving and withdrawal compared to the chewing gum (p’s < .01) and no-product control conditions (p’s < .0001). Interestingly, smokeless tobacco administration was not significantly different than smokeless tobacco subsitute administration post-stressor with respect to craving, anxiety, and withdrawal levels. The smokeless tobacco substitute condition also showed significantly lower levels of withdrawal compared to the control condition (p = .031) and significantly lower levels of craving compared to the chewing gum and no-product control conditions (p’s < .01).

A significant difference in anxiety level was not observed between smokeless tobacco substitute and chewing gum or smokeless tobacco substitute and the control condition.

**Extended Effects**

One-way repeated measure ANOVAs of extended effects were significant for craving, [F(3, 23) = 11.26, p = .0001], withdrawal, [F(3, 23) = 22.11, p = .0001], and anxiety, [F(3, 23) = 14.23, p = .0001], at Time 4. In the smokeless tobacco condition, participants reported significantly lower levels of anxiety compared to the smokeless tobacco substitute (p = .029), chewing gum (p = .0007), and no-product control (p = .0001) conditions 30 minutes post-stressor. At this time point, the smokeless tobacco condition also showed significantly lower levels of withdrawal compared to the smokeless tobacco substitute (p = .037), chewing gum (p = .0001) and no-product control (p = .0001) conditions. The smokeless tobacco condition did not show significantly lower levels of craving compared to the smokeless tobacco substitute condition, but was significantly lower compared to the chewing gum (p = .0001) and no-product control (p = .0001) conditions. The smokeless tobacco substitute condition, however, showed significantly lower levels of craving compared to the chewing gum (p = .007) and no-product control conditions (p = .016) as well as lower levels of withdrawal compared to the no-product control condition (p = .026). There were no significant differences observed between the chewing gum and no-product control conditions at Time 4.

**DISCUSSION**

The purpose of this study was to examine the effects of sensory and behavioral substitutes (ie, a nicotine-free smokeless tobacco substitute and confectionary chewing gum) on craving, withdrawal, and anxiety among smokeless tobacco users who were abstinent for 24 hours. Furthermore, this study examined the differential impact of these substitutes following a laboratory-induced stressor. To our knowledge, this is the first study to examine the utility of confectionary chewing gum as a substitute for smokeless tobacco. The smokeless tobacco, smokeless tobacco substitute, and chewing gum conditions allowed for investigation of the impact of conditioned, substance-related factors on craving, withdrawal, and anxiety, three constructs known to correlate highly with relapse. It was hypothesized that smokeless tobacco administration would produce the greatest relief, followed by the smokeless tobacco substitute. Given the encouraging findings in the smoking literature, it was further hypothesized that confectionary chewing gum would produce relief from smokeless tobacco abstinence compared to the no-product control, but less so than the smokeless tobacco substitute.

Results indicated that the administration of a smokeless tobacco substitute following 24 hours of abstinence significantly reduced craving and withdrawal levels compared to the no-product control and chewing gum conditions. This finding extends previous research in a number of ways. First, previous research has been mixed with respect to the effect of a smokeless tobacco substitute on urge/craving following overnight/24-hour abstinence.\(^{16,18}\) It is important to note, however, that in both of these studies urge/craving was measured using only a single item. The present study examined the impact of a smokeless tobacco substitute on craving using a multidimensional measure. Second, the present study found a reduction in withdrawal symptoms following administration of a smokeless tobacco substitute.

**TABLE 1. Mean and standard deviation of craving, anxiety, and withdrawal scores over time by condition**

<table>
<thead>
<tr>
<th></th>
<th>Craving</th>
<th></th>
<th>Withdrawal</th>
<th></th>
<th>Anxiety</th>
<th></th>
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<td>T2</td>
<td>T3</td>
<td>T4</td>
<td>T1</td>
<td>T2</td>
</tr>
<tr>
<td>Control</td>
<td>47.92</td>
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<td>34.46</td>
<td>36.38</td>
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<td>6.67</td>
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<td>Smokeless Tobacco Substitute</td>
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<td>40.67</td>
<td>42.17</td>
<td>41.25</td>
<td>11.58</td>
<td>9.42</td>
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<td>(14.91)</td>
<td>(15.72)</td>
<td>(16.64)</td>
<td>(16.58)</td>
<td>(7.57)</td>
<td>(5.67)</td>
<td>(6.29)</td>
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<tr>
<td>Chewing Gum</td>
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<td>47.79</td>
<td>50.29</td>
<td>48.46</td>
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<td>(6.57)</td>
<td>(5.65)</td>
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</table>
substitute after 24 hours of abstinence, replicating the findings of McChargue and colleagues.18

Following the laboratory-induced stressor, smokeless tobacco substitute continued to perform well relative to smokeless tobacco as significant differences were not observed between these products with regard to withdrawal, craving, and anxiety levels. In addition, significantly lower levels of craving and withdrawal were observed in both smokeless tobacco and smokeless tobacco substitute conditions compared to the control condition following the stressor. To our knowledge, this is the first study to show a benefit of using smokeless tobacco substitute on withdrawal symptoms post-stressor. Results also replicated previous research which indicated that urge ratings did not differ significantly between smokeless tobacco and smokeless tobacco substitute following a stressor.16 Clinically, these results indicate that a smokeless tobacco substitute may help individuals to manage craving and withdrawal levels following stressful events.

Thirty minutes post-stressor the smokeless tobacco substitute condition continued to show decreased withdrawal and craving levels compared to control condition and significant differences in craving level were not observed between smokeless tobacco substitute and smokeless tobacco. These findings suggest that the smokeless tobacco substitute resulted in a sustained decrease in craving levels over time, similar to what is observed when smokeless tobacco is used. From a clinical perspective, this also suggests the potential utility of smokeless tobacco substitute use in the treatment of individuals who wish to quit their smokeless tobacco use.

The present study indicates that the administration of a smokeless tobacco substitute can be useful in reducing withdrawal and craving levels following 24 hours of abstinence as well as after a laboratory-induced stressor. While the results of the smokeless tobacco substitute administration were encouraging, findings regarding the utility of confectionary chewing gum in reducing craving, withdrawal, and anxiety levels compared to a no-product control condition were not. These results are inconsistent with previous research conducted with individuals who smoke cigarettes showing that chewing gum is effective in lessening the severity of nicotine withdrawal following brief abstinence.12,13,34 Data suggest that unlike their smoking counterparts, smokeless tobacco users do not find general oral stimulation through the use of chewing gum helpful in reducing the severity of subjective withdrawal, craving, and anxiety following brief abstinence or after laboratory-induced stressor. This suggests that the unique sensory components of smokeless tobacco must be considered if smokeless tobacco treatment programs are to advance.

In addition, these findings implicate the role of conditioned factors (eg, environmental15 and sensory)17 that may contribute to the maintenance of tobacco after repeated pairings with the effects of nicotine. This is consistent with previous literature indicating that drug-related cues specific to smokeless tobacco become conditioned18 and may elicit a response similar to the response produced by smokeless tobacco itself.16 Therefore, it is important to consider that the effects observed in the current study may be related to maintaining some of the conditioned sensory and behavioral cues specific to smokeless tobacco use (eg, handling a tin or packing a dip) without the delivery of nicotine.

Despite the promising findings, certain limitations are noteworthy. First, our sample is exclusively college-aged, Caucasian males who have a relatively short history of ST use. Prior studies, however, indicate that smokeless tobacco use is significantly more prominent among Caucasians than any other ethnic group.36 Furthermore, the sample for the present study reflects the age range in which problematic smokeless tobacco use has been observed most frequently.1 Regardless, it remains unclear whether similar results would be observed among older, racially diverse samples of smokeless tobacco users. Second, data were not collected at the time of each participant’s first dip. This should not have impacted the results because all participants experienced similar levels of deprivation (24 hours) before each experimental session and significant differences were not observed within product condition for craving, withdrawal, or anxiety following 24 hours of abstinence when controlling for number of years of smokeless tobacco use. It is possible, however that there are individual differences not accounted for that might have led to differing intensities of withdrawal during the same time period. Third, although saliva samples were collected during each experimental session, they were not assayed due to cost. Although participants were encouraged to report their non-compliance with the 24-hour abstinence requirement, this was not biochemically verified. As stated earlier, however, the bogus pipeline used in this study has been shown to increase the reliability of self-reported tobacco abstinence from 17 to 100%.28–30 Fourth, the fact that this study was not conducted in double-blind fashion may have also impacted the results. Findings from this study need to be replicated across an extended period of abstinence (eg, 48 hours or longer) that utilizes a double-blind design. Finally, the current study did not control for external stressful events (eg, poor performance on exams) that may have impacted anxiety, craving, or withdrawal levels of participants and oral pH levels were not standardized prior to administration of products.

CONCLUSIONS

In sum, the current study extends the results of previous research and suggests that a smokeless tobacco substitute may be useful during a quit attempt in reducing craving levels and when facing stressors. Significant differences were not observed with respect to the use of confectionary chewing gum compared to nothing at all. This finding suggests
that the general oral stimulation that has been found to be useful among smokers does not lead to similar decreases in craving, withdrawal, or anxiety levels among smokeless tobacco users. Future research, therefore, needs to focus on helping smokeless tobacco users more effectively cope with the unique aspects of smokeless tobacco if treatment in this area is to advance.

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Declaration of Interest
The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

REFERENCES


