# Psychology of Addictive Behaviors


## Attentional Biases for Betel Nut Cues in Heavy and Light Chewers


Ming-Chou Ho, Catherine Fountain Chang, Ren-Hau Li, and Tze-Chun Tang



Online First Publication, February 25, 2013. doi: 10.1037/a0030562

CITATION

Ho, M.-C., Chang, C. F., Li, R.-H., & Tang, T.-C. (2013, February 25). Attentional Biases for Betel Nut Cues in Heavy and Light Chewers. *Psychology of Addictive Behaviors*. Advance online publication. doi: 10.1037/a0030562

Psychology of Addictive Behaviors

0893-164X/13/$12.00 DOI: 10.1037/a0030562

# Attentional Biases for Betel Nut Cues in Heavy and Light Chewers

Ming-Chou Ho
Chung-Shan Medical University and Chung-Shan Medical University Hospital, Taichung, Taiwan

Catherine Fountain Chang
Chung-Shan Medical University Hospital, Taichung, Taiwan

Ren-Hau Li
Chung-Shan Medical University, Taichung, Taiwan

Tze-Chun Tang
Kaohsiung Medical University Chung-Ho Memorial Hospital, Kaohsiung, Taiwan

The betel nut (*Areca catecu*) is regarded by the World Health Organization as the fourth most prevalent human carcinogen. Our study aims to investigate whether habitual chewers show bias in their attention toward betel nut usage. In the current study, heavy and light betel nut chewers were instructed to respond to a probe presented immediately after either one of a pair of areca-related picture and non-areca-matched picture. The presentation durations of these pictures were manipulated to investigate attentional biases under awareness threshold (17 ms), in initial orienting (200 ms), and maintenance of attention (2,000 ms). Faster response to the probe replacing the areca-related picture, in comparison with a matched picture, indicated attentional bias. The results showed that neither group showed subliminal attentional biases. Further, heavy chewers, but not light chewers, exhibited supraliminal biases toward betel nut cues in initial orienting of attention and maintained attention. Moreover, attentional bias scores at 2,000 ms were also shown to be positively associated with betel nut craving and dependence. Implications of the current findings are thoroughly discussed in the article.

*Keywords:* betel nut, areca, attentional bias, craving, dependence

Betel nut (*Areca catecu*) chewing is a common practice across various Asian-Pacific areas and among a small number of migrant communities in Western countries. It is ranked fourth among the most prevalent abuse substances worldwide after caffeine, tobacco, and alcohol (Gupta & Ray, 2004; Winstock, 2002; Winstock, Trivedy, Warnakulasuriy, & Peters, 2000). Recent studies found that betel nut chewing can improve habitual chewers' useful field of view after one night of deprivation (Ho & Wang, 2010) and can concentrate habitual chewers' attention foveally (Ho & Wang, 2011). Although betel nut is regarded as a human carcinogen by the World Health Organization (International Agency for Research on Cancer, 2004), chewing betel nut remains popular among people in Taiwan (Chen & Shaw, 1996; Chuang, Chang, & Chang, 2007).

One important, yet unexplored, issue about betel nut is whether habitual chewers have a bias to selectively attend to betel nut cues at the expense of other stimuli. This issue is important because attentional bias toward substance has been demonstrated to relate to the craving for the substance (Field, Munafò, & Franken, 2009), thus increasing the likelihood of consuming the substance (Kavanagh, Andrade & May, 2005; Schoenmakers et al., 2010), and, in this case, the risk of betel-nut-related diseases (e.g., oral submucous fibrosis).

The visual probe task is a common task employed to measure attentional bias toward substance cues. In a typical visual probe task, participants respond as quickly as possible to a visual probe presented immediately after the offset of a pair of pictures or words. Many studies have shown that substance users can respond faster to the probe replacing a substance-related stimulus than a matched, unrelated one (for reviews, see Field & Cox, 2008; Robbins & Ehrman, 2004). This indicates a preferential attentional allocation to the locations of substance-related stimuli.

The presentation duration of substance-related stimuli can be manipulated to explore different underlying mechanisms of attentional processing (Field, Mogg, Zetteler, & Bradley, 2004). Stimuli presented below the awareness threshold (e.g., 17 ms) can reflect preconscious processing, whereas a rapid presentation (e.g., 200 ms) may indicate biases in the initial shifts in attention. The incentive sensitization theory (Robinson & Berridge, 1993, 2003, 2008) argues that repeated exposure to the substance renders the brain hypersensitive to the substance and substance-related cues. Through classical conditioning, the substance-related cues (conditioned stimuli) are progressively associated with the addictive substance (unconditioned stimuli), thereby acquiring conditioned

Ming-Chou Ho, Department of Psychology, Chung-Shan Medical University, Taichung, Taiwan, and Clinical Psychological Room, Chung-Shan Medical University Hospital, Taichung, Taiwan; Catherine Fountain Chang, Department of Psychology, Chung-Shan Medical University Hospital, Taichung, Taiwan; Ren-Hau Li, Department of Psychology, Chung-Shan Medical University; Tze-Chun Tang, Department of Psychiatry, Kaohsiung Medical University Chung-Ho Memorial Hospital, Kaohsiung, Taiwan.

This study was supported by NSC-98–2410-H-040–005-MY3 from the National Science Council. We thank Hui-Tzu Kuo and Chen-Chia Hsu for their assistance with the current study.

Correspondence concerning this article should be addressed to Ming-Chou Ho, Department of Psychology, No.110, Sec. 1, Chien-Kuo N. Road Taichung 402, Taiwan. E-mail: mingchou@csmu.edu.tw

incentive properties (i.e., incentive salience). Consequently, such cues become highly attractive and can capture substance users' attention; this reaction may operate automatically and outside conscious awareness. With increased consumption of addictive substance, the substance-related cues require more incentive salience and may increase the likelihood of attentional bias for substance-related cues.

Longer presentations (e.g., 2,000 ms) of substance cue was also often used to allow multiple shifts in attention, representing maintained attention (Franken, 2003; LaBerge, 1995). Two partially separate neural systems may underlie attentional biases under awareness threshold, and in initial orienting and maintained attention (LaBerge, 1995; for a review, see Corbetta & Shulman, 2002). For example, maintained attention that involves voluntary control may rely on a dorsal frontoparietal network, whereas attentional biases under awareness threshold and in initial orienting that involve reflexive control of attention may rely on a ventral frontoparietal network. Some studies (e.g., Mogg & Bradley, 2002; Townshend & Duka, 2001) adopted 500-ms duration and considered that this duration reflected initial orienting. This view was primarily based on the eye movement studies on biases in overt attention (e.g., Bradley, Mogg, & Millar, 2000; Mogg, Bradley, Field, & De Houwer, 2003), suggesting that the initial gaze fixations were associated with attentional biases within 500-ms presentation. However, the attentional processing underlying 500-ms duration involves both initial orienting and multiple shifts over substances (i.e., maintained attention; Field et al., 2004). Therefore, the current study employed presentation duration of 200 ms, rather than 500 ms, to investigate attentional bias in initial orienting for betel nut cues.

Many studies have investigated attentional bias toward addictive substances for heavy and light users by using primarily 500- and 2,000-ms durations (for reviews, see Robbins & Ehrman, 2004). For example, heavy drinkers of alcohol exhibited greater attentional bias than light drinkers did for alcohol cues presented for 500 ms (Field et al., 2004; Townshend & Duka, 2001) and 2,000 ms (Field et al., 2004), but not for 200 ms. However, attentional bias may depend on the type of substance used. The results in the case of smokers appear mixed. In some studies, heavy smokers showed greater attentional bias than light smokers did at 200-ms and 2,000-ms presentation durations (e.g., Bradley, Field, Mogg, & De Houwer, 2004). However, some studies reported the reverse pattern (light smokers had greater attentional bias; e.g., Bradley, Mogg, Wright, & Field, 2003; Hogarth, Mogg, Bradley, Duka, & Dickinson, 2003; Mogg, Field, & Bradley, 2005) or null results (e.g., Waters, Shiffman, Bradley, & Mogg, 2003).

The reversed or null effect of attentional bias may be attributed to the reduced, or even diminished, incentive salience of smoking cues in heavy smokers relative to the light smokers (Mogg et al., 2005). Mogg et al. (2005) speculated that these reduced incentive effects of smoking cues may be associated with an increase in automaticity of smoking behavior among heavy smokers (Field, Mogg, & Bradley, 2006; Tiffany, 1990), thereby reducing the importance of external smoking cues in determining smoking behavior.

We aim to reveal whether attentional bias exists among the heavy betel nut chewers under the awareness threshold in initial orienting and in maintained attention. Since the betel nut is a distinctive psychoactive substance that is exotic to Western societies, betel nut chewers' attentional bias for betel nut cues remains fairly undiscovered. We adopted the experimental design guided by the methodology developed by Bradley et al. (2004). Specifically, we utilized a short presentation of 200 ms to assess initial orienting of attention, a long presentation of 2,000 ms to assess maintenance of attention, and an extremely short presentation of 17 ms to assess subliminal attentional bias.

Our main hypothesis, following Robinson and Berridge (1993, 2003, 2008) and LaBerge (1995), was that heavy chewers, rather than light chewers, would exhibit attentional bias at 200-ms and 2,000-ms presentations. Alternatively, it remained possible that the incentive salience of betel nut cues might be diminished in heavy chewers, as in the case of heavy smokers (e.g., Field, Mogg, et al., 2006; Mogg et al. 2005). Consequently, the light chewers, rather than the heavy chewers, might exhibit greater attentional bias. Further, we tested subliminal attentional bias at 17-ms presentation that was not found in previous studies (e.g., Bradley et al., 2004).

## Method

### Participants

The participants were recruited via three methods. First, the agency from human resource companies introduced day labors who were habitual to chewing betel nut. Second, we posted the recruitment advertisement on the largest bulletin board system (BBS) in Taiwan. Third, we asked former participants to introduce other betel nut chewers. Betel nut chewing participants were eligible if they were (a) current betel nut chewers, (b) at least 18 years of age, and (c) free from current major medical or vision problems that could interfere with the experiment protocol. All of the participants were compensated for participation, receiving 500 NT dollars as honorarium.

The final sample included 95 betel nut chewers. We split the chewers by using the median (26) of these chewers' dependence scores, measured by the Betel Nut Dependency Scale (BNDS; Li, Ho, Tang, & Chang, 2012). The BNDS consists of three factors: craving and desire (four items), withdrawal response (four items), and tasting habits (three items). Higher scores indicate a higher level of dependence on betel nuts. As a result, chewers with BNDS scores equal to or larger than the median were categorized as heavy chewers ($N = 53$; one female). Alternatively, chewers with BNDS scores smaller than the median were categorized as light chewers ($N = 42$; three females).

### Apparatus

Both visual probe tasks were programmed with E-prime software (Schneider, Eschman, & Zuccolotto, 2002) and presented on a 17-in. CRT desktop monitor (refresh rate = 85 Hz).

### Materials

A set of 20 areca-related color photographs (14.6° in length × 10.2° in width) was paired with matched photographs without areca content. Each pair of stimuli were cautiously produced and edited to be as perceptually identical as possible, except for the areca content (e.g., a man pinching a betel nut toward his mouth vs. pinching a piece of chewing gum). An addition of 20 pairs of non-areca-related photographs were used as stimuli for filler trials, and their reaction time (RT) did not enter the analysis process.

The matched pictures would be 3.4° apart, edge to edge, when they were simultaneously presented on the monitor. In each trial, the probe consisted of an arrow sign, which was randomly either pointing up or down; it appeared on one of a pair of pictures, 6° apart from the fixation point. A mask made of one of the filler photographs and cut into 35 pieces, and randomly rearranged into a mosaic format, was used to ensure the exact presentation stimulus onset asynchrony (SOA) in the 1-ms trials.

## Procedure

The habitual betel nut chewers needed to complete an integrative questionnaire form, which was used to collect demographic background, major medical history, betel nut usage histories, and BNDS (Li et al., 2012). After completing the questionnaire, participants were asked to rate their urge to chew at this moment (preurge). Participants then completed the masked task, followed by the awareness check and the second rating of their urge to chew (middle urge). Participants then completed the unmasked task, in which stimuli were randomly presented in either SOA of 200 ms or 2,000 ms. Finally, participants were asked to rate their urge to chew (posturge). To rate their urge to chew, we asked participants to assess "how strong your urge to chew is right now" on an anchored rating scale, which ranged from 0 (*not at all*) to 10 (*extremely*).

The urge rating and visual probe tasks were administered in a dimly lit room, where each participant leaned his or her chin on a chinrest with a viewing distance of 50 cm from the monitor. In each of the masked and the unmasked tasks, all of the participants had to pass the practice trials (16 trials in each of masked and unmasked tasks). Both tasks included two additional nonareca buffer trials. Each SOA manipulation had 120 formal trials presented randomly (80 critical test trials and 40 filler trials). Each of 20 experimental picture pairs (areca-related picture and matched neutral picture) was repeated four times, with areca-related picture equally and randomly on the left and right of the center. The arrow appeared on the areca-related picture or the matched neutral picture equally and randomly. The arrow pointed upward or downward equally and randomly. Similarly, each of 20 filler pairs repeated twice, with each picture appearing equally on the left or right of the center fixation point. In the filler trials, the presentation of arrow location (left or right) and arrow direction (pointing upward or downward) were equally and randomly distributed.

Throughout the whole visual probe task, each participant was instructed to focus on a central fixation point at all times. After a mere fixation presented for 1,000 ms, two pictorial cues would appear, side by side, for 17, 200, or 2,000 ms. In the masked task, the mask appeared for 50 ms to mask the pictorial cues. After the mask disappeared in the masked task, or after the pictorial cues disappeared in the unmasked task, an arrow-shaped probe appeared immediately. The participant was asked to press the corresponding keys (direction of arrow) as accurately and quickly as possible. An erroneous response was signaled with a warning tone. For every 60 trials presented, there was a break interval, and the duration of the break interval could match the participant's need.

After the masked 17-ms task and before the unmasked task, an additional awareness check was designed to check whether each picture remained in the subliminal processing. This manipulation check consisted of 10 practice, 2 buffer, and 40 formal trials. In the formal trials, 20 experimental picture pairs and 20 filler picture pairs from the 17-ms masked task were presented in random order. The locations of pictures were randomized. The design was similar to the 17-ms masked task except that each participant was asked to report whether areca-related pictures were present. Participants were instructed to press "O" when areca-related pictures were present and "X" when absent.

# Results and Discussion

## Participant Characteristics

Summary data for heavy and light chewers are shown in Table 1. The measures listed in Table 1—except for the overall bias and the biases at three durations—were log transformed before the independent samples *t* tests and correlation analysis (described later) to reduce skewness. Because the items of urge to chew (pretask, middle task, and posttask) and hours since last chew had values of zero, their values were added by one before log transformation. The groups did not have any differences in gender ratio (Yates-corrected $\chi^2 = .57$, $df = 1$, $p = .45$).

## Assessing Attentional Bias in Heavy and Light Chewers

Practice trials, buffer and filler trials, and erroneous trials (1% in the masked task and 1% in the unmasked task) were excluded from the analysis. All of the participants had at least a 90% hit rate in both masked and unmasked tasks. Correct latencies in formal trials that were less than 200 ms and more than 2,000 ms were also excluded, leading to a loss of .8% of data.

A one-way ANOVA was conducted to examine the possible group difference in awareness check of subliminal presentation (17 ms). The hit rates between the heavy chewers ($M = .50$, $SD = .04$)

Table 1
*Characteristics of Heavy and Light Betel Nut Chewers*

| | Heavy chewers ($N$ = 53) | Light chewers ($N$ = 42) | $t$(93) | $p$ |
|---|---|---|---|---|
| BNDS | 30.4 (3.8) | 20.7 (3.7) | 12.0 | $<.0001$ |
| Age (years) | 30.1 (9.1) | 28.9 (9.3) | .6 | ns |
| Monthly income | 2.4 (1.1) | 2.3 (1.3) | .5 | ns |
| Weekly expense | 4.7 (1.9) | 3.9 (1.8) | 2.3 | $<.05$ |
| Number per day | 27.6 (29.2) | 15.4 (11.4) | 2.5 | $<.05$ |
| Days per week | 5.0 (1.9) | 4.0 (1.9) | 2.5 | $<.05$ |
| Months | 93.9 (93.7) | 66.6 (80.2) | 1.3 | ns |
| Urge to chew (pretask) | 6.1 (1.9) | 3.2 (1.9) | 7.0 | $<.0001$ |
| Urge to chew (middle task) | 6.2 (2.2) | 3.1 (2.2) | 6.3 | $<.0001$ |
| Urge to chew (posttask) | 6.3 (2.3) | 3.5 (2.6) | 5.5 | $<.0001$ |
| Hours since last chew | 7.2 (14.2) | 17.1 (25.2) | 2.5 | $<.05$ |

*Note.* Standard deviations are in parentheses. For the weekly expense, participants selected from the following options (unit is NT dollars): (1) none, (2) within 100, (3) 100–200, (4) 200–300, (5) 300–400 (6) 400–500, and (7) over 500. For monthly income, participants selected from the following options (unit is thousands of NT dollars): (1) lower than 10, (2) 10–20, (3) 20–30, (4) 30–50, (5) over 50. BNDS = Betel Nut Dependency Scale; ns = nonsignificant.

and the light chewers ($M = .51$, $SD = .03$) were comparable, $F(1, 93) = 3.12$, $MSe = .001$, $p = .08$, $\eta_p^2 = .033$. More importantly, the one-sample $t$ tests revealed that the hit rates for the heavy, $t(52) = .97$, $p = .34$, and the light, $t(41) = 1.56$, $p = .12$, groups were about the chance ratio of .50, suggesting that participants were unaware of the stimuli content while performing the mask task.

To assess attentional bias under awareness (17 ms) in the masked task, we conducted a 2 (Group: heavy or light chewers) × 2 (Probe Location: matched or betel nut cue) ANOVA (see Table 2). We did not find any significant effects (all $ps > .4$). This indicated that there was no attentional bias under awareness for both groups.

To assess attentional bias in initial orienting, and maintained attention in the unmasked task, a 2 (Group: heavy or light chewers) × 2 (SOA: 200, or 2,000 ms) × 2 (Probe Location: matched or betel nut cue) ANOVA was conducted. The main effect of probe location were significant, $F(1, 93) = 4.79$, $MSe = 2991.60$, $p < .05$, $\eta_p^2 = .049$. The effect revealed faster RTs when a probe was on the location previously occupied by the betel nut cue (615.7 ms) than the matched cue (628.1 ms), showing an attentional bias toward betel nut. An interaction of Group × Probe Location was significant, $F(1, 93) = 4.98$, $MSe = 2991.60$, $p < .05$, $\eta_p^2 = .051$. Further analysis showed equivalent probe RTs on the betel nut cues (600.8 ms) and matched cues (600.5 ms) for the light chewers ($p = .95$). For the heavy chewers, the probe RTs on the betel nut cues (630.6 ms) were faster than the matched cues (655.6 ms), $t(52) = 2.59$, $p < .05$, indicating an attentional bias across 200- and 2,000-ms presentations. There were no other significant main and interaction effects (all $ps > .05$).

To further specify the time courses where attentional bias was likely to occur, we compared the probe RTs on betel nut cues and matched cues at 200- and 2,000-ms durations for each group. For the heavy chewers, the probe RT difference (attentional bias) was significant at 200-ms SOA, $t(52) = 3.10$, $p < .005$, and marginally significant at 2,000-ms SOA, $t(52) = 1.91$, $p = .06$. For the light chewers, there was no significant probe RT difference at any SOA level (all $ps > .78$).

## Correlations Between Betel-Related Measures

Pearson correlations were conducted to investigate relationships between betel-related measurements listed in Table 3. As previously mentioned, all measurements were log transformed before analysis. Age, monthly income, and betel nut use history (weekly expense, numbers per day, days per week, months; $r$ values ranged from .25 to .60) were positively correlated. BNDS was positively related to betel nut use history (weekly expense, numbers per day, days per week, months) and urge to chew (pre-, middle, and posttask; $r$ values ranged from .23 to .58) but negatively related to hours since last chew ($r = -.35$).

## Correlations Between Attentional Bias and Betel-Related Measures

Pearson correlations were employed to examine relationships between overall bias, biases at three durations, and betel-related measurements listed in Table 1. Overall bias was positively related to biases at three durations: weekly expense, days per week, BNDS, and urge to chew (pre-, middle, and posttask; $r$ values ranged from .21 to .92). Attentional bias scores at 200 ms were positively correlated with bias at 2,000 ms, weekly expense, days per week, BNDS, and urge to chew (posttask; $r$ values ranged from .23 to .58). Attentional bias scores at 2,000 ms were positively correlated with bias at 200 ms, BNDS, and urge to chew (pre-, middle, and posttask; $r$ values ranged from .21 to .58).

# General Discussion

We reported that heavy chewers exhibited biases to betel nut cues primarily in initial orienting of attention and maintained attention. The light chewers did not show attentional biases to betel nut cues. Attentional bias to betel nut cues in heavy chewers led us to reject a proposal that betel nut cues are not important for heavy chewers because the chewing behavior is automatic, as in the smoking case (Field, Mogg, et al., 2006; Mogg et al., 2005). The current findings extended the knowledge of attentional bias for addictive substances familiar to the Western societies (e.g., alcohol and cigarettes) to the one herein commonly used yet barely known to them.

Both heavy and light chewers did not show attentional bias in preconscious processing. This result was consistent with previous studies that typically did not report subliminal attentional bias for addictive substance cues (e.g., Bradley et al., 2004). It has been proposed that subliminal attentional bias may occur primarily for aversive cues (e.g., a fearful face; for a review, see Cisler, Bacon, & Williams, 2009; Mogg, Bradley, & Williams, 1995) rather than appetitive cues (e.g., Bradley et al., 2004; Franken, Kroon, Wiers, & Jansen, 2000).

As for supraliminal attentional bias, we reported a rapid, initial orienting for betel nut cues in heavy chewers when the betel nut stimuli flashed briefly for 200 ms. In the same group, we demonstrated a trend of bias in maintenance of attention on betel nut cues, reflecting motivational processes (LaBerge, 1995). The finding of initial orienting appears mixed, a result perhaps dependent on

Table 2
*Mean Reaction Times and Standard Errors of Means (in Parenthesis) in Three Presentation Durations*

| | Heavy chewers ($n = 53$) | | | | | Light chewers ($n = 42$) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Matched | Betel nut | Bias | $t(52)$ | $p$ | Matched | Betel nut | Bias | $t(41)$ | $p$ |
| 17 ms | 550.2 (14.9) | 550.3 (15.6) | −.1 (3.7) | .03 | ns | 531.8 (16.7) | 533.0 (17.5) | −1.2 (4.2) | .3 | ns |
| 200 ms | 653.2 (17.0) | 628.4 (15.2) | 24.8 (6.6) | 3.1 | <.005 | 596.7 (19.1) | 597.4 (17.0) | −.7 (7.4) | .1 | ns |
| 2,000 ms | 657.9 (16.7) | 632.8 (14.4) | 25.1 (10.3) | 1.9 | .06 | 604.3 (18.8) | 604.2 (16.2) | .1 (11.6) | .03 | ns |
| Average | 620.5 (15.1) | 603.8 (14.0) | 16.7 (5.3) | 2.4 | <.05 | 577.6 (17.0) | 578.2 (15.7) | −.6 (5.9) | .2 | ns |

*Note.* ns = nonsignificant.

Table 3
*Correlations Between Attentional Bias and Betel-Related Measures*

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0. Overall bias | .33** | .79** | .92** | −.05 | .05 | .24* | .05 | .24* | .00 | .30** | .23* | .21* | .26** | −.13 |
| 1. Bias at 17 ms | — | −.00 | .16 | −.04 | .14 | .14 | .09 | .04 | −.07 | .11 | .12 | .06 | .06 | .01 |
| 2. Bias at 200 ms | | — | .58** | .02 | .09 | .23* | −.07 | .24* | .07 | .26* | .17 | .16 | .24* | −.13 |
| 3. Bias at 2,000 ms | | | — | .08 | −.04 | .18 | .10 | .20 | −.01 | .26* | .21* | .21* | .23* | −.12 |
| 4. Age | | | | — | .45* | .43** | .26* | .42** | .60** | .10 | −.03 | .01 | .03 | .13 |
| 5. Monthly income | | | | | — | .42** | .25* | .42** | .44** | .15 | −.04 | .08 | .04 | −.14 |
| 6. Weekly expense | | | | | | — | .46** | .67** | .48** | .32** | .27** | .33** | .24* | −.20* |
| 7. Number per day | | | | | | | — | .43** | .41** | .29** | .23* | .42** | .18 | −.20 |
| 8. Days per week | | | | | | | | — | .45** | .33** | .31** | .39** | .28** | −.34** |
| 9. Months | | | | | | | | | — | .23* | .13 | .30** | .20 | −.16 |
| 10. BNDS | | | | | | | | | | — | .58** | .55** | .49** | −.35** |
| 11. Urge to chew (pretask) | | | | | | | | | | | — | .83** | .77** | −.14 |
| 12. Urge to chew (middle task) | | | | | | | | | | | | — | .75** | −.13 |
| 13. Urge to chew (posttask) | | | | | | | | | | | | | — | .05 |
| 14. Hours since last chew | | | | | | | | | | | | | | — |

*Note.* As described in the text, all, except for the overall bias and the three bias scores, were log transformed before the correlation analysis. BNDS = Betel Nut Dependency Scale.
* $p < 0.05$. ** $p < 0.01$.

different classes of substance. For example, attentional biases in initial orienting were observed in smokers (Bradley et al., 2004) but not in alcohol drinkers (Field et al., 2004). Possibly, incentive salience was developed for different substance cues in different rates, thus seizing attention to different extents. For example, cigarette and betel nut cues may be faster than alcohol cues to acquire incentive salience, thereby attracting attention at short presentation. In opposition to the mixed patterns at 200-ms duration, maintained attention (2,000 ms) has been consistently observed in substance users, particularly in heavy users. Attentional bias in maintained attention may be a general phenomenon for heavy users across substances (Field, Eastwood, Bradley, & Mogg, 2006; Field et al., 2004) because habitual substance users are usually motivated to consume addictive substances, and such bias is influenced by motivational need states (LaBerge, 1995).

Overall bias and attentional bias at 2,000 ms were shown to be positively associated with betel nut craving and dependence. These positive correlations have also been reported across various substances, supporting the view that biases in maintained attention may be a general phenomenon for substance users (Field, Eastwood, et al., 2006). Attentional bias in maintained attention was associated with self-reported urge to chew before, in the middle of, and after the visual probe task. This result was consistent with studies using other substances, such as cigarettes (e.g., Field, Mogg, & Bradley, 2004a; Mogg et al., 2003), alcohol (e.g., Field et al., 2004), cocaine (e.g., Franken, Kroon, & Hendriks, 2000), and cannabis (e.g., Field, Mogg, & Bradley, 2004b). Attentional bias in maintained attention was also positively associated with dependence level, as measured by BNDS (Li et al., 2012). This result was consistent with previous studies on cigarettes (e.g., Bradley et al., 2003; Mogg et al., 2005), alcohol (e.g., Townshend & Duka, 2001), and cannabis (e.g., Field, 2005). In contrast, attentional scores at 200 ms were only positively associated with the urge to chew measured after the task. This weak correlation between initial orienting and urge was consistent with a recent meta-analytic study (Field et al., 2009). As noted by Field et al. (2009), their result of weak correlation was based on a small number ($N = 12$) of studies, so future studies are necessary to confirm this correlation.

In conclusion, the current study reported that heavy betel nut chewers showed attentional biases for betel nut cues in initial orienting and maintained attention. In the current study, we were particularly interested in attentional biases to betel nut cues among heavy and light chewers. Thus, the inclusion of habitual chewers should be sufficient to answer our research question. However, since nonchewers were not included, the current results should be generalized to a possible attentional bias difference between chewers and nonchewers.

## References

Bradley, B., Field, M., Mogg, K., & De Houwer, J. (2004). Attentional and evaluative biases for smoking cues in nicotine dependence: Component process of biases in visual orienting. *Behavioural Pharmacology, 15,* 29–36. doi:10.1097/00008877-200402000-00004

Bradley, B. P., Mogg, K., & Millar, N. H. (2000). Covert and overt orienting of attention to emotional faces in anxiety. *Cognition and Emotion, 14,* 789–808. doi:10.1080/02699930050156636

Bradley, B. P., Mogg, K., Wright, T., & Field, M. (2003). Attentional bias in drug dependence: Vigilance for cigarette-related cues in smokers. *Psychology of Addictive Behaviors, 17,* 66–72. doi:10.1037/0893-164X.17.1.66

Chen, J.-W., & Shaw, J.-H. (1996). A study on betel quid chewing behavior among Kaohsiung residents aged 15 years and above. *Journal of Oral Pathology & Medicine, 25,* 140–143. doi:10.1111/j.1600-0714.1996.tb00209.x

Chuang, C.-Y., Chang, C.-H., & Chang, C.-C. (2007). The workplace relevant factors of betel quid chewing among transportation workers in Central Taiwan. *Taiwan Journal of Public Health, 26,* 433–442.

Cisler, J. M., Bacon, A. K., & Williams, N. L. (2009). Phenomenological characteristics of attentional biases toward threat: A critical review. *Cognitive Therapy and Research, 33,* 221–234. doi:10.1007/s10608-007-9161-y

Corbetta, M., & Shulman, G. L. (2002). Control of goal-directed and stimulus-driven attention in the brain. *Nature Reviews Neuroscience, 3,* 201–215. doi:10.1038/nrn755

Field, M. (2005). Cannabis "dependence" and attentional bias for cannabis-related words. *Behavioural Pharmacology, 16,* 473–476. doi:10.1097/00008877-200509000-00021

Field, M., & Cox, W. M. (2008). Attentional bias in addictive behaviors: A review of its development, causes, and consequences. *Drug and Alcohol Dependence, 97,* 1–20. doi:10.1016/j.drugalcdep.2008.03.030

Field, M., Eastwood, B., Bradley, B. P., & Mogg, K. (2006). Selective processing of cannabis cues in regular cannabis users. *Drug and Alcohol Dependence, 85,* 75–82. doi:10.1016/j.drugalcdep.2006.03.018

Field, M., Mogg, K., & Bradley, B. P. (2004a). Eye movements to smoking-related cues: Effects of nicotine deprivation. *Psychopharmacology, 173,* 116–123. doi:10.1007/s00213-003-1689-2

Field, M., Mogg, K., & Bradley, B. P. (2004b). Cognitive bias and drug craving in recreational cannabis users. *Drug and Alcohol Dependence, 74,* 105–111. doi:10.1016/j.drugalcdep.2003.12.005

Field, M., Mogg, K., & Bradley, B. P. (2006). Automaticity of smoking behaviour: The relationship between dual-task performance, daily cigarette intake, and subjective nicotine effects. *Journal of Psychopharmacology, 20,* 799–805. doi:10.1177/0269881106063997

Field, M., Mogg, K., Zetteler, J., & Bradley, B. P. (2004). Attentional bias for alcohol cues in heavy and light social drinkers: The role of initial orienting and maintained attention. *Psychopharmacology, 176,* 88–93. doi:10.1007/s00213-004-1855-1

Field, M., Munafò, M. R., & Franken, I. H. A. (2009). A meta-analytic investigation of the relationship between attentional bias and subjective craving in substance abuse. *Psychological Bulletin, 135,* 589–607. doi:10.1037/a0015843

Franken, I. H. A. (2003). Drug craving and addiction: Integrating psychological and neuropsychopharmacological approaches. *Progress in Neuro-Psychopharmacology & Biological Psychiatry, 27,* 563–579. doi:10.1016/S0278-5846(03)00081-2

Franken, I. H. A., Kroon, L. Y., & Hendriks, V. M. (2000). Influence of individual differences in craving and obsessive cocaine thoughts on attentional processes in cocaine abuse patients. *Addictive Behaviors, 25,* 99–102. doi:10.1016/S0306-4603(98)00112-9

Franken, I. H. A., Kroon, L. Y., Wiers, R. W., & Jansen, A. (2000). Selective cognitive processing of drug cues in heroin dependence. *Journal of Psychopharmacology, 14,* 395–400. doi:10.1177/026988110001400408

Gupta, P. C., & Ray, C. S. (2004). Epidemiology of betel quid usage. *Annals, Academy of Medicine, Singapore, 33,* 31–36.

Ho, M. C., & Wang, C. K. (2010). Can betel nut chewing affect the UFOV size after sleep deprivation? *Chinese Journal of Psychology, 52,* 445–456.

Ho, M. C., & Wang, C. K. (2011). The effect of betel nut chewing on contour and object masking. *Attention, Perception, & Psychophysics, 73,* 2583–2593. doi:10.3758/s13414-011-0214-7

Hogarth, L. C., Mogg, K., Bradley, B. P., Duka, T., & Dickinson, A. (2003). Attentional orienting towards smoking-related stimuli. *Behavioural Pharmacology, 14,* 153–160. doi:10.1097/00008877-200303000-00007

International Agency for Research on Cancer. (2004). Betel-quid and Areca-nut chewing and some areca-nut-derived nitrosamines. In *IARC Monographs on the Evaluation of Carcinogenic Risks to Humans: Vol. 38*. Lyon, France: IARC Press.

Kavanagh, D. J., Andrade, J., & May, J. (2005). Imaginary relish and exquisite torture: The elaborated intrusion theory of desire. *Psychological Review, 112,* 446–467. doi:10.1037/0033-295X.112.2.446

LaBerge, D. (1995). *Attentional processing*. Cambridge, MA: Harvard.

Li, R. H., Ho, M. C., Tang, T. C., & Chang, F. T. (2012). Development of the Betel Nut Dependency Scale (BNDS). *Chinese Journal of Psychology, 54,* 331–348.

Mogg, K., & Bradley, B. P. (2002). Selective processing of smoking-related cues in smokers: Manipulation of deprivation level and comparison of three measures of processing bias. *Journal of Psychopharmacology, 16,* 385–392. doi:10.1177/026988110201600416

Mogg, K., Bradley, B. P., Field, M., & De Houwer, J. (2003). Eye movements to smoking-related pictures in smokers: Relationship between attentional biases and implicit and explicit measures of stimulus valence. *Addiction, 98,* 825–836. doi:10.1046/j.1360-0443.2003.00392.x

Mogg, K., Bradley, B. P., & Williams, R. (1995). Attentional bias in anxiety and depression: The role of awareness. *British Journal of Clinical Psychology, 34,* 17–36. doi:10.1111/j.2044-8260.1995.tb01434.x

Mogg, K., Field, M., & Bradley, B. P. (2005). Attentional and approach biases for smoking cues in smokers: An investigation of competing theoretical views of addiction. *Psychopharmacology, 180,* 333–341. doi:10.1007/s00213-005-2158-x

Robbins, S. J., & Ehrman, R. N. (2004). The role of attentional bias in substance abuse. *Behavioral and Cognitive Neuroscience Reviews, 3,* 243–260. doi:10.1177/1534582305275423

Robinson, T. E., & Berridge, K. C. (1993). The neural basis of drug craving: An incentive-sensitization theory of addiction. *Brain Research Reviews, 18,* 247–291. doi:10.1016/0165-0173(93)90013-P

Robinson, T. E., & Berridge, K. C. (2003). Addiction. *Annual Review of Psychology, 54,* 25–53. doi:10.1146/annurev.psych.54.101601.145237

Robinson, T. E., & Berridge, K. C. (2008). The incentive sensitization theory of addiction: Some current issues. *Philosophical Transactions of the Royal Society of London*. Series B, Biological Sciences, *363,* 3137–3146. doi:10.1098/rstb.2008.0093

Schneider, W., Eschman, A., & Zuccolotto, A. (2002). *E-Prime user's guide*. Pittsburgh, PA: Psychology Software Tools.

Schoenmakers, T. M., Bruin, M., Lux, I. F. M., Goertz, A. G., Van Kerkhof, D. H. A. T., & Wiers, R. W. (2010). Clinical effectiveness of attentional bias modification training in abstinent alcoholic patients. *Drug and Alcohol Dependence, 109,* 30–36. doi:10.1016/j.drugalcdep.2009.11.022

Tiffany, S. T. (1990). A cognitive model of drug urges and drug-use behavior: Role of automatic and nonautomatic processes. *Psychological Review, 97,* 147–168. doi:10.1037/0033-295X.97.2.147

Townshend, J. M., & Duka, T. (2001). Attentional bias associated with alcohol uses: Differences between heavy and occasional social drinkers. *Psychopharmacology, 157,* 67–74. doi:10.1007/s002130100764

Waters, A. J., Shiffman, S., Bradley, B. P., & Mogg, K. (2003). Attentional shifts to smoking cues in smokers. *Addiction, 98,* 1409–1417. doi:10.1046/j.1360-0443.2003.00465.x

Winstock, A. (2002). Areca nut-abuse liability, dependence and public health. *Addiction Biology, 7,* 133–138. doi:10.1080/13556210120091509

Winstock, A. R., Trivedy, C. R., Warnakulasuriy, K. A. A. S., & Peters, T. J. (2000). A dependency syndrome related to areca nut use: Some medical and psychological aspects among areca nut users in the Gujarat community in the UK. *Addiction Biology, 5,* 173–179. doi:10.1080/13556210050003766

Received May 14, 2012
Revision received August 30, 2012
Accepted September 4, 2012 ■