Can Betel Nut Chewing Affect the UFOV Size after Sleep Deprivation?

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Betel nut is a common stimulant in many Asian countries, including Taiwan. However, few behavioral studies focusing on the betel nut chewing effects were reported. The current study examined the effects of betel nut chewing on the useful field of view (UFOV) under sleep deprivation. After one night of deprived sleep, habitual chewers and non-chewers chewed either betel nut or gum before proceeding to the UFOV subtests. In the UFOV subtests, participants needed to identify the central target, divide their attention to the peripheral target, and detect the peripheral target embedded in the distractors while identifying the central target. We report that betel nut chewing could broaden the UFOV size for the habitual chewers, but not for the non-chewers. The implication for people often chewing betel nut for refreshment during long-hour working is discussed.

Keywords: areca, betel nut, sleep deprivation, useful field of view

In Taiwan, betel nuts (also known as areca) is a common refreshment for people working at night shifts. About 1.5 million Taiwanese are betel nut users, with about 30\% of these users chewing betel nuts for refreshment (Directorate-General of Budget, Accounting and Statistic, 1999). People place a whole betel nut into their mouth and macerate it by biting for approximately two to three minutes; they then spit out the red chewing saliva of the betel nut.

A betel nut usually consists of three major ingredients: a raw areca nut, slaked lime, and piper betel flower. The slaked lime, which is handled in the form of a paste, is either white lime or red lime. Red lime betel nut, containing green areca fruit, piper betel inflorescence and red lime paste, is the main such product consumed in Taiwan (about 70\% of all betel nuts). The primary chemical ingredients in betel nuts are alkaloids (e.g., arecoline, arecaidine, guvacine, and acolidine), polyphenolic compounds, safrole, eugenol, and hydroxychavicol.

Betel nuts have long been chewed by people as a stimulant because of their physiological effects, which include: increased stamina, a general feeling of well-being (Nieschulz, 1967), sweating, salivation, stimulation, cardioacceleration, a slightly drunk feeling and warming of the body and mouth cavity (Hwang, Wang, & Kao, 1999).

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Many studies have shown that betel nut chewing can heighten the state of alertness (e.g., Cawte, 1985; Chu, 1993, 1994a, 1994b, 2001; Chu & Chang, 1994; Haubrich & Watson, 1972; Molinengo, Fundaro, & Cassone, 1988; Rinaldi & Himwich, 1955; Wyatt, 1996); additionally, such effects occur only for habitual betel nut chewers. According to Chu and Chang’s survey, the first three effects experienced by the new chewers were dizziness, hot sensation, and palpitation. Contrarily, the first three effects for habitual chewers were: heightened alertness, hot sensation, and palpitation.

Evidence that supports the refreshment effect of betel nut chewing comes primarily from physiological studies. In general, the physiological effects of betel nut chewing may result from the chemical effects of the betel nut ingredients on the autonomic and central nervous systems (for a review, refer to Chu, 2001). Chu (1994a) conducted an electroencephalographic (EEG) study on the effects of betel nut chewing. Results showed an increase in both beta (associated with alertness) and alpha (associated with relaxation) activities and a decrease in theta (associated with drowsiness) activity. Both an increase in beta and a decrease in theta indicated an increase in the state of alertness, whereas an increase in alpha indicated a relaxation or calmness while chewing betel nut. In addition, these EEG changes were restricted mainly to posterior areas (particularly the occipital areas) for alpha activity, but were more widespread for theta and beta activities.

Chu (1993) investigated the time course of betel nut chewing comes primarily from physiological studies. We focus on whether betel nut chewing could improve visual attention after sleep deprivation. Governmental surveys have reported that long-distance bus and truck drivers usually have long driving hours, which increases the possibility of car accidents. For example, Department of Statistics, Ministry of Transport and Communications (2003) surveyed the working hours of employers in transportation, storage and communication businesses. This survey showed that the working hours of long-distance bus (198.1 hours/month) and truck (190.8 hours/month) drivers are the longest two among the surveyed businesses. In addition, Chen, Huang, Song, and Chang (2003) reported that 20.9% of the bus drivers were betel nut users. Thus, it is of practical importance to examine whether chewing betel nut could influence visual attention after sleep is deprived. To our knowledge, no studies have provided behavioral data on the betel nut chewing effect on visual attention under sleep deprivation.

One of the important indexes of visual attention is the useful field of view (UFOV). UFOV has been shown to mediate the likelihood of car accidents when sleep is
deprived (Clay et al., 2005; Cross et al., 2009; Leat & Lovie-Kitchin, 2006; Owsley & McGwin, 1999; Rogé, Pèbayle, Hannachi, & Muzet, 2003), thus it is chosen for measure of visual attention in the current study. The UFOV refers to a spatial area that is functional or useful for the ongoing task(s) (Sanders, 1970). Attentional resources are allocated to this spatial area in order to process the incoming information. Any stimuli within the UFOV would receive further processing; however, any stimuli falling outside of the UFOV would receive only basic pretattentive processing (e.g., physical properties e.g. color and texture). That is, when the size of the UFOV shrinks, fewer stimuli within the UFOV are processed further.

Measures of the UFOV typically involve three well-documented components: speed of identifying a central target alone (hereafter processing speed), dividing attention between central and peripheral targets presented simultaneously (hereafter divided attention), and localization of a peripheral target embedded in distractors while identifying a central target (hereafter selective attention) (for a review, see Ball, Roenker, & Bruni, 1990; Sekuler & Ball, 1986). The size of the UFOV varies across situations. The size of the UFOV is decreased by the slowing of visual information processing (Ball, Beard, Miller, & Roenker, 1987; Leibowitz & Appelle, 1969). When the central task demand increases (Chan & Courtney, 1993; Sekuler & Ball), a peripheral target localization or detection is impaired. The UFOV size deteriorates when the peripheral target is embedded in the background distractors (Drury & Clement, 1978; Scialfa, Kline, & Layman, 1987; Sekuler & Ball). Furthermore, when the similarity of a peripheral target and the background distractors increase, the size of UFOV is reduced even more (Ball et al., 1990).

The size of the UFOV also varies across individuals. Individuals with more impaired components of the UFOV (i.e., processing speed, divided attention and selective attention) suffer from further reduction of the UFOV size (Ball & Owsley, 1992). Many have shown that sleep deprivation deteriorates the UFOV size (e.g., Pilcher & Huffcutt, 1996; Rogé et al., 2003; Williamson & Feyer, 2000). Sleep deprivation decreases participants’ ability to identify a critical signal in the central visual field (Williamson & Feyer). In addition, the divided attention task is impaired and reached levels equivalent to the maximum alcohol dosage given to participants (Williamson & Feyer). Pilcher and Huffcutt (1996) reported a meta-analysis of 143 study coefficients in a total sample size of 1932, and suggested that sleep deprivation strongly reduces cognitive and motor functions.

Because many habitual chewers chew betel nut for refreshment when they need to stay awake overnight, we test whether betel nut chewing could affect the UFOV size under deprived sleep. Physiological studies have reported that the ingredients of betel nuts are able to increase stamina and alertness for the chewers (e.g., Chu, 2001). We hypothesize that after sleep deprivation, betel nut chewing can affect the UFOV size measured in terms of the three well-developed components: processing speed, divided attention and selective attention. Furthermore, these betel nut effects on the UFOV only occur to the habitual betel nut chewers, rather than the non-chewers.

### Method

#### Participants

There were sixteen current betel nut chewers (one female) (mean age = 35 years old, $\pm$ = 10 years, range = 20 ~ 50 years old) and ten non-chewers (three females) (average age = 38 years old, $\pm$ = 14 years, range = 22 ~ 56 years old) participated in this study (Table 1). All

<table>
<thead>
<tr>
<th></th>
<th>Average age (years)</th>
<th>ESS</th>
<th>MEQ</th>
<th>VSS (betel nut)</th>
<th>VSS (gum)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chewers</td>
<td>35 (10)</td>
<td>6 (3)</td>
<td>52 (7)</td>
<td>94.30 (23.6)</td>
<td>94.14 (24.65)</td>
</tr>
<tr>
<td>Non-Chewers</td>
<td>38 (14)</td>
<td>6 (3)</td>
<td>53 (7)</td>
<td>102.13 (36.37)</td>
<td>80.56 (30.62)</td>
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</table>

Note: Standard deviations are shown in the parenthesis.
the participants were recruited from the temporal worker company. For the habitual chewers, the average months of chewing betel nut were 46 (SD = 46, range = 10 ~ 120), the average days per week of chewing were 5 (SD = 2, range = 2 ~ 7), and the average number of betel nuts chewed per day is 22 (SD = 15, range = 3 ~ 50). All chewers and non-chewers had a low level of drowsiness in daily life on the Epworth sleepiness scale (ESS; Johns, 1991, 1992), and were morning (two chewers and three non-chewers; scores between 59 and 86) or intermediate (fourteen chewers and seven non-chewers; scores between 42 and 58) types on the Morning-Evening Questionnaire (MEQ; Horne & Östberg, 1976). There were no age difference [t(24)=1.35, p > .1], ESS difference [t(24)=.36, p > .7] and MEQ difference [t(24)=.66, p > .5] between the chewers and non-chewers, thus one can rule out the possibility that different everyday sleepiness status affects sleep deprivation. Each participant had normal or corrected-to-normal vision. They had not used betel nut or any food or drink with alcohol or caffeine during the night in the laboratory before the UFOV test. None of them work night shifts.

**Apparatus**

We used an IBM-compatible PC with a 17 inch touch screen CRT desktop monitor (refresh rate = 60 Hz).

**Design and Procedure**

Each participant underwent two conditions of experiments (chewing gum and betel nut conditions), counterbalanced across participants. Half of the participants took part in the chewing gum condition first, and the remaining half took part in the betel nut condition first. The chewing gum condition was adopted in order to have a control for the effect of mere chewing. These two conditions were separated by about one week. The laboratory purchased the betel nuts and chewing gum so that all the participants chewed the same type of betel nuts and chewing gum.

In both the chewing gum and betel nut conditions, participants needed to stay awake all night in the company of the experimenter. Each participant arrived at the laboratory at 22h00, the night before the UFOV test. Participants could carry out quiet activities and the luminance in the laboratory was 310 lux. After the participants arrived at the laboratory, they needed to fill out the Verran and Snyder-Halpern sleep scale (VSS; Simpson, Lee, & Cameron, 1996; Snyder-Halpern & Verran, 1987) in order to evaluate their sleep quality the night before the experiment. In order to evaluate participants’ sleepiness degree overnight, the Stanford sleepiness scale (SSS; Hoddes, Zarcone, Smythe, Phillips, & Dement, 1973) was administered every hour from 22h00 to 7h00. The following morning at 7h00, each participant chewed either the betel nut or chewing gum before the UFOV test. In either the betel nut or chewing gum condition, participants chewed one material (betel nut or chewing gum) for three minutes and then spit it out before they began the UFOV test.

The functional field of view was assessed by the commercial UFOV software (Visual Awareness, Inc., Birmingham, AL), consisting of three subtests that measure the processing speed (Subtest 1), divided attention (Subtest 2) and selective attention (Subtest 3) respectively (Figure 1). These three subtests were presented subsequently (Subtest 1 first, then Subtest 2, and finally Subtest 3). The UFOV test was administered in a dim room where each participant leaned his/her chin on the chin rest with a viewing distance of 50 cm from the monitor.

Subtest 1 consisted of a sequence of stimuli in which a single target (a silhouette of either a car or a truck with 2.3° in width and 1.7° in height) inside the central outlined rectangle (3.3° in width and 4° in height) was presented for various presentation time from 16 to 500 ms, which was followed by a 1-s random dot mask with the size of the display screen. The mask was followed by a response screen in which both the car and truck icons were presented always to the right and left of fixation. Participants were instructed to discriminate between these two possible targets and responded to the target by touching the stimulus icon displayed on the touch monitor without time pressure.

The UFOV test is not an RT test; rather, it is an accuracy test. For each subtest, the UFOV software
adjusts the length of stimulus presentation in milliseconds if needed. This adjustment procedure is a “two up, one down” adaptive staircase in which two successive correct responses to the central target in Subtest 1 (or both central and peripheral targets in Subtests 2 and 3) result in a shortened stimulus presentation duration for the next trial; an incorrect response (to either a central or peripheral target) results in a lengthened stimulus presentation duration for the next trial. The procedure of adjusting the perceptual threshold is continued until a stable estimate of 75% correct is calculated. Scores yielded from each subtest of the UFOV are expressed in terms of stimulus presentation time. Longer stimulus presentation time (i.e., stimulus is displayed on the screen for a longer period of time for correct responses) indicates that more time is needed to process the stimuli to reach the performance criteria.

In Subtest 2, in addition to identifying the central target as Subtest 1, participants needed to detect a simultaneously presented peripheral target, always a silhouette of a car. The center-to-center distance between the central and peripheral targets was 13.5°. This peripheral target appeared randomly at one of eight different peripheral locations along eight radial spokes (4 cardinal and 4 oblique). The center-to-center distance between two nearest peripheral locations was 9.1°. As Subtest 1, participants responded by touching the monitor first to discriminate which target was seen in the center. Then, they needed to localize the peripheral target; the identity of this target was unimportant. The response screen for localization judgment consisted of eight boxes at the eight possible peripheral target locations linked to the central box by eight radial lines. Participants were instructed to touch one of the eight boxes on the display to indicate the location.

The tasks in Subtest 3 were the same as those in Subtest 2 (i.e., central target discrimination and peripheral target localization tasks); however, distractors (upside-down outlined triangles with each side length of 2.3°) were added to the remaining area of the screen. These distractors were arranged in three imaginary circles with three different radii (4.3°, 8.8°, and 12.8°). In each imaginary circle, the center-to-center distance between two nearest triangles was 3.8°. There were 8 distractors in the inner circle and 16 in the middle circle. The peripheral target was presented in one of eight locations (as Subtest 2) in the outer circle, resulting in 23 distractors in the outer circle. In each subtest, four practice trials were presented before the formal trials. In general, the UFOV test lasts for about 15 minutes or less.

The UFOV test used in the current study differed from the previous paradigm (e.g., Sekuler & Ball, 1986) in that the current test did not manipulate the spatial distance between the central and peripheral targets, and the response time was not the primary dependant variable. The current UFOV test has been shown to have high test-retest reliability ($r = .735$) and high correlation with the previous paradigm manipulating spatial distance and recording response time ($r = .746$) (Edwards, Vance, Wadley, Cissell, Roenker, & Ball, 2005). Also, the current UFOV test takes less time (15 minutes or less) than the past paradigm (about 20 to 30 minutes). The un-speeded
response in the current UFOV test also allows controlling for the possible confounds from post-perceptual stages (e.g., decision making and motor function). Thus, the current UFOV test is appropriate to assess participants’ functional field of view.

Results and Discussion

Sleepiness Scores

For the habitual chewers, regression analysis showed that SSS scores increased as the hours that participants stayed awake in the laboratory increased in both conditions (in chewing gum condition, $\beta = .718$; in betel nut condition, $\beta = .694$; both $p < .001$). In both conditions, the mean SSS score was 1 (“feeling active and vital; alert; wide awake”) at 22h00 (in betel nut condition, $SD = .7$; in chewing gum condition, $SD = .6$) and was 5 (“fogginess; beginning to lose interest in remaining awake; slowing down”) at 7h00 (in betel nut condition, $SD = 1.5$; in chewing gum condition, $SD = 1.3$). For the non-chewers, regression analysis showed that SSS increased as the hours that participants stayed awake in the laboratory increased in both conditions (in the chewing gum condition, $\beta = .745$; in the betel nut condition, $\beta = .691$; both $p < .001$). In the betel nut condition, the mean SSS score was 1 (“feeling active and vital; alert; wide awake”) at 22h00 ($SD = .7$) and was 5 (“fogginess; beginning to lose interest in remaining awake; slowing down”) at 7h00 ($SD = 1.6$). In the chewing gum condition, the mean SSS score was 2 (“functioning at a high level, but not at peak; able to concentrate”) at 22h00 ($SD = 1.1$) and was 6 (“sleepiness; prefer to be lying down; fighting sleep; woozy”) at 7h00 ($SD = 1.3$).

An analysis of variance (ANOVA) of 2 (betel nut use: chewer or non-chewer) × 2 (treatment: betel nut or gum) on VSS showed main effect of treatment [$F(1, 24) = 4.95, MSE = 293.3, p < .05$, partial $\eta^2 = .171$] and the interaction [$F(1, 24) = 4.81, MSE = 293.3, p < .05$, partial $\eta^2 = .167$]. The main effect showed that VSS was higher in the betel nut condition than in the gum condition. Further analysis on the interaction effect showed that the VSS difference was shown primarily in the non-chewers ($p < .05$, partial $\eta^2 = .402$), but not in the habitual chewers ($p > .9$, partial $\eta^2 = .0$). That is, non-chewers had better sleep quality the night before the experiment in which they chewed betel nut than before they chewed gum.

To assess whether the VSS was critical for the UFOV performances, in each group (the habitual chewers and non-chewers), the VSS in the betel nut condition was correlated to three UFOV subtests in the betel nut condition. Also, the VSS in the gum condition was correlated to three UFOV subtests in the gum condition as well. None of these correlations reached the significant level (all $p > .1$). That is to say, in the current study, the VSS was not crucial to account for the UFOV performance.

UFOV Scores

The mean stimulus presentation times are shown in Table 2 and the ANOVA table is shown in Table 3. To assess the betel nut chewing effect on the UFOV under sleep deprivation, we conducted an ANOVA of 2 (treatment: betel nut or gum) × 3 (UFOV test: processing speed, divided attention and selective attention) × 2 (betel nut use: chewer or non-chewer). The first two variables (treatments and UFOV tests) were within-

<table>
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<tr>
<th>Table 2 Mean stimulus presentation time (in ms) for betel nut and chewing gum conditions in three subtests of the UFOV test in the current study</th>
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<td><strong>Subtest</strong></td>
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<td>Subtest 3</td>
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Note: Standard errors of mean are shown in the parenthesis.
Betel Nut Effects on UFOV 451

subject variables, and the last one (betel nut use) was a between-subject variable. The main effect of UFOV test and treatment × betel nut use interaction were obtained. The main effect of UFOV test \( F(2, 48) = 55.52, \ MSE = 5018.7, p < .001, \ \text{partial } \eta^2 = .698 \) showed that more processing time was required for more complex tasks. Namely, the average stimulus presentation time of Subtest 1 (29 ms) was shorter than Subtest 2 (74 ms), which was shorter than Subtest 3 (176 ms) (all \( p < .001 \)).

Most critically and intriguingly, the interaction of treatment × betel nut use \( F(1, 24) = 4.24, \ MSE = 9879.1, p < .05, \ \text{partial } \eta^2 = .150 \) had revealed a betel nut chewing effect for the habitual chewers when their sleep was deprived for one night. That is, for each group of chewers and non-chewers, the simple main effect analysis was further conducted to compare whether the average stimulus presentation times were different between the betel nut and gum conditions, based on alpha = .05. For the chewers, the average stimulus presentation time when they chewed betel nuts (69 ms) was significantly shorter than that when they chewed gums (123 ms) \( (p < .05, \ \text{partial } \eta^2 = .127) \). However, for the non-chewers, the average stimulus presentation time in the betel nut condition (97 ms) did not differ significantly from that in the gum condition (83 ms) \( (p > .4, \ \text{partial } \eta^2 = .054) \). These results indicated that the chewers’ UFOV could be facilitated after the betel nuts were consumed. Also, this facilitation effect did not take place in the non-chewers.

Given the facilitated UFOV after the habitual chewers chew betel nuts, although the three-way interaction (treatment × UFOV test × betel nut use) was not significant, it was still of interest to see which subtest is affected by betel nut chewing. The post-hoc analysis (alpha was controlled using least significant difference, LSD) showed that for the chewers, only in the third subtest (selective attention), the average stimulus presentation time in the betel nut condition was faster than that in the gum condition [processing speed: \( t(15) = 1.52, p > .1 \); divided attention: \( t(15) = 1.97, p > .06 \); selective attention: \( t(15) = 2.27, p < .05 \)]. That is to say, when the chewers chewed betel nut, they could quickly detect the peripheral target embedded in the distractors while identifying the central target.

It was suggested to the current study that because the commercial UFOV software measured the temporal variable, it may in effect measure a general visual sensitivity (e.g., the temporal summation behavior) rather than attention. That is, the habitual chewers may just have a better sensitivity to the stimuli than the non-chewers. It was suggested that one can have a pretest baseline to control for this confound. Thus, we ran another group of 12 chewers and 12 non-chewers to establish the baseline (Table 4 & 5). For the habitual chewers, the average months of chewing betel nut were 154 \( (SD = 73, \text{ range } = 36 \sim 276) \), the average days per week of chewing were 7 \( (SD = 1, \text{ range } = 5 \sim 7) \), and the average number of betel nuts chewed per day is 50 \( (SD = 52, \text{ range } = 10 \sim 200) \). The design and procedure were similar to those mentioned above except that all the participants had normal sleep at home before they began the UFOV tasks. There were no age, ESS, and MEQ difference between the chewers and non-chewers. A 2 (betel nut use) × 2 (treatment) ANOVA on VSS showed no main and interaction effects. For the UFOV performance, an ANOVA of treatment × UFOV test × betel nut use revealed that only main effect of UFOV test \( F(2, 44) = 68.90, \ MSE = 2642.4, p < .001, \ \text{partial } \eta^2 \)

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was obtained. The average stimulus presentation time of Subtest 1 (19 ms) was shorter than Subtest 2 (37 ms), which was shorter than Subtest 3 (133 ms) (all ps < .05). When the habitual chewers and non-chewers had normal sleep, they had comparable UFOV performance in the gum betel nut and conditions. This indicates that the habitual chewers did not have a better visual sensitivity than the non-chewers, filtering out the confound.

To conclude, betel nut chewing can affect the UFOV size for the habitual betel nut chewers when their sleep was deprived for one night. Yet, betel nut chewing had no effect on the UFOV performance of non-chewers.

### General Discussion

We examined whether betel nut chewing could influence the UFOV size for both habitual chewers and non-chewers given sleep deprivation. Our results indicate that betel nut chewing could influence the UFOV size for the habitual chewers, but not for the non-chewers.

The change of the UFOV size in the current study is better characterized by more successful inhibition of surrounding distractor interference (i.e., selective attention), rather than the more efficient processing of central target (i.e., stimulus identification) or of dividing attention from the single peripheral target (i.e., divided attention). In other words, the UFOV appeared to be broadened to some extent which was sufficient in inhibiting the peripheral distractors efficiently (Bergen & Julesz, 1983; Drury & Clement, 1978; Scialfa, Kline, & Layman, 1987; Sekuler & Ball, 1986). This facilitated inhibition may be associated with elevated working memory capacity (WMC; Barrett, Tugade, & Engle, 2004; Conway et al., 2005), causing more flexible attentional allocation on the possible target locations (Bleckley, Durso, Crutchfield, Engle, & Khanna, 2003). That is, chewing betel nuts may facilitate the habitual chewers’ WMC which has been temporally deteriorated by deprived sleep, thus affecting attentional allocation (e.g., Bleckley et al.). Future studies could measure habitual chewers’ and non-chewers’ WMC to investigate whether it is modulated by sleep deprivation and chewing substance (e.g., betel nut).

Some possibilities could account for the betel nut chewing effects on the UFOV found only in habitual chewers. First, the expectancy effect of betel nut chewing may be larger in the chewers. In Taiwan, it is thought to be common knowledge that chewing betel nut has a refreshing effect. Possibly, the chewers are more anticipative of betel nut’s refreshment effect, thus causing better performance while chewing betel nut. However, because many physiological studies have

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### Table 4 Demographic characteristics in the normal sleep baseline

<table>
<thead>
<tr>
<th></th>
<th>Average age (years)</th>
<th>ESS</th>
<th>MEQ</th>
<th>VSS (betel nut)</th>
<th>VSS (gum)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chewers</td>
<td>36 (7)</td>
<td>5 (3)</td>
<td>54 (11)</td>
<td>92.50 (29.35)</td>
<td>103.00 (30.07)</td>
</tr>
<tr>
<td>Non-Chewers</td>
<td>41 (14)</td>
<td>7 (3)</td>
<td>54 (11)</td>
<td>96.67 (29.13)</td>
<td>91.42 (22.63)</td>
</tr>
</tbody>
</table>

Note: Standard deviations are shown in the parenthesis.

### Table 5 Mean stimulus presentation time (in ms) for betel nut and chewing gum conditions in three subtests of the UFOV test in the normal sleep baseline

<table>
<thead>
<tr>
<th></th>
<th>UFOV test</th>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Subtest 1</td>
<td>Subtest 2</td>
<td>Subtest 3</td>
<td></td>
</tr>
<tr>
<td>Chewers</td>
<td>Betel nut</td>
<td>18 (2)</td>
<td>31 (20)</td>
<td>110 (27)</td>
</tr>
<tr>
<td></td>
<td>Chewing gum</td>
<td>22 (15)</td>
<td>26 (30)</td>
<td>116 (31)</td>
</tr>
<tr>
<td>Non-Chewers</td>
<td>Betel nut</td>
<td>18 (2)</td>
<td>46 (20)</td>
<td>172 (27)</td>
</tr>
<tr>
<td></td>
<td>Chewing gum</td>
<td>17 (15)</td>
<td>44 (30)</td>
<td>136 (31)</td>
</tr>
</tbody>
</table>

Note: Standard errors of mean are shown in the parenthesis.
Betel Nut Effects on UFOV 453

reported the refreshment effect of betel nut chewing, it is unlikely that this effect is merely due to habitual chewer’s expectations. A mixed effect of physiological contributions and expectations may be more likely the case. The future study could include a placebo control to examine how physiological effect alone, expectancy effect alone or their interaction influence habitual chewers’ or non-chewers’ behavior.

Second, previous surveys have shown that the initial feelings of chewing betel nut are: dizziness, hot sensations, and palpitation (Chu & Chang, 1994). Such uncomfortable feelings may result from an increase in systolic blood pressure after chewing betel nut but only for non-chewers, rather than habitual chewers (Chu, 1993). It is possible that the selective effect of betel nut chewing on blood pressure for non-chewers and habitual chewers results in different performances in both groups. Future study should examine the possible link between online physiological and behavioral measures.

Third, after a short-term deprivation of betel nut chewing (at least 9 hours), the performance of the habitual chewers may become enhanced when they start to chew betel nut again. Studies from habitual smokers have shown a decrease in several perception and cognition tasks (e.g., Bell, Taylor, Singleton, Henningfield, & Heishman, 1999; Gross, Jarvik, & Rosenblatt, 1993); however, smokers abstinent for a brief period (at least 13 hours) demonstrated an enhanced inhibition ability of interference in a Stroop task after smoking a single cigarette (e.g., Domier et al., 2007). The enhanced performance gained from betel nut chewing after a brief abstinence may have important implications on the effectiveness of the betel nut abstinence programs.

In the present study, the three UFOV subtests were always presented sequentially; thus, one may discern the interaction between the time course of betel nuts and subtest sequence. However, this concern may become minor. Results of ANOVA showed that the effect of treatments was obtained only for the habitual chewers, but not the non-chewers. In other words, betel nut chewing shortened the stimulus presentation durations in all three UFOV subtests for the habitual chewers. Although the effects of betel nut chewing are constrained by its time course (an average of about 16.8 minutes; Chu, 1993), betel nut chewing indeed affects habitual chewers’ performances in the UFOV tests. It is difficult to investigate the interaction between the time course of betel nut chewing effect and the UFOV subtests by adopting the current design. However, the whole story is clear; that is, betel nut chewing can affect habitual chewers’ functional fields of views assessed by UFOV tests.

The current study has important implication for people who often chew betel nut for refreshment during long-hour working. Since betel nut chewing could improve chewer’s attentional system in general (e.g., processing speed, divided attention and selective attention in the current case), it is expected that many working errors could be prevented because of this improved attentional system. However, the betel nut chewing is only effective for the habitual chewers. For example, sleep deprivation could raise the likelihood of car accidents, mediated through the deteriorated UFOV (Clay et al., 2005; Cross et al., 2009; Leat & Lovie-Kitchin, 2006; Owsley & McGwin, 1999; Rogé et al., 2003). An overnight truck driver could chew betel nut to improve their UFOV, which could reduce the likelihood of car accidents. After chewing betel nut, this truck driver could process information ahead more quickly (processing speed), notice a fast passing car (divided attention), and ignore the distracting billboards near the road (selective attention). What causes fatigue (e.g., sleep deprivation in our case) may not be critical for obtaining betel nut chewing effect, whereas the extent of fatigue may be important. The betel nut chewing may be effective for people with some degree of fatigue, no matter what causes this fatigue. Future studies could test this hypothesis by manipulating sources that cause fatigue.

References


嚼檳榔是否會影響睡眠剝奪後的有效視域？

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檳榔在台灣內的許多亞洲國家常見的提神物品。但是，只有極少的有關檳榔嚼食的行為研究報告。本研究檢驗在睡眠剝奪下，檳榔嚼食對有效視域的影響。在剝奪一夜睡眠之後，習慣嚼食者與從未嚼食者嚼食檳榔或者口香糖，接著進行有效視域作業。在有效視域作業中，參與者需要辨認單一中央目標、同時辨別中央目標與周邊目標，以及同時辨別中央目標與在干擾物中的周邊目標。我們發現對習慣嚼食者，但非從未嚼食者，嚼食檳榔能擴大他們的有效視域。本研究對長時間工作者以嚼檳榔提神之重要意涵也在文內討論。

關鍵詞：有效視域、睡眠剝奪、檳榔