



Associations between affect, craving, and smoking in Korean smokers: An ecological momentary assessment study

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ABSTRACT

Cigarette smoking remains the largest cause of preventable death in the United States and worldwide. In South Korea and other Asian countries, a large proportion of males smoke, increasing the need to examine cigarette smoking in these populations. Research suggests that the association between positive affect and negative affect, and between affect and craving, may differ across cultures, and that it is useful to examine these associations using Ecological Momentary Assessment (EMA). South Korean smokers ($N = 20$, Mean Age = 21.15, 25% female) completed baseline questionnaires and downloaded an EMA app which prompted 4 random assessments (RAs) each day for 1-week. At each assessment, participants responded to items assessing momentary negative affect (NA) and positive affect (PA), craving, and number of cigarettes smoked since the previous EMA assessment. Linear mixed models (LMMs) were used to analyze EMA data (544 assessments), separating out between- and within- subject associations. There was a significant positive association between positive affect and negative affect at the between-subjects level. Both positive affect and negative affect were significantly positively associated with craving at between-subjects and within-subject levels. Craving was associated with subsequent smoking behavior at the within-subjects level. Overall, results suggest that associations between positive affect and negative affect may be different in South Korean smokers than in Western smokers, and that there are robust associations between both negative and positive affect and craving.

1. Introduction

Cigarette smoking remains the leading cause of preventable death in the United States and worldwide (U.S. Department of Health and Human Services, 2014). The number of smokers worldwide is increasing, and in some countries a large proportion of males continue to smoke (Stewart, 2017). Therefore, a better understanding of smoking behavior across different cultures, in both males and females, is needed to help develop tailored interventions for different populations.

South Korea is a country in which a high proportion of males continue to smoke; in 2015, the reported prevalence of males and females over age of 15 was 41.3% and 5.9%, respectively (World Health Organization, 2018). Factors contributing to the elevated prevalence of smoking in South Korean males include the low cost of cigarettes, the relative dearth of anti-smoking campaigns/legislation, social influences that encourage smoking, and military service obligations for South Korean men (Gunter, Szeto, Jeong, Suh, & Waters, 2019).

It is important to examine the psychological processes underlying smoking in South Korea male and female smokers to facilitate development of interventions. In Western countries, theory and data suggest a causal relationship between negative affect and smoking behavior. For example, in a theoretical article Baker, Piper, McCarthy, Majeskie, and Fiore (2004) argue that escape and avoidance of negative affect is the prepotent motive for addictive drug use (see also Kassel, Stroud, & Paronis, 2003). Laboratory studies have revealed that acute manipulations of negative affect increases craving to smoke (see Heckman et al., 2013 for meta-analysis), suggesting that a causal relationship between negative affect and craving can be demonstrated in the laboratory. In another meta-analysis, Heckman et al. (2015) reported that acute manipulations of negative affect also increased smoking assessed by latency to smoke and number of puffs, although the effect size was smaller less robust than that reported for craving.

However, the relationship between positive affect and craving in Western smokers is less clear (Veilleux, Conrad, & Kassel, 2013). A

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meta-analysis of cue-provoked craving studies found positive affect inductions demonstrated inconsistent effects on craving (Heckman et al., 2013). On the other hand, among continuing smokers not attempting abstinence, one study reported that positive affect was positively associated with urges (Zinser, Baker, Sherman, & Cannon, 1992). Regarding the association between craving and smoking, although some reviews have reported that the association is of relatively modest magnitude (Wray, Gass, & Tiffany, 2013), Motschman, Germeroth, and Tiffany (2018) reported that the association is stronger when craving is assessed as a proximal predictor of smoking. This finding argues for use of a methodology in which assessments are made at frequent intervals.

Ecological Momentary Assessment (EMA) is a widely used methodology in both smoking (Ferguson & Shiffman, 2011) and emotion research (e.g., Scollon, Diener, Oishi, & Biswas-Diener, 2005) which involves collection of data in the participant's natural environment (Shiffman, Stone, & Hufford, 2008), and yields detailed datasets with relatively high external validity. Contemporary EMA studies typically requires participants to make responses on mobile devices such as smartphones, and provides information that is complementary to data collected through passive monitoring (e.g., Dagum, 2018). Importantly, EMA enables the separation between- and within-subject associations. That is, analysis of EMA data can address the following two questions: 1) Do individuals who report generally higher levels of negative affect report generally higher levels of positive affect (or craving)? (a between-subject association), and 2) When individuals report higher levels of negative affect than is typical, do they report higher levels of positive affect (or craving)? (a within-subject association).

Consistent with data from laboratory studies, many EMA studies conducted with Western smokers have reported a robust association between negative affect and craving (e.g., Bold, Witkiewitz, & McCarthy, 2016; Serre, Fatseas, Swendsen, & Auriacombe, 2015; Shiyko, Naab, Shiffman, & Li, 2014). However, we are aware of only one EMA study of Western smokers that has demonstrated a positive association between positive affect and craving (Dunbar, Scharf, Kirchner, & Shiffman, 2010; see also Bujarski et al., 2015). Note, however, that data from Bold et al. (2016) suggest that the association between positive affect and craving may differ across phases of smoking cessation in individuals attempting to quit.

Although the current study is not a cross-cultural comparison study (i.e., only South Korean smokers are assessed), it is important to consider how associations between negative affect, positive affect, craving and smoking might be expected to differ in a South Korean population. Particularly relevant for the current study, Scollon et al. (2005) assessed mood of several populations using EMA. Across cultures, individuals tended to report emotions similarly at the within-subjects level. That is, when participants reported more negative affect they reported less positive affect. Between-subjects analyses, however, demonstrated that aggregated over time, the relationship between positive and negative emotions differs across cultures. Specifically, relative to European Americans, the relationship between positive and negative emotions was relatively more positive among American participants of Asian descent.

Moreover, most EMA studies have been conducted in North America or Europe. Therefore, it is not known whether EMA methodology will provide valid results in other cultures. Shiffman et al. (2008) noted that EMA "may be useful in a wide array of patient populations, [but] investigators should not make decisions about feasibility without testing their assumptions". Therefore, we also evaluated feasibility in this study, as assessed by compliance on study assessments. A recent review reported that no EMA studies of smoking have been conducted in Korea (Gunter et al., 2019). However, in an EMA study using a sample of Chinese smokers, Yuan et al. (2018) recently reported a positive association between positive affect and craving and between negative affect and craving.

In sum, few studies have examined the relationships linking affect, craving, and smoking in a Korean (or East Asian) population, and none

have done so using EMA. The study aims were as follows. The first aim was to examine the association between positive affect and negative affect in a sample of South Korean smokers. Based on prior data and theory (Scollon et al., 2005), we hypothesized that positive and negative affect would be positively associated at the between-subjects level (i.e., individuals who report generally higher levels of negative affect would report generally higher levels of positive affect), but negatively associated at the within-subjects level (i.e., when individuals report higher levels of negative affect than usual they would report lower levels of positive affect). The second aim was to examine the association between negative affect/positive affect and craving. Based on prior data (Yuan et al., 2018) and theory, we hypothesized that negative affect/positive affect and craving would be positively associated at the between-subjects level and at the within-subjects level. The third aim was to examine the association between craving and smoking. Based on prior data and theory, we hypothesized that craving and smoking would be positively associated at the between-subjects level and at the within-subjects level.

2. Methods

2.1. Participants

Participants ($N = 20$) were recruited in Seoul, South Korea using fliers and email listservs in the local community, and other electronic communications. Participants were non-treatment-seeking male and female Korean smokers. The inclusion criteria were: 1) self-reported smoking at least six cigarettes per day; 2) expired breath carbon monoxide (CO) level of at least 8 parts per million (ppm); 3) ability to read at a 6th grade level in Korean; and 4) aged 18–64. The exclusion criteria were: 1) inability to use study software; 2) use of non-cigarette tobacco products; 3) recent use of tobacco cessation products (past seven days) and/or treatment for smoking cessation (past 90 days). The study was approved by the Institutional Review Boards of the Uniformed Services University of the Health Sciences in the United States and Sungshin Women's University in Seoul, Korea.

2.2. Procedure

After an initial telephone screening participants were invited to an in-person visit (Lab Visit 1) based on the inclusion/exclusion criteria. During Lab Visit 1, a detailed description of the study was provided. Assessment of expired breath carbon monoxide (CO) was completed. Written informed consent was obtained (for eligible participants). Participants completed several questionnaires as summarized in Table S1 and trained on completing the EMA assessment. Participants were asked to smoke as usual during the study. In total, 44 participants were screened over the phone of whom 35 were eligible. From those 35, 23 participants attended Lab Visit 1 of whom 2 were ineligible due to CO level ≤ 7 ppm (these two participants received compensation 10,000 KRW for attending the orientation visit).

Of the 21 participants who signed the informed consent form, 1 did not download the app and did not complete the study. The remaining 20 participants completed the EMA study and attended the second laboratory visit (Lab Visit 2; Fig. S1). Following Lab Visit 1 (Day 1), eligible participants used their own smartphone to complete assessments throughout the next 7-days.

Software from Metricwire mobile diary software was used for EMA (<https://metricwire.com/>). The app prompted the participant up to four random times (RA = random assessment) daily during subject-specified waking hours. Participants identified their "wake-up" and "bed" times on the mobile device. Based on these times, the program divided the waking hours into four approximately equal epochs, and one RA was scheduled in each epoch (median response time to initiate an RA = 7.4 mins). If the subject did not respond to an RA, it timed out, forfeiting the chance to contribute data. Participants had the opportunity to

complete “make-up” assessments in the event they missed an RA by initiating an assessment; however, they were not compensated for make-up assessments.

At Lab Visit 2 (i.e., Day 8), participants completed an author constructed questionnaire assessing perceptions of the study. They were then debriefed and given an opportunity to ask questions. Participants were compensated for their time. They received 10,000 South Korean Won (KRW) (~\$8.24) for each laboratory study visit, 2500 KRW for each day they contributed data to the study, and 2000 KRW for each assessment they completed on the mobile device. Compensation was not provided in cases of missed assessment(s) or for “make-up” assessments (described later).

2.3. Lab and phone measures

2.3.1. Biochemical measure

Carbon monoxide (CO) was assessed using the Bedfont smokelyzer system. Expired CO in breath provides an index of recent smoking (SRNT Subcommittee on Biochemical Verification, 2002). Light smokers typically score 8+ ppm on this test, whereas heavier smokers usually score > 10 ppm.

2.3.2. Demographics

Questions included items on age, gender, and marital status. Participants were also asked to provide their usual wake-time and bed-time.

2.3.3. Smoking

A single item assessed the current number of cigarettes smoked per day.

2.3.4. Questionnaire for Nicotine dependence (Korean Version)

The Fagerstrom Test for Nicotine Dependence (Korean Version; FTND-K) is a 6-item dependence measure (Ahn et al., 2002). Higher scores (0–10 scale) reflect greater dependence. Ahn et al. (2002) reported that the test-retest reliability coefficient was $r = 0.88$ and the correlation between FTND-K scores and expired breath carbon monoxide (CO) was $r = 0.56$. To the authors' knowledge, this is the only cross-cultural validation of the FTND with a largely non-clinical sample, which Ahn et al. (2002) validated along with the Fagerstrom Tolerance Questionnaire (Korean Version; FTQ-K) which has two additional items. Both FTND-K and FTQ-K yielded similar psychometric properties, and the FTND-K was selected to reduce participant burden.

2.3.5. Tobacco craving questionnaire – Short form (TCQ-SF)

The TCQ-SF is a 12-item self-report instrument that assesses tobacco craving, as described by four dimensions (emotionality, expectancy, compulsivity, purposefulness) and a total score (Heishman, Singleton, & Pickworth, 2008). Each item is rated on a Likert scale from 1 (strongly disagree) to 7 (strongly agree). In the current study, Cronbach's alpha (total score) was $\alpha = 0.85$. The TCQ-SF (12 items) was favored over TCQ (47 items) due to lower burden. To the authors' knowledge, TCQ-SF has not been validated in Korean, and the assessment was translated and back-translated by study staff.

2.3.6. International positive affect and negative affect schedule - short form

The I-PANAS-SF was used to assess two broad domains of affect - positive affect (PA) and negative affect (NA). I-PANAS-SF is a 10-item cross-culturally validated version of the PANAS. Across 20 cultures (including two in East Asia), items were shown to be interpreted similarly regardless cultural backgrounds (Karim, Weisz, & Rehman, 2011; Thompson, 2007). Individuals rated the extent to which they have experienced each particular emotion within a specified time period; in this study, “right now” was used. Each item is scored on a 5-point Likert scale, ranging from 1 “very slightly or not at all” to 5 “very much”. In the current study, the reliabilities were $\alpha = 0.55$ (NA scale)

and $\alpha = 0.74$ (PA scale).

2.3.7. Perceived stress scale (K-PSS)

The PSS is a measure of one's appraisal of life demands in relation to one's perceived coping ability. The Korean Version of the PSS (K-PSS) scale used has 14 items (rated on a 5-point scale from 0 = Never to 4 = Very Often). Studies have reported that Cronbach's alpha for the K-PSS was 0.75 and 0.82, respectively, and the test-retest reliability coefficient was 0.80 and 0.66 respectively (Lee et al., 2012; Lee, Chung, Suh, & Jung, 2015).

2.4. EMA assessments

2.4.1. International positive affect and negative affect schedule - short form

The 10-item I-PANAS-SF was used, which is psychometrically sound (Mackinnon et al., 1999; Thompson, 2007) and has been used for EMA studies (e.g., Szeto, Schoenmakers, van de Mheen, Snelleman, & Waters, 2019). In the current study, Cronbach's alphas for Positive Affect (Alert, Inspired, Determined, Attentive, Active; 0–4 scale for all items) and Negative Affect (Upset, Hostile, Ashamed, Nervous, Afraid; 0–4 scale for all items) were 0.88 and 0.85 respectively, supporting the reliability of the 10-item I-PANAS-SF in EMA.

2.4.2. Craving

Craving was assessed using 1 item (“How much do you want to smoke at this moment?”; 0–6 scale; 0 = “Not at All”, 6 = “Very Strongly”).

2.4.3. Smoking

Smoking was assessed using the following item: “Since the last assessment, how many cigarettes have you smoked?” (Response options: any number).

2.5. Analytic plan

Linear mixed models (LMM) were used for the primary analyses using SAS PROC MIXED (SAS Institute Inc., 2020). LMMs are a standard method of analyzing EMA data (Bolger & Laurenceau, 2013). LMM analyses can deal with the dependence between observations due to clustering of data by participants. LMMs also permit different numbers of observations across participants. For all models, a random (subject-specific) intercept and an autoregressive model of order 1 for the residuals within subjects was used. The random intercept takes into account clustering of data by subjects, i.e., that data from an individual subject tends to be more similar to other data from that subject than data from different subjects. The autoregressive model of order 1 for the residuals takes into account temporal sequencing within a subject, i.e., that residuals from adjacent assessments in a given subject are more likely to be similar in magnitude than residuals from two assessments further apart in time. Day in study (numeric variable) was included as a covariate in all models; for analysis of intensive longitudinal data, Bolger and Laurenceau (2013, p. 71) have recommended including a measure of time in study as a covariate. All analyses used the Satterthwaite option for the denominator degrees of freedom ($df =$ Satterthwaite in SAS PROC MIXED).

An advantage of LMMs is their ability to separate out between- and within-subject associations (Bolger & Laurenceau, 2013; Hedeker & Gibbons, 2006), which is important in the current study. In Aim 1, the dependent variable was Positive Affect, and the primary independent variable was Negative Affect. Note that Negative Affect and Positive Affect may be associated in two ways: 1) Individuals who report generally high levels of Negative Affect report generally higher Positive Affect ratings (a between-subject association), and/or 2) Individuals report higher Positive Affect ratings when they report more Negative Affect than usual (a within-subject association). Following usual practice, a model was run that includes subjects' mean Negative Affect

(Mean Negative Affect) as well as a difference score between the observed Negative Affect score at each assessment and the (subject-specific) Mean Negative Affect score (Deviation Negative Affect). A significant coefficient for Mean Negative Affect would indicate a between-subject association. That is, individuals who report generally more Negative Affect generally report higher (or lower) Positive Affect ratings during EMA. A significant coefficient for Deviation Negative Affect would reveal a within-subject association. That is, when individuals report more Negative Affect than their subject-specific average they report higher (or lower) Positive Affect ratings. Coefficients for level 1 variables (including Deviation scores) were treated as fixed in analyses.

The above analysis treats Positive Affect as the dependent variable and Mean Negative Affect and Deviation Negative Affect as the independent variables. Assignment of variables into independent and dependent variables was arbitrary. The analyses were therefore re-computed using Negative Affect as the dependent variable and Mean Positive Affect and Deviation Positive Affect as the independent variables.

The same methods, i.e. use of Mean and Deviation scores, were used to separate between- and within-subject associations for Aims 2 and 3.

Whereas analyses for Aims 1 and 2 were “contemporaneous” (e.g., analyses examined whether Deviation Negative Affect ratings at Assessment *t* were associated with Craving at Assessment *t*), for Aim 3 the data were lagged such that Deviation Craving ratings at Assessment *t* predicted Smoking before the next assessment, Assessment *t*₊₁. These analyses were subset to assessments occurring on the same day as the preceding assessment. Time since last assessment was also included as a covariate in this analysis, since there would be more opportunity for smoking with greater time intervals.

For all analyses alpha was set to 0.05 (2-tailed). Given the number of analyses conducted, a false discovery rate (FDR) procedure was implemented to help identify findings (“discoveries”) likely to be more robust. Following procedures described in Howell (2012) for the Benjamini and Hochberg Linear Step Up (LSU) procedure, in all cases in which the uncorrected *p* value was significant, the LSU procedure identified the finding as a “discovery”. According to the logic of FDR correction, in the long run 95% of the discoveries identified by this procedure will be “true positives” with the remaining 5% “false positives” (Benjamini & Hochberg, 1995).

3. Results

Subjects were on average 21.2 years old (*SD* = 1.69), 50% were married, and 25% were female. Subjects reported that they smoked an average of 12.3 cigarettes per day. The mean score on the FTND-K was 4.00 (*SD* = 2.10), suggesting low to moderate dependence (see Supplementary Material, Table S1, for more detail).

Table 1
Results of LMMs for Aims 1, 2, and 3.

Aim →		1					2					3				
DVs →		PA					Craving					Smoking				
IVs ↓	Component ↓	<i>df</i>	<i>PE</i>	<i>SE</i>	<i>F</i>	<i>p</i>	<i>df</i>	<i>PE</i>	<i>SE</i>	<i>F</i>	<i>p</i>	<i>Df</i>	<i>PE</i>	<i>SE</i>	<i>F</i>	<i>p</i>
NA	Mean	1, 522	0.52	0.24	4.70	0.03	1, 522	1.06	0.36	8.57	0.004	.	.	.	.	.
	Deviation	1, 522	-0.09	0.06	2.39	0.12	1, 522	0.43	0.15	8.42	0.004	.	.	.	.	.
PA	Mean	.	.	.	.	.	1, 522	1.02	0.30	11.91	0.0006	.	.	.	.	.
	Deviation	.	.	.	.	.	1, 522	0.30	0.12	6.55	0.01	.	.	.	.	.
Craving	Mean	.	.	.	.	.	.	.	.	.	.	1, 367	0.22	0.17	1.88	0.17
	Deviation (Lagged)	.	.	.	.	.	.	.	.	.	.	1, 367	0.10	0.04	5.14	0.02

Note: Data are results for Linear Mixed Models (LMMs). *PE* = Parameter Estimate; *SE* = Standard Error; *F* = *F* value for LMM; For Aim 3. Assessment at time *t* + 1 occurs on the same day as assessment at time *t*. Analysis for Aim 3 controls of smoking at assessment *t*. NA = Negative Affect; PA = Positive Affect.

3.1. Descriptive statistics

During EMA, subjects completed 544 assessments (534 RAs and 10 participant-initiated assessments) across 155 days; 24.08% of assessments occurred before 1:00 PM, 42.65% between 1:00 PM and 7:00 PM, and 33.27% after 7:00 PM. Subject contributed data on an average of 7.75 days (*SD* = 0.44). The average duration between assessments occurring on the same day was 3.64 h (*SD* = 2.18 h). Note that 71.69% of assessments occurred on the same day as the preceding assessment, and 28.31% of assessments occurred on a different day (e.g., the preceding assessment could be presented on Monday evening and assessment occurred on Tuesday morning). The average duration between assessments occurring on different days was 14.69 h (*SD* = 5.67 h). Compliance, defined as the proportion of random assessments that were completed, was good (*M* = 94.08%, *SD* = 4.80). All 20 participants had a compliance of over 85%, and 10 participants (50% of sample) had a compliance of at least 95%.

Aggregated over EMA assessments, mean Negative Affect was 0.54 (*SD* = 0.79, Range 0–4), mean Positive Affect was 0.92 (*SD* = 0.97, Range 0–4), mean Craving was 2.10 (*SD* = 1.97, Range 0–6), and mean cigarettes smoked since the previous assessment was 2.02 (*SD* = 1.88, Range 0–10). The intraclass correlation coefficient (*ICC*) for Negative Affect, Positive Affect, Craving, and Smoking was 0.67, 0.63, 0.38, and 0.15 respectively. The *ICC* captures the proportion of variability in the dependent variable that is due to variability between-subjects. For Negative Affect, 67% of the variability in PANAS ratings is due to between subjects variability, with the remainder due to within-subjects variability.

Study Day was not significantly associated with reported number of cigarettes smoked, *Parameter Estimate (PE)* = 0.04, *SE* = 0.03, *t* = 1.21, *p* = .23, suggesting that there was no evidence participants reduced smoking over time. As expected, hours since the previous assessment, was strongly associated with reported smoking at Assessment *t*₊₁, *PE* = 0.16, *SE* = 0.03, *t* = 4.73, *p* < .001, presumably because participants have more opportunity to smoke with longer intervals.

3.2. Correlation between lab and EMA craving/smoking

Breath CO assessed at Lab Visit 1 was associated with reported number of cigarettes smoked during EMA, *PE* = 0.06, *SE* = 0.03, *t* = 2.03, *p* = .04, and reported cigarettes smoked per week at the telephone assessment was associated with reported number of cigarettes smoked during EMA, *PE* = 0.08, *SE* = 0.03, *t* = 2.48, *p* = .01, supporting the validity of the EMA item. The FTND-K score also was associated with smoking during EMA, *PE* = 0.22, *SE* = 0.08, *t* = 2.75, *p* = .006. The total score of the TCQ-12 was marginally associated with craving ratings during EMA, *PE* = 0.56, *SE* = 0.33, *t* = 1.69, *p* < .09.

3.3. Aim 1: Association between negative affect and positive affect

There was a significant positive association between Mean Negative Affect and Positive Affect. As Mean Negative Affect increased by 1 unit, the predicted value of Positive Affect increased by 0.52 units (when controlling for other variables) (Table 1, Fig. S2). Therefore, participants who reported higher average levels of Negative Affect reported generally more Positive Affect. The association between Deviation Negative Affect and Positive Affect was not significant but trended in the direction that when participants reported more Negative Affect than usual (their subject-specific average) they reported less Positive Affect.

The analysis above treats Positive Affect as the dependent variable and Mean Negative Affect and Deviation Negative Affect as independent variables. If Negative Affect is the dependent variable and Mean Positive Affect and Deviation Positive Affect are the independent variables, there was a significant effect for Mean Positive Affect, $PE = 0.39$, $SE = 0.16$, $p = .03$, and a non-significant effect for Deviation Positive Affect, $PE = -0.05$, $SE = 0.03$, $p = .11$.

3.4. Aim 2: Association between negative Affect/positive affect and craving

There was a significant association between Mean Negative Affect and Craving. Therefore, participants who reported higher average levels of Negative Affect reported generally more Craving. As Mean Negative Affect increases by 1 unit, predicted values of Craving increase by 1.06 units. There was a significant association between Deviation Negative Affect and Craving. Therefore, when participants reported higher levels of Negative Affect than usual they reported more Craving. As Deviation Negative Affect increases by 1 unit, predicted values of Craving increase by 0.43 units (Table 1, Fig. 1). There were also significant associations between Mean Positive Affect and Craving, and between Deviation Positive Affect and Craving (Table 1, Fig. 2). Therefore, participants who reported higher average levels of Positive Affect reported generally more Craving, and when participants reported

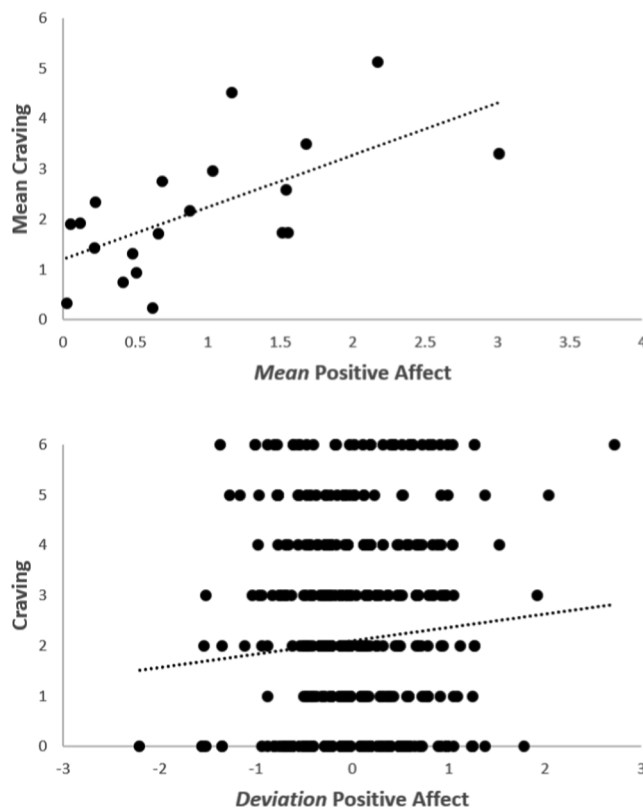


Fig. 2. Associations between positive affect and craving.

higher levels of Positive Affect than usual they reported more Craving. As Mean Positive Affect increases by 1 unit, predicted values of Craving increase by 1.02 units. As Deviation Positive Affect increases by 1 unit, predicted values of Craving increase by 0.30 units.

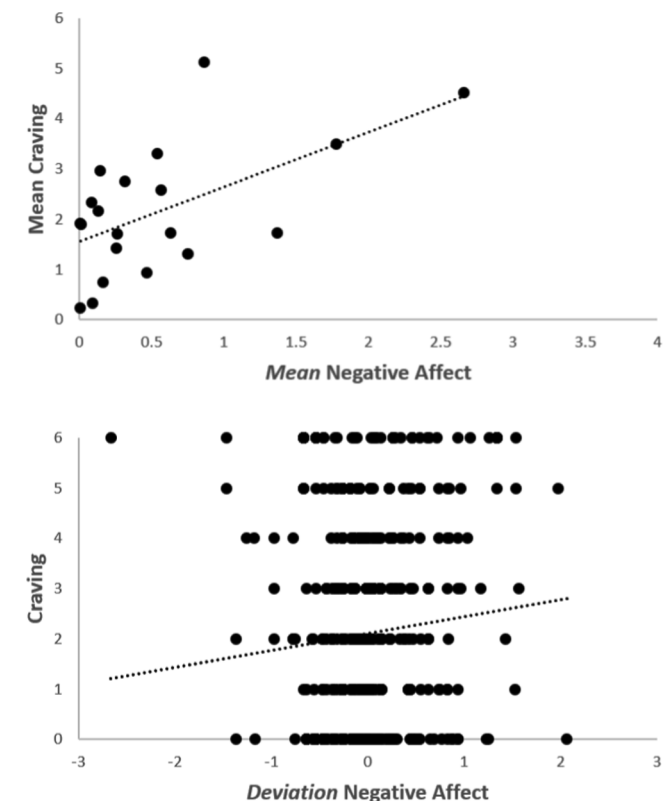


Fig. 1. Associations between negative affect and craving.

3.5. Aim 3: Association between craving and subsequent smoking

The association between Mean Craving and subsequent Smoking was not significant. However, there was a significant association between Deviation Craving and Smoking (Table 1). Therefore, when participants reported higher levels of Craving than usual they reported more Smoking before the next assessment. As Deviation Craving increases by 1 unit, predicted values of Smoking before the next cigarette increase by 0.10 units (cigarettes) (Table 1, Fig. S3).

As noted earlier, coefficients for Deviation scores were treated as fixed, given the small sample sizes. There was little evidence that treating the coefficients as random improved model fit. For Aim 1, treating the coefficients (of the Deviation Negative Affect scores) as random yielded a higher Akaike Information Criterion (AIC) (i.e., worse fit) (1048.2) than treating the coefficients as fixed (1048.1). For Aim 2, treating the coefficients of the Deviation Negative Affect score as random yielded a higher AIC (2082.1) than treating the coefficients as fixed (2079.9). Similarly, treating the coefficients of the Deviation Positive Affect score as random yielded a higher AIC (2080.1) than treating the coefficients as fixed (2079.4). For Aim 3, treating the coefficients (of the lagged Deviation score) as random yielded a higher AIC (1419.2) than treating the coefficients as fixed (1416.5). These data can justify the use of fixed coefficients for Deviation scores.

4. Discussion

The main results were as follows. First, there was a significant positive association between negative affect and positive affect at the between-subjects level. Second, both negative affect and positive affect

were significantly positively associated with craving at both between-subjects and within-subjects levels. Third, craving was associated with subsequent smoking behavior at the within-subjects level. Results from each aim are discussed in further detail below.

Mean Positive Affect and Mean Negative Affect were significantly positively associated with each other, meaning that participants who reported higher average levels of Negative Affect reported generally more Positive Affect. As discussed earlier, typically Positive Affect and Negative Affect are negatively correlated in between-subject analyses, at least in Western populations. Culture may influence the association between Positive Affect and Negative Affect such that associations are less negative (or more positive) in Asian populations than compared to Western populations. One previous EMA study found a similar result (a positive association) at a between-subject level in an Asian population (Scollon et al., 2005).

To interpret the results, one can consider the dialectical thinking of Asian culture which may influence how Asians experience and/or report affect (Peng & Nisbett, 1999). Dialecticism refers to a cognitive tendency wherein two perspectives may both contain some amount of truth, thereby necessitating some acceptance of contradiction. Therefore, dialectic philosophy does not necessarily consider opposites, such as negative affect and positive affect, as contradictory (Miyamoto & Ryff, 2011; Peng & Nisbett, 1999; Schimmack, Oishi, & Diener, 2002). For example, Schimmack et al. (2002) reported that correlations between positive and negative emotions were less negative in individuals from East Asian (vs. Western) countries.

Non-dialectical processes may also play a role. Following Scollon et al. (2005), one factor may be the presence of a more prevention-focused orientation in East Asians, meaning East Asians may be more focused on avoiding mistakes than pursuing achievement. Individuals may retrospectively experience negative emotions about a positive event due to anticipatory worry (Elliot, Chirkov, Kim, & Sheldon, 2001; Lee, Aaker, & Gardner, 2000). Therefore, positive events can elicit both positive affect, and (retrospectively) negative affect in Asian populations. Individuals who experience more positive affect (due to positive event/s) may therefore report more negative affect.

Another potential explanation is related to goal conflict. Asians may pursue a variety of important goals, which can conflict, resulting in the experience of negative as well as positive emotions (Pomerantz, Saxon, & Oishi, 2000). Therefore, individuals who experience a lot of positive affect (due to obtaining a goal) may therefore report more negative affect (due to conflict with other unmet goals). A third explanation may be that Asians who are experiencing a lot of negative feelings receive a lot of support from friends (Scollon et al., 2005) and also experience the positive emotions associated with that consolation.

Contrary to results of Scollon et al. (2005), a significant negative association was not observed between Positive Affect and Negative Affect at a within-subject level. Therefore, when a participant reported feeling more negative affect than usual, there was no evidence that he or she reported less positive affect at the same timepoint (as would be intuitively expected). It is possible that the dialectical and/or the non-dialectical explanations proposed above may account for the lack of negative association observed in the current study. However, it should be noted that the regression coefficient was negative ($PE = -0.09$, $SE = 0.06$) and tending in the expected direction, and the null association should not be over-interpreted. A significant effect may have been obtained with a larger sample; the number of assessments in Japanese participants in Scollon et al. (2005) was much larger (3158 assessments) than the number of assessments in the current study (544 assessments).

For Aim 2, the associations between negative affect and craving are consistent with those observed in Western smokers (e.g., Bold et al., 2016). Our results also indicate that positive affect was associated with craving at both levels (between and within), and the parameter estimates were of similar magnitude as those observed for negative affect (Table 1). As noted earlier, in a recent EMA study of Chinese smokers,

Yuan et al. (2018) also reported both positive affect and negative affect were associated with craving. The explanations posited earlier for accounting for the association between negative affect and positive affect may be relevant to the association between positive affect and craving. For example, goal conflict may also contribute to the robust relationship between positive affect and craving in this sample. Another possible explanation is related to the influence of smoking in social situations (Kim, Son, & Nam, 2005). If smoking is a common way to socialize with others, particularly in this population, it is possible that being amongst friends in a social setting both elicits positive affect and craving. Last, it is possible that the relationship between positive affect and craving (and between positive and negative affect) may be due to response styles. Literature suggests East Asian populations in comparison to Western populations are more likely to exhibit an acquiescent response style (ARS), the tendency to overuse the positive end of a continuous scale (Kemmelmeier, 2016; Dolnicar & Grün, 2007). However, in the current study, there was little evidence that participants overused the highest response option (e.g., endorsement of the highest response option was < 6% on each PANAS item).

For Aim 3, results indicated that individuals were more likely to report more smoking after they felt more craving than usual, which is consistent with data from Western samples (Serre et al., 2015). Additionally, although there was not a between-subjects effect, the direction of this effect was in the expected direction (i.e., craving was positively, but not significantly, associated to smoking). In light of the small sample size ($n = 20$), the lack of a significant between-subjects association may be due to a lack of power.

This study had limitations. First, and most important, the sample size was small (particularly for level 2, subjects), which reduced power (Supplementary Materials). The small number of subjects limits the generalizability of the findings of this study to the larger Korean population, and underscores the need for replication in a larger sample. The small number of females made it difficult to compare males and females. Another methodological limitation was the absence of data from a Western sample, which would have permitted stronger conclusions regarding cross-cultural differences. Moreover, in the current study, no assessments of dialecticism, prevention-focused orientation, or goal conflict were administered, and so that discussion of these constructs is speculative at this time. Regarding assessment of smoking, although expired breath carbon monoxide was assessed at the first lab visit, there was no day-to-day biological verification of smoking. The study relied on self-report of participants. Note, however, that carbon monoxide assessed at baseline did predict smoking assessed during EMA. As noted by Chen, Bai, Lee, and Jing (2016), the positive and negative affect schedule (PANAS) primarily addresses high activation Positive and Negative Affect. One could argue that there was an absence of information about affect at low levels of activation (e.g., bored, calm). For example, Lim (2016) has argued that in Eastern culture “low arousal emotions are valued more than high arousal emotions”. In addition, the reliability of Negative Affect was relatively low in the lab assessment (though it was higher in EMA). Finally, in common with all EMA studies, the data are correlational. For example, one cannot conclude that elevations in positive affect cause craving. It is possible that a third (level 1) variable causes both positive affect and craving creating a “spurious relationship”. However, “micro-randomized trials” can potentially be implemented within EMA to gain stronger evidence for causal relationships and to facilitate development of just-in-time interventions (Klasnja et al., 2015).

This study had strengths. To our knowledge, this was the first EMA study of smoking (or addiction) using a South Korean sample. Given the compliance of respondents, this study suggests that future EMA (or Ecological Momentary Intervention) studies in this population may be useful (Gunter et al., 2019). Future studies using larger samples can examine factors that influence the relationship between affect and craving (e.g., social context, alcohol consumption). The use of lagged predictor variables can help to clarify the direction of associations

between negative affect and craving, and between positive affect and craving. In addition, future studies could examine individual differences in smoking patterns that may influence this association. Specifically, some smokers may tend to smoke more when they experience positive affect (“positive affect smoker”), while others smoke more when they experience negative affect (“negative affect smoker”). It would also be useful to examine the associations between affect and smoking using multilevel mediation analyses (Preacher, Zyphur, & Zhang, 2010). Finally, assessments may specifically ask about dialecticism, prevention-focused orientation, goal conflict, or other factors previously discussed to determine the extent to which these variables underlie the association between positive and negative affect.

5. Contributors

RG and ES contributed equally to this manuscript. ES and AW conceived the idea of the study. AS, ES, and YK assisted with study implementation. RG and ES completed the literature review. RG and AW completed the data analysis. RG wrote the first draft of the manuscript. AW, SJ, AS, ES and YK reviewed the draft and made amendments.

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Author Statement

Rebekah Gunter and Edwin Szeto: Contributed equally to this manuscript. **Edwin Szeto and Andrew Waters:** Conceptualization, Funding Acquisition, Data Curation. **Edwin Szeto:** Validation, Software. **Edwin Szeto, Sooyeon Suh, Andrew Waters:** Resources. **Sooyeon Suh, Edwin Szeto, and Yoonji Kim:** Investigation. **Rebekah Gunter and Andrew Waters:** Formal Analysis. **Rebekah Gunter, Edwin Szeto:** Writing – Original Draft. **Andrew Waters, Se-Hoon Jeong, Sooyeon Suh, Edwin Szeto and Yoonji Kim:** Writing – Review & Editing. **Andrew Waters, Sooyeon Suh, Edwin Szeto:** Supervision and Project Administration.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary material

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.abrep.2020.100301>.

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