ORIGINAL INVESTIGATION

Hostility and Cigarette Use: A Comparison Between Smokers and Nonsmokers in a Matched Sample of Adolescents

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ABSTRACT

Introduction: We examined the association between hostility—a personality trait reflective of negativity and cynicism toward others—and smoking in adolescents by measuring (a) several subcomponents of hostility, and (b) facial emotion processing ability, which has been previously linked to hostility.

Methods: Participants ($N = 241$ aged 14–19) were 95 smokers and 95 demographically matched nonsmokers as well as 51 non-matched smokers. All participants completed the Cook–Medley (C-M) hostility scale, which provides a general hostility score and 3 component scores (cynicism, hypersensitivity, and aggressive responding), and a facial emotion processing task. This task, designed to assess emotion recognition, requires quickly identifying the emotion of faces that gradually morph from neutral to high-intensity happy, angry, or fearful.

Results: Independent sample t tests indicated that matched smokers scored significantly higher in cynicism and aggressive responding than nonsmokers. Among smokers, age of smoking onset was negatively correlated with general hostility and aggressive responding. All hostility scales were positively correlated with the intensity needed to recognize happy faces. Counterintuitively, smokers required a greater intensity to recognize angry faces than nonsmokers. No other relations between hostility/smoking status and facial emotion processing were observed.

Conclusions: Aspects of hostility, particularly aggressive responding, may be a risk factor for early onset smoking. Although hostile participants exhibited a deficiency in their ability to recognize happiness in facial pictures, these results did not translate to differences in smoking status. This study elucidates some of the complex interrelations between hostility, emotion processing, and adolescent smoking, which may have implications for teen smoking prevention.

INTRODUCTION

Although adolescent smoking has declined since the mid 1990s, prevalence has leveled off and remains unacceptably high with 18% of U.S. 8th graders and 30% of 10th graders reporting lifetime cigarette use (Johnston, O'Malley, Bachman, & Schulenberg, 2012). Smoking during these ages is especially concerning because one-third to half of adolescents who try cigarettes become regular smokers shortly after experimentation (Kessler, 1995), while 88% of daily smokers in their 30s began smoking by the age of 18 (U.S. Department of Health and Human Services, 2012). Since adolescent smoking is a risk factor for heavy use later on, and smokers experience rates of mortality nearly three times those of nonsmokers (Jha et al.,

2013), understanding tobacco use during these formative years carries major public health implications.

A range of psychosocial characteristics are associated with cigarette smoking initiation (Tyas & Pederson, 1998) and progression over time (Chassin, Presson, Pitts, & Sherman, 2000). One psychological factor that appears to convey risk for smoking is hostility (Bunde & Suls, 2006), a broad personality trait (cf., Robinson, Brower, & Gombert, 2001) with affective, cognitive, and behavioral components marked by negativity and cynicism toward others (Miller, Smith, Turner, Gujjarro, & Hallet, 1996).

Across diverse samples, cross-sectional studies have shown that hostile adolescents are at an elevated risk of lifetime cigarette use (Weiss et al., 2005, 2008) and report smoking more

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cigarettes than those who score lower on hostility (Schwinn, Schinke, & Trent, 2010) (for exceptions, see Piko & Gibbons, 2008; Piko, Luszczynska, Gibbons, & Teközel, 2005). Prospectively, higher baseline hostility predicts smoking several years later (Gruder et al., 2013; Hampson, Tildesley, Andrews, Luyckx, & Mroczek, 2010; Weiss et al., 2005; Weiss, Mouttapa, Cen, Johnson, & Unger, 2011) while increases in hostility over time are positively related to an increase in cigarette use (Hampson et al., 2010; Weiss et al., 2005) and reduced likelihood of abstaining (Gruder et al., 2013). While these studies are informative, they rely exclusively on survey measures of hostility. Moreover, the surveys used (namely, the Buss–Durkee Hostility Inventory) are general measures of a broad hostility construct, which precludes the ability to conduct more fine-grained analyses of the most relevant hostility components.

The hostility–smoking link is consistent with negative reinforcement models of smoking, which hold that people often smoke to cope with or regulate negative affect (Baker, Brandon, & Chassin, 2004; Brandon, Herzog, Irvin, & Gwaltney, 2004; Eissenberg, 2004), including during the early stages of use (Bidwell et al., 2013; Colby et al., 2010; Leventhal & Cleary, 1980). Across two laboratory studies, Jamner, Shapiro, & Jarvik (1999) observed that self-reported anger among smokers high in trait hostility was reduced by almost half when exposed to a nicotine, versus placebo, patch. Thus, hostile adolescents may be particularly prone to cigarette smoking, especially during heightened aggression or anger.

Facial Emotion Processing and Hostility

Although extant research supports a hostility–smoking relation among adolescents, the mechanisms underlying this association have received less attention (although, in one study, Hampson et al., 2010, hypothesize that peer influences may be a mediator). Among adults, however, a cognitive processing sensitivity in high-hostile individuals has been identified which could prove useful for research examining the link between hostility and smoking. Specifically, high-hostile individuals seem especially likely to interpret facial expressions as aggressive. This facial emotion processing sensitivity may result in hostile individuals viewing their own environment as especially threatening (Kahler et al., 2012), further exacerbating hostile attitudes and possibly creating a proximal risk for smoking. Past research with emotion processing tasks have shown that psychopathy is negatively related to the successful recognition of disgust (Acharya & Dolan, 2012) and sadness (Blair, Colledge, Murray, & Mitchell, 2001). Also, among adult smokers using 10 or more cigarettes per day, those with high scores on the Cook–Medley Hostility inventory required a more expressive face to successfully recognize happiness (Kahler et al., 2012). If the tendency to hyperperceive faces as being threatening represents a core psychological process that underlies hostile attitudes and behavior, it could be important in explaining the relation between self-reported hostility and smoking. Some research, in addition to the Kahler et al. study described above, also supports a trend for hostile participants to exhibit sensitivities on emotion recognition. When asked to judge angry, happy, and neutral faces on a scale from very hostile to very friendly, participants who scored higher on baseline hostility rated faces as more hostile across all emotions (Knyazev, Bocharov, Slobodskaya, & Ryabichenko,

2008; Knyazev, Bocharov, & Slobodskoj-Plusin, 2009). This trend, however, was limited to female participants in one study (Knyazev et al., 2009), and to female faces in the other (Knyazev et al., 2008). Similarly, Larkin, Martin, & McClain (2002) found that hostility was positively associated with misidentifying disgust as anger, while Leventhal & Kahler (2010) observed that high-hostile participants made fewer errors in identifying the gender of angry versus neutral faces compared to those low on hostility, suggesting that angry faces may be less surprising and distracting to high-hostile individuals.

To summarize, hostile individuals tend to perceive faces as overly threatening. Although research has shown that people with alcohol dependence (Townshend & Duka, 2003) and users of illicit drugs (Kemmis, Hall, Kingston, & Morgan, 2007; Kim, Kwon, & Chang, 2011; Martin et al., 2006) also have a facial processing sensitivity, the literature is generally lacking with respect to whether tobacco users process emotions differently from nontobacco users, in spite of the hostility–smoking link described above. In one notable exception, Ernst and colleagues (2010) had 77 12- to 14-year-olds (all nonsmokers at baseline) categorize photographs of happy, sad, angry, or fearful faces. Three and a half years later, when comparing those who had become smokers to those who remained nonsmokers on baseline facial processing, results indicated that smokers had made fewer errors in categorizing angry faces (suggesting hyperaccuracy in identifying anger) compared to participants who remained nonsmokers. No self-report personality assessments were given.

Present Study

In the present study, we sought to further examine the hostility–adolescent smoking relation and extend the existing literature in two ways. First, we tested this association with a self-report hostility questionnaire and a facial emotion processing task assessing aspects of emotion processing ability which may act as a mechanism for the relation between hostility and smoking. To our knowledge, no other study has utilized both types of measures. Second, we examined the nature of the hostility–smoking relation with more specificity than has been done previously. The self-report questionnaire used here (Cook–Medley [C-M] scale) provides both a general hostility score and three hostility subscales (cynicism, hypersensitivity, and aggressive responding; social avoidance was dropped due to poor reliability).

Adolescent smokers and nonsmokers, closely matched on demographic factors, completed questionnaires that examined hostility and lifetime cigarette use as well as a computerized facial emotion processing task. We hypothesized that scores on the C-M scales will be higher in smokers compared to nonsmokers and sought to test whether this was restricted to certain C-M components. Regarding the facial emotion processing task, we expected (a) hostility, as measured by the C-M, and (b) smoking status (0 = nonsmoker, 1 = smoker), to be positively correlated with the intensity required to recognize a happy face, and negatively related to the intensity required to recognize an angry face. We had no specific assumptions for the fear. These latter hypotheses are based on the premise that participants high on hostility, which likely are over-represented among smokers, will be sensitive to recognizing angry faces, but have difficulty perceiving happy faces, since the research summarized above suggests that people are better

able to recognize emotion in others that are typically congruent with one's own affect. Finally, we explored whether hostility is related to the age of smoking onset, although no *a priori* hypothesis was established due to a lack of research.

METHODS

Eligibility and Recruitment

The current investigation is a secondary analysis of a broader study conducted in 2003–2005 comparing adolescent smokers to nonsmokers on a variety of psychosocial characteristics and availability of reinforcers in the natural environment. To methodologically control for potential confounds in these comparisons, nonsmoker participants were recruited to match enrolled smoker participants. Matched participants were equivalent on: gender; grade (within 1 year); a proxy of socioeconomic status (eligible for free or reduced price lunch vs. full pay lunch); race (non-Hispanic White vs. Other); and school type (private parochial, private non-parochial, Rhode Island [RI] public school, Massachusetts [MA] public school). RI public school students were further matched on performance rating of school (high performing, moderately performing, or needs improvement, based on statewide testing). MA public school students were matched within specific schools. Additional (unmatched) adolescents were recruited from the same settings, although the present study excludes unmatched nonsmokers ($n = 22$). However, we include unmatched smokers to achieve greater statistical power for analyses among smokers only.

Participants were recruited in the community through newspaper advertisements and in RI and MA schools via posted flyers and informational tables set up in school cafeterias. Study participation involved completing two 90-min after-school sessions 1 week apart. Sessions took place, based on participants' preference, at school, a community location such as a library, or at Brown University research offices (transportation was provided if needed). Participants received \$25 for completing each of the two sessions. Written informed consent was obtained from parents of minors and participants over 18, while all participants 17 and under gave assent prior to research

participation. All procedures were approved by the Brown University Institutional Review Board.

To be eligible, individuals had to be between the ages of 14 and 19 inclusive and currently attending high school. Nonsmokers were defined as those who reported: never smoking a whole cigarette, not smoking at all (even a puff) in the past year, and not using other forms of tobacco or nicotine in the past 30 days. Smokers were defined as those who reported: smoking tobacco in the past 14 days, and not using other forms of tobacco or nicotine on more than 4 days in the past 30 days. For a more detailed description of participants, see [Table 1](#).

Participants and Procedure

The study was described as an investigation of teens' decisions about daily activities and health behaviors; assessments covered a broad range of topics, including smoking patterns and expectancies, personality, and quality of life. For brevity, only the assessments analyzed for the current study are described below. Of these, all except the morphing task and the Smoking History and Patterns Questionnaire (SHPQ) were completed during session 1.

Three different analytic samples were used depending on the analysis. When comparing smokers to nonsmokers, we used the matched sample ($n = 190$; 95 smokers and 95 nonsmokers). For analyses on smokers only, the 95 matched participants were included, plus 51 unmatched smokers, yielding a total sample of $n = 146$. Finally, the entire sample of $n = 241$ was used for analyses of hostility measures that were independent of smoking status.

Materials

Demographics. A demographics questionnaire assessed participant's age, sex, grade, race, and ethnicity.

Timeline followback (TLFB). The TLFB is a calendar-assisted interview initially developed by [Sobell & Sobell \(1992\)](#) for obtaining valid estimates of daily alcohol use; subsequent research has validated the procedure for obtaining daily smoking data ([Harris et al., 2009](#); [Lewis-Esquerre et al., 2005](#)). Average number of cigarettes per day was based on report of the prior 14 days.

Table 1. Descriptive Characteristics in Matched and Nonmatched Sample

Variable	Matched		Nonmatched
	Smoker ^{a,b}	Nonsmoker ^a	Smoker ^b
Demographics			
Percent female	50.5	51.6	39.2
Age	16.43 (1.25)	16.16 (1.21)	16.65 (1.10)
Current grade	10.84 (1.03)	10.78 (1.06)	10.98 (0.96)
Percent White	86.3	84.2	80.4
Cigarette use			
Cigarettes per day ^c	5.54 (5.09)	—	6.56 (6.07)
FTQ dependence	3.87 (1.80)	—	4.00 (2.11)
Percent daily smoker	82.5	—	95.7
Sample size	95	95	51

Note. FTQ = Fagerstrom Tolerance Questionnaire. Means and *SD* are represented, unless otherwise noted. *T* tests and χ^2 tests between matched smokers and nonsmokers revealed no significant difference for any variable, except number of cigarettes.

^aUsed for all analyses comparing smokers to nonsmokers.

^bUsed for all analyses among smokers only.

^cMore than 14 days.

SHPQ. This survey was designed by Colby and colleagues (2005) to assess smoking history and is used in the current study to determine age of smoking onset. Specific questions include: age of first puff, age of first whole cigarette, and age of daily smoking onset (if applicable).

Modified Fagerstrom Tolerance Questionnaire (mFTQ). A 7-item version of the FTQ (Fagerstrom, 1978; $\alpha = 0.72$) was used as a measure of nicotine dependence. The mFTQ was adapted by Prokhorov and colleagues (Prokhorov, Pallonen, Fava, Ding, & Niaura, 1994) as a psychometrically superior version to the original questionnaire among adolescents.

C-M. The C-M scale is a 50-item true-false questionnaire derived from the Minnesota Multiphasic Personality Inventory 2 (MMPI-2; Butcher, Dahlstrom, Graham, Tellegen, & Kreamer, 1989; Cook & Medley, 1954; Han, Weed, Calhoun, & Butcher, 1995), with higher scores indicative of greater hostility. We used a slightly adapted version of this questionnaire, which edited four items, and replaced another two, to simplify wording and ensure age appropriateness. (L. D. Jamner, personal communication, July 14, 2004). Details can be obtained by contacting the corresponding author. The C-M scale has good test-retest reliability up to several years and is associated with other hostility surveys (Smith, 1992).

A general hostility factor was scored based on the 17 items (e.g., "I tend to be on guard with people who are somewhat more friendly than I expected") identified by Strong and colleagues (2005) as forming a reliable, unidimensional measure of the construct (Cronbach's $\alpha = 0.78$; Strong, Kahler, Greene, & Schinka, 2005). They showed that this shortened scale is strongly related to the full survey ($r > 0.90$) and accounts for 74% of the total variance. We were also interested in examining specific dimensions of hostility. Although several factor structures for the C-M have been proposed (Barefoot, Dodge, Peterson, Dahlstrom, & Williams, 1989; Contrada & Jussi, 1992; Costa, Zonderman, McCrae, & Williams, 1986; Steinberg & Jorgensen, 1996), we calculated subscales reflecting cynicism (18 items; e.g., "Most people make friends because friends are likely to be useful to them"), hypersensitivity (15 items; e.g., "Someone has it in for me"), aggressive responding (nine items; e.g., "When people do me a wrong, I feel I should pay them back if I can, just for the principle of the thing."), and social avoidance (six items; e.g., "I am likely not to speak to people until they speak to me) in line with Han and colleagues (1995) who had determined the factor structure using a large, diverse sample (Han et al., 1995). The social avoidance factor, however, was dropped due to poor reliability ($\alpha = 0.40$). Reliability for the other subscales were acceptable (cynicism: $\alpha = 0.76$; hypersensitivity: $\alpha = 0.70$; aggressive responding: $\alpha = 0.66$).

Morphing task. This is an emotion recognition task taken from Kahler and colleagues (2012), which is on prior work (Blair et al., 2001; Coupland et al., 2004). Using Morph Man software, participants were presented with a series of faces taken from six male and six female models in the Pictures of Facial Affect (Ekman & Friesen, 1976). At first, each face was neutral, and it gradually morphed to be highly expressive in 40 increments of 0.5 s each, such that the maximum time from the beginning to the end of each trial was 20 s. Five different faces were used for each of three different emotions: happiness ($\alpha = 0.74$), anger ($\alpha = 0.63$), and fear ($\alpha = 0.72$). Sadness was originally included, but is not used in these analyses because of unacceptable reliability ($\alpha = 0.44$). The order of faces was randomly predetermined, with no emotion

shown more than twice in a row. Participants were asked to classify the emotion by pressing one of four labels as soon as a determination could be made, although participants were allowed to change their reply as the face continued to morph. Each trial was scored as the intensity required to successfully recognize the emotion, with potential scores ranging from 2.5% (correct determination made with a very neutral expression) to 100% (correct determination made with a very intense expression). Each additional increment (out of 40 total) resulted in a 2.5% increase in the intensity score. Four practice rounds were given prior to the 15 trials used in these analyses.

Data Scoring and Cleaning

Morphing task. As done by Kolassa, Kolassa, Musial, & Miltner (2007), we deleted any response (0.2% of total) that occurred in less than 200 ms, since this likely indicates a lack of effort. Consistent with previous research (Blair et al., 2001; Kolassa et al., 2007; Leventhal & Kahler, 2010; Leventhal et al., 2012), all incorrect replies (8.7% of total) on the morphing task were excluded (we also reran analyses in which incorrect replies were recoded to 102.5%, representing one unit higher than the maximum intensity score of 100%. Results did not vary substantially and reliabilities for each emotion were generally superior using the former approach). Next, we generated a mean intensity score for each emotion (averaged across all five faces). Higher scores reflected that participants needed a more intense face to recognize the emotion.

Distributions. Normality was examined for all variables. Total number of cigarettes was positively skewed, so we brought in one outlier to one unit greater than the next highest score. After this adjustment, skewness and kurtosis fell within an acceptable range. No other transformations were needed.

Data Analysis

Using t tests and χ^2 tests, smokers and nonsmokers were first compared on key demographic characteristics to ensure there were no significant differences. Then we used correlation analyses (Pearson's r) to investigate whether hostility was related to demographic variables and intensity scores for each of the four emotions. Next, matched smokers and nonsmokers were compared on self-reported hostility and emotion intensities with a series of t tests. Among smokers only, zero-order correlations were used to examine whether age of smoking onset and current smoking rate were related to hostility. All analyses were conducted with SPSS version 21.

RESULTS

Demographics and Correlations

As expected, matched smokers ($n = 95$) and matched nonsmokers ($n = 95$) were similar on all demographic information, $ps > .1$. Similarly, there were no significant differences between matched smokers ($n = 95$) and nonmatched smokers ($n = 51$), $ps > .10$, despite those in the nonmatched group reporting an average of 1.02 more cigarettes per day. See Table 1 for more information.

Among all participants ($N = 241$), demographic characteristics (gender, age, and race) were mostly unrelated to hostility,

although aggressive responding was correlated with being male and being a racial minority. The general hostility measure was highly correlated with all subscales ($r_s > 0.55$), suggesting that it appropriately captures the full construct. Correlations between cynicism, hypersensitivity, and aggressive responding were high, $r_s \geq 0.50$. Table 2 depicts these in detail.

Morphing Task

Consistent with our expectations, the self-reported hostility indices (i.e., general hostility, cynicism, hypersensitivity, and aggressive responding) were positively related to happiness intensity, respectively, indicating that adolescents who scored higher on general and more specific facets of hostility required a more intense expression to correctly recognize happy emotion in faces. The only other significant finding was a positive relation between fear intensity and general hostility, see Table 2 for more information. Correlations between hostility and emotion intensities broken down by smoking status are given in Supplementary Tables 1 and 2.

Smoker–Nonsmoker Comparisons

Results indicate that matched smokers were higher on all hostility scales than matched nonsmokers, and this reached statistical significance for cynicism and aggressive responding (Table 3). Although matched smokers and nonsmokers did not significantly differ on the intensity of emotion required to identify happiness in facial expressions, the relationship was in the hypothesized direction. However, counter to our expectations, matched smokers were significantly slower than matched nonsmokers to recognize angry facial expressions.

Smoker-Only Analyses

As shown in Table 4, hostility, and in particular aggressive responding, was negatively related to the age of first puff, age of first whole cigarette, and age of daily smoking onset among all smokers ($n = 146$). However, there was no relation between number of cigarettes smoked and hostility.

DISCUSSION

The current study replicates previous work (Weiss et al., 2005, 2008, 2011) showing that smokers score higher on self-report hostility than nonsmokers. This association was verified using the C-M scale, which has better test–retest and internal consistency reliability than the Buss–Durkee Hostility Inventory (Bishop & Quah, 1998; Vassar & Hale, 2009), as used elsewhere (Gruder et al., 2013; Weiss et al., 2005, 2008, 2011). Furthermore, our results did not indicate that hostility is related to smoking quantity, but hostile smokers did begin using cigarettes at an earlier age than their less hostile peers who also smoke.

These results carry some degree of specificity, since aggressive responding was the only hostility subscale related to both smoking status and smoking onset. More-so than cynicism and hypersensitivity, aggressive responding items consist of specific behaviors one would like to engage in, which suggests the behavioral components of hostility might be especially correlated with smoking. Nonetheless, that explanation should be treated with caution for a number of reasons. First, aggressive responding is not associated with smoking substantially more than the other subscales. Interestingly, in prior work in adult treatment-seeking smokers, other components of hostility, particularly cynicism, has been more closely associated smoking relapse (Kahler et al., 2009). Moreover, the subscales used here have some conceptual overlap, evidenced by the fact different researchers have observed varying factor structures of the C-M.

Given these considerations, more research is needed to further tease apart the precise components of hostility that are most strongly associated with smoking. Doing so, however, requires careful consideration of the psychometric properties of the measure being used, including the scale's factor structure and internal reliability of any derived subscales. While the C-M queries trait hostility, the morphing task is related to the ability to perceive emotion in others, and these results were more modest. Consistent with Kahler and colleagues (2012), hostile participants needed a more expressive face to recognize happiness, but were not especially sensitive to angry faces, although we expected emotion processing sensitivities for both. That

Table 2. Correlations Between Demographic Variables and Hostility Measures Among All Participants ($N = 241$)

Variables	1	2	3	4	5	6	7	8	9	10
Demographics										
1. Female gender										
2. Age	−0.17**									
3. Caucasian race	0.01	−0.04								
Cook-Medley scales										
4. General hostility	−0.11	−0.04	−0.13							
5. Cynicism	−0.08	−0.01	−0.11	0.88***						
6. Hypersensitivity	−0.07	−0.06	−0.05	0.78***	0.62***					
7. Aggressive responding	−0.27***	−0.06	−0.13*	0.59***	0.50***	0.46***				
Morphing task										
8. Happiness intensity	−0.11	−0.02	−0.03	0.19**	0.14*	0.17*	0.15*			
9. Anger intensity	−0.03	−0.04	−0.09	0.06	0.06	−0.04	0.08	0.54***		
10. Fear intensity	−0.05	−0.11	−0.18**	0.13*	0.06	0.10	0.10	0.62***	0.53***	
Mean or percent	48.5 ^a	16.4	84.2 ^a	8.17	9.53	6.06	4.26	48.5	67.9	66.4
SD	—	1.22	—	3.85	3.78	3.14	2.23	12.8	8.72	9.90

^aRefers to percentage of sample.

* $p < .05$; ** $p < .01$; *** $p < .001$.

Hostility and smoking

Table 3. Comparison Between Smokers ($n = 95$) and Nonsmokers ($n = 95$) on Hostility Variables

Variable	Smoker M (SD)	Nonsmoker M (SD)	dfs	t value
Cook–Medley scales				
General hostility	8.27 (3.53)	7.26 (4.13)	188	1.81 ⁺
Cynicism	9.80 (3.37)	8.65 (4.19)	188	2.08*
Hypersensitivity	6.07 (2.83)	5.45 (3.32)	188	1.39
Aggressive responding	4.42 (2.28)	3.69 (2.14)	188	2.26*
Morphing scores				
Happiness intensity	49.5 (12.42)	46.5 (12.11)	185	1.66
Anger intensity	69.2 (8.25)	66.0 (8.75)	184	2.59*
Fear intensity	66.8 (10.17)	65.4 (9.57)	185	1.02

⁺ $p < .10$; * $p < .05$.

Table 4. Correlations Among Smoking Variables and Hostility for Smokers Only ($n = 146$)

Variable ^a	Age at first puff	Age at first whole cigarette	Age started to smoke daily	Cigarettes per day ^b
General hostility	−0.26**	−0.19*	−0.22*	−0.07
Cynicism	−0.22*	−0.15	−0.14	−0.05
Hypersensitivity	−0.25**	−0.13	−0.17	−0.14
Aggressive responding	−0.21*	−0.25**	−0.25*	−0.09

^aMeasured with Cook–Medley Hostility Scale.

^bDuring past 14 days.

* $p < .05$; ** $p < .01$.

hostile participants were not quick to recognize anger is inconsistent with other research on adults (Leventhal & Kahler, 2010) and college students (Larkin et al., 2002), which found that hostile participants were prone to recognizing anger (for an exception, see Kahler et al., 2012). Given the lack of an association between anger processing and hostility, it is possible that, among adolescents, these tasks tap slightly different affective states or processes. This may help explain why smoking was consistently related to the C-M, but not strongly associated with the morphing task.

The one significant association between smoking status and morphing scores is that, counter to expectations, smokers required a more intense expression to recognize anger than nonsmokers. This finding stands in contrast to Ernst and colleagues (2010) who observed that a reduced error rate in identifying angry faces was associated with an increased likelihood of smoking onset 3–4 years later. However, the outcome used by Ernst and colleagues (number of incorrect responses) has a very low base rate. As such, many participants correctly identified all emotions, so the error rate is likely not capturing their full sample.

One possibility for the results from the present study is that smokers self-select into hostile environments where anger is frequently expressed. If smokers become habituated to angry faces, they may require a more intense expression to identify anger and have greater difficulty recognizing the emotion than nonsmokers. It is also possible that teen smokers, relative to nonsmokers, may be less adept at emotion recognition in general, since the former had a higher morphing score for each emotion tested in the current study, even though this did not always reach statistical significance.

Strengths and Weaknesses

Strengths of the current study include matching smokers to nonsmokers in a 1:1 ratio on relevant demographic variables. Matching designs reduce the influence of covariates and are

superior to statistically controlling for potential nuisance variables in a regression framework (Stuart & Rubin, 2008), as done elsewhere (e.g., Weiss et al., 2005, 2008). Additionally, the sample was a diverse group of adolescents drawn from the community.

A weakness of this study is that all data are cross-sectional. A longitudinal approach would allow us to directly test the hypothesized directionality of the relationship, specifically, that hostility is an antecedent of smoking. While this hypothesis is consistent with laboratory research inducing negative affect (McKee et al., 2010), prospective studies (Gruder et al., 2013; Weiss et al., 2005), and the negative reinforcement model of smoking (Baker et al., 2004; Brandon et al., 2004), directionality of effects cannot be established using the present data. Finally, since the C-M and morphing tasks were not completed at the same time, participants may have been in different affective states, reducing the precision of this relation.

Implications and Future Research

The present study suggests there may be value in targeting smoking prevention programs to adolescents with elevated trait hostility. Similarly, researchers could examine whether interventions aimed at reducing hostile behavior also curb tobacco use. The utility of considering emotion processing with respect to smoking prevention remains unclear, and more research is needed to elucidate this further, especially given the discrepant results from the current study and that of Ernst and colleagues (2010). Finally, longitudinal studies could explicitly examine whether emotion processing mediates the relation between hostility and smoking.

Summary

Matched smokers were higher than matched nonsmokers on hostility, particularly with respect to cynicism and aggressive

responding hostility facets. Additionally, hostility was negatively correlated with smoking onset. Smoking interventions might benefit from considering these findings.

SUPPLEMENTARY MATERIAL

Supplementary Tables 1 and 2 can be found online at <http://www.ntr.oxfordjournals.org>

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DECLARATION OF INTERESTS

None declared.

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