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Abstract

Children of smokers are significantly more likely to experiment with cigarettes and become habitual smokers than children of non-smokers. The current study examined the effect of parental smoking on children's implicit and explicit responses towards smoking behavior and smoking-related cues with the goal of identifying potential mechanisms for this relationship. A sample of 8-12 year old children of smokers (n = 57) and children of non-smokers (n = 86) completed a dot probe task to assess implicit attentional bias towards smoking cues and the Affect Misattribution Procedure (AMP) to assess implicit affective responses to smoking cues. In addition, children indicated their explicit perceptions of smokers and smoking behavior. Results demonstrated that children of smokers showed more sustained implicit attentional bias toward pictures of smoking stimuli presented alone than children of non-smokers. Overall, participants showed negative implicit affective responses to smoking stimuli regardless of parental smoking. Children of smokers indicated that smokers would experience fewer negative consequences than children of non-smokers; these relationships were moderated by age. Together, our findings suggest that parental smoking affects the ways that pre-adolescent children implicitly process smoking cues and their perceptions about smoking and its consequences. These findings help us understand the environmental mechanisms associated with smoking behavior in this vulnerable population.

Key Words: parental smoking, attentional bias, dot probe, implicit bias

The Effect of Parental Smoking on Pre-Adolescents' Implicit and Explicit Perceptions of Smoking-related Cues

Despite its well-documented adverse effects, tobacco addictions are prevalent around the world and represent a serious risk to the health and prosperity of afflicted individuals and their families. Nearly six million people die globally every year from smoking-related illnesses, and this number is expected to rise to eight million annually in the next fifteen years (World Health Organization, 2011). In the United States, cigarette smoking continues to be one of the largest public health concerns, and is consistently listed as the number one preventable cause of death (Centers for Disease Control and Prevention, 2016; U.S. Department of Health and Human Services, 2014). According to recent estimates, more than $325 billion is spent each year in the United States on healthcare costs and lost productivity as a result of smoking-related illness (U.S. Department of Health and Human Services, 2014; Xu, Bishop, Kennedy, Simpson, & Pechacek, 2015).

As a result of the prevalence of smoking behavior, approximately one in four children in the U.S. lives with a parent who smokes tobacco (Moritsugu, 2006; Centers for Disease Control and Prevention, 2014). These children are more likely to experiment with smoking during adolescence, and to become habitual smokers like their parents (Bauman, Foshee, Linzer, & Koch, 1990; Chassin, Presson, Rose, Sherman, & Prost, 2002; den Exter Blokland, Engels, Hale, Meeus, & Willemsen, 2004; Hill, Hawkins, Catalano, Abbott, & Guo, 2005; Leonard-Bee, Jere, & Britton, 2011; Villanti, Boulay, & Juon, 2011; but see Piko, 2001). Given the dire health and economic consequences of smoking, it is essential to investigate the mechanisms responsible for the relationship between parental and child smoking behavior.

Consistent with Social Learning Theory (Bandura & Walters, 1977), children's beliefs about smoking norms are modeled after their parents' smoking behaviors from a young age (Avenevoli & Merikangas, 2003; de Leeuw, Scholte, Vermulst, & Engels, 2010; Harakeh, Scholte, Vermulst, de Vries, & Engels, 2004; Villanti et al., 2011). As reviewed in a recent meta-analysis (Amrock & Weitzman, 2016), parental smoking is associated with children having more positive beliefs about smoking (Brook,

Mendelberg, Galili, Priel, & Bujanover, 1999; Porcellato, Dugdill, Springett, & Sanderson, 1999; Schuck, Otten, Engels, & Kleinjan, 2012) and its health consequences (Chassin, Presson, Todd, Rose, & Sherman, 1998; Copeland et al., 2007; Schuck et al., 2012). This is concerning because children's perceptions about smoking predict their subsequent smoking behavior (e.g., Andrews & Duncan, 1998; Andrews, Hampson, Barckley, Gerrard, & Gibbons, 2008; Aryal, Petzold, & Krettek, 2013; Carvajal, Wiatrek, Evans, Knee, & Nash, 2000; Otten, Engels, & Prinstein, 2009; Pallonen, Prochaska, Velicer, & Smith, 1998; Song, Morrell, Cornell, Ramos, Biehl, Kropp et al., 2009).

It is also important to consider other cognitive factors that may be involved in smoking initiation. Previous research suggests that repeated exposure to smoking in the home may be associated with the development of implicit attentional biases (Forestell, Dickter, Wright & Young, 2012) and positive affective responses (Forestell & Mennella, 2005) to smoking-related cues. These cognitive responses may also predict subsequent smoking initiation (Field & Cox, 2008; Mogg, Bradley, Field & de Houwer, 2003).

Implicit Attention to Smoking-related Cues

Previous work suggests that addictive behaviors are thought to be largely a result of automatic processes over which individuals have little, if any, control (Tiffany, 1990). One such process involves enhanced (or biased) attention toward smoking-related stimuli. Through repeated exposure to tobacco, individuals learn to associate this addictive drug with pleasure, which in turn increases their incentive motivational significance (Robinson & Berridge, 1993). As a result, stimuli associated with drug use become more attention-grabbing. Consistent with this, research has shown that despite smokers' efforts to ignore smoking-related cues, their attention is subconsciously drawn to these emotionally-valenced stimuli (Bradley, Mogg, Wright, & Field, 2003; Waters & Feyerabend, 2000; Williams, Mathews, & MacLeod, 1996).

Previous research has suggested that children who are exposed to parental smoking may also develop attentional biases for smoking-related cues. Forestell et al. (2012) demonstrated that non-smoking young adults with a parent who smoked exhibited an implicit attentional bias towards smoking-related

cues; daily smokers also showed a greater attentional bias if they reported having a parent who smoked (Dickter & Forestell, 2012). Similarly, Lochbuehler, Otten, Voogd, and Engels (2012) demonstrated that children of smokers between 10-13 years of age showed a greater implicit attentional focus to smoking-related stimuli relative to a matched sample of children of non-smokers. The development of attentional biases to smoking-related cues in children could predispose them to smoking initiation, even though most children are aware of the negative health implications of smoking and report that they do not want to smoke (Goddard, 1992; Stern, Prochaska, Velicer, & Elder, 1987).

Implicit Evaluation of Smoking-related Cues

Repeated exposure to parental smoking may also affect the development of positive implicit affective responses to smoking-related stimuli (McConnell & Rydell, 2014). Positive implicit affective responses to smoking stimuli can activate reward pathways in the brain and motivate drug use (Koob & Le Moal, 2008). Indeed, smokers have more positive implicit associations with smoking cues than non-smokers (e.g., Haight, Dickter, & Forestell, 2012; Huijding, de Jong, Wiers, & Verkooijen, 2005; Sherman, Rose, Koch, Presson, & Chassin, 2003; but see Swanson, Swanson, & Greenwald, 2001).

Several studies suggest that parental smoking leads to more positive implicit affective responses to smoking cues in children (Bountress, Chassin, Presson, & Jackson, 2016; Pieters, van der Vorst, Engels, & Wiers, 2010; Sherman, Chassin, Presson, Seo, & Macy, 2009; Stacy, 1995). It is possible that the intergenerational transmission of implicit affective responses occurs through subtle modes of communication (Sherman et al., 2009). It is also possible that the degree to which children form implicit positive affective responses to smoking-related cues may be influenced by the context in which their parent smokes. Previous work demonstrates that children who experience parental smoking in negative emotional situations such as a mother who smokes to alleviate negative affect were less likely to indicate that they liked the smoking-related cue relative to those whose parents did not smoke to alleviate negative affect (Forestell & Mennella, 2005).

As longitudinal studies have demonstrated that children's implicit responses to smoking predicted later smoking initiation (Bountress et al., 2016; Sherman et al., 2008), more research is needed to

understand how parental smoking may foster implicit affective responses towards smoking stimuli in children.

The Current Study

The current study examined the effect of parental smoking on children's implicit and explicit responses towards smoking behavior and smoking-related cues with the goal of identifying potential cognitive mechanisms to explain the relationship between parental smoking and child smoking perceptions. We chose to focus on the responses of children between the ages of 8-12 years (hereafter referred to as pre-adolescents) in the current study because this group is particularly vulnerable to smoking initiation (Baker, Brandon, & Chassin, 2004; Copeland, Proctor, Terlecki, Kulesza, & Williamson, 2014). One reason for this is that pre-adolescents' health-related beliefs are more malleable than those of adolescents (Eagly & Chaiken, 1993). Additionally, pre-adolescence is a key period for increasing positive outcome expectancies and decreasing negative outcome expectancies (Copeland et al., 2014), which may be important as previous work demonstrated that children's perceptions of smoking become more positive as they near adolescence (Pisano & Rooney, 1988). Finally, research suggests that experimentation with cigarettes typically begins to occur after 12 years of age (Bauman & Phongsavan, 1999; Mowery, Farrelly, Haviland, Gable, & Wells, 2004; Winkleby, Fortmann, & Rockhill, 1993), making pre-adolescence a critical time period to examine beliefs about smoking and responses to smoking cues.

To achieve the goals of this study, we examined attentional responses to smoking-related cues in children of smokers and non-smokers using a dot-probe task in which we presented smoking-related and neutral cues (Bradley et al., 2003; Forestell et al., 2012). We hypothesized that children of smokers would show a greater attentional bias toward smoking-related cues than children of non-smokers as reported with young adults in Forestell et al. (2012).

We also examined children's implicit affective responses to smoking-related cues using the Affective Misattribution Procedure (AMP). In this task participants evaluate a neutral stimulus that is preceded by a prime which depicts a smoking-related or neutral cue (Payne, McClernon & Dobbins,

2007). No research has examined adults' or children's implicit affective responses as a function of parental smoking but previous research suggests that, in smokers, contextual and motivational factors such as individual differences in craving and addiction are associated with these responses (Haight et al., 2012; Payne et al., 2007). Based on previous work that demonstrated that children of smokers preferred the odor of cigarette cues to neutral cues relative to children of non-smokers (Forestell & Mennella, 2005), we predicted that children whose parents smoke would be more likely to indicate that the smoking-related cues were pleasant.

In addition, we assessed children's explicit perceptions of smokers and smoking behavior. We expected that children of smokers would perceive fewer health consequences of smoking and have less negative judgments of smokers (Amrock & Weitzman, 2016; Chassin, Presson, Rose, & Sherman, 1998; Copeland, Diefendorff, Kendzor, Rash, Businelle, Patterson, & Williamson, 2007; Schuck et al., 2012).

Finally, the current study sought to conduct exploratory analyses examining the relationships between age and the variables of interest. Characteristic of adolescents' ability to view a situation from multiple perspectives, perceptions of smoking become more complex as children approach adolescence (Pisano & Rooney, 1988). While most young children view smoking as harmful (e.g., Milton, Woods, Dugdill, Porcellato, & Springett, 2004; Porcellato, Dugdill, & Springett, 2005), adolescents may also begin to recognize various benefits associated with smoking, such as reducing negative moods and stress (Bountress et al., 2016; Freeman, Brucks, & Wallendorf, 2005; Gillmore et al., 2002; O'Connor, Fite, Nowlin, & Colder, 2007; Raina, Krishan, Murali, Shamala, Yalamalli, & Kumar, 2015). To support this, Piko (2001) found that age correlated positively with the degree to which smoking is associated with perceptions of positive consequences such as the belief that smoking helps one to relax or feel good. In line with this finding, we predicted that age would be positively correlated with perceptions of the positive consequences of smoking. We also predicted that age would positively correlate with implicit cognitive responses. Finally, because children of parents who smoke are more frequently exposed to the positive effects that nicotine has on mood, we examined whether the relationship between age and children's perceptions of smoking behavior were moderated by parental smoking status.

Method

Participants

A statistical power analysis was performed for sample size estimation, based on data from a previous study in our lab that used a dot probe task in which undergraduate students who had a parent who smoked were compared to those who did not have a parent who smoked (Forestell et al., 2012). The effect size in this study (η^2 = 0.069) was considered to be medium using Cohen's (1988) criteria. To determine our sample size for the current study we conducted power analyses using G*Power 3, a flexible statistical power analysis program for the social sciences (see Faul, Erdfelder, Lang, & Buchner, 2007). With an alpha = .05 and power = 0.80, the projected sample size needed with this effect size was N = 80 (40 children of smokers and 40 children of non-smokers). In order to determine how many people we would need to recruit to get 40 children of smokers we consulted previous research (Forestell & Mennella, 2005), which was conducted in Philadelphia where approximately 20% of people smoke. In this study of 250 children recruited, approximately 40% of this sample had at least one parent who smoked, and about 5% were not classifiable. In James City County and York City County, where we recruited our children, approximately 13% of people smoked. Therefore we predicted that we would need approximately 160 children in order to recruit 40 children of smokers (26% of the total sample). We also predicted that we would lose approximately 10% of children due to noncompliance or failure to understand the AMP (Williams, Steele, & Lipman, 2016), bringing us to a goal of 176 children for recruitment.

In the current study, one hundred seventy-four 8-12 year old children (100 female, 74 male) and their parent were recruited through online postings on Craigslist, flyers in the community, and letters sent home through local schools advertising a study that examined responses to smoking-related images. Of the 174 children who participated, there were 27 sibling pairs and 4 sibling triads. Written informed assent for the child and written informed consent for the parent were obtained at the beginning of the study. All testing procedures were approved by and in accordance with the ethical standards of the Protection of Human Subjects Committee at William & Mary.

Materials

Dot Probe. One hundred sixty-eight participants completed the dot probe task, which was used to assess participants' relative attentional allocation toward smoking and non-smoking-related stimuli (MacLeod, Mathews & Tata, 1986). As shown in Figure 1, the dot probe task first showed participants a fixation cross on the middle of the screen for 1000ms. When the fixation cross disappeared, two paired stimuli, one smoking-related and one non-smoking-related, appeared side by side. Both images remained on the screen for either 500ms or 2000ms depending on the block. Previous research has shown that responses to smoking stimuli on this task differ based on how long the stimuli are presented; responses thought to represent initial orientation are elicited by 500ms presentations and those thought to represent sustained attention are elicited by 2000ms presentations (Forestell et al., 2012). Within each block the order of the stimuli was randomized, and the order of the blocks was counterbalanced across conditions. The paired stimuli, as depicted in Figure 2, were then replaced with a visual mask for 433ms. Following the visual mask, a black dot appeared on the screen where one of the pictures was previously located, and participants were asked to press a button on the keyboard indicating which side of the screen (the left or the right) the dot appeared as quickly as possible. The dot remained on the screen until participants selected a response. The inter-trial interval (ITI) varied randomly between 1000ms and 2000ms to account for the potential effect of expectation. The participant completed four practice trials to ensure they understood the task and then completed 40 trials with a break after the first 20. Each pair of stimuli appeared twice.

Stimuli for the dot probe consisted of 20 original color images, 10 of which included smoking-related content such as cigarettes, ashtrays, or lighters, and 10 of which included color, size, and shape-matched non-smoking images of everyday common items (Forestell et al, 2012). These images were previously pilot tested with 9 children between 8-11 years-old (M = 9.89, SD = 1.69) who were instructed to categorize images displayed for less than one second on a computer screen as smoking- or non-smoking-related. Children in the pilot study had an accuracy rate of 91%. For both the smoking- and non-

smoking-related images, half included people interacting with the objects (hereafter referred to as active cues) and the remaining photos depicted the stimulus alone (hereafter referred to as inactive cues).

The decision to include active and inactive stimuli was based on previous work by Forestell and colleagues (2012), which demonstrated that college students who reported that they come from a family in which one of their parents smoked cigarettes implicitly attended more to inactive smoking-related cues relative to inactive control pictures in a dot probe task. No difference was found between active smoking-related cues and active control pictures.

Affective Misattribution Procedure (AMP). The AMP was developed to measure participants' implicit affective responses to presented primes (Payne et al., 2005) and was previously used to examine non-smokers' and smokers' implicit affective responses to smoking-related and non-smoking-related stimuli (Payne et al., 2007). Stimuli for the AMP were taken from Payne et al.'s (2007) study and consisted of 60 pictures of smoking-related cues and 60 pictures of non-smoking-related cues. Although Payne and colleagues (2007) did not examine differences in the stimuli in terms of whether the pictures showed people interacting with the objects, the stimulus set consisted of both active and inactive stimuli which we examined as a within-subjects variable in our analyses. This decision was based on previous research by Haight and colleagues (2012) demonstrating that daily smokers had more positive implicit affective responses to active smoking-related cues relative to active control cues in an AMP task.

One hundred seventy participants completed the AMP. The AMP consists of a presentation of a prime for 75 milliseconds (ms), followed by a blank screen for 125 ms, a Chinese pictograph for 100 ms, and a black and white masking screen. The masking screen remains on the monitor until a response from the subject has been made. Participants indicated whether the pictograph was pleasant or unpleasant by pressing one of two keys on a computer keyboard. There were 120 trials presented to participants during the AMP; each stimulus picture was presented once.

Questionnaires.

Parent Questionnaires: Primary parents were defined as those who brought the child to the session and completed the questionnaires about their smoking behavior during the study. Secondary parents were

those who did not attend the session; the primary parent provided information about the secondary parent's smoking behavior. Primary parents were asked how many cigarettes they (and the child's other parent) currently smoked per week and at what age they began smoking. The parent was also asked whether the child spent a significant amount of time with anyone else who smoked, and if so, to indicate the relationship of that person to the child, and how much time per day, week, or year the child spent with that person. The parent also provided general demographic information.

Child Questionnaires: One hundred seventy-two children completed a brief smoking outcomes questionnaire adopted from Anderson, Pollak, and Wetter (2002) to determine their susceptibility to smoking. The experimenter read the questions aloud to children. The children were asked to identify their three best friends, they were then asked if any of these friends smoked cigarettes; and if not, how likely they thought each of their friends would smoke a cigarette using a 5-point scale ranging from unlikely to very likely. Children were also asked if they would try a cigarette if one of their best friends offered it to them; if they have any brothers, sisters, or other friends who smoke cigarettes; if they have ever smoked a cigarette or tried orbs, snus, or stonewall (each of which was defined by showing a picture of the package); and if they thought they would try a cigarette during the next year or five years.

The Child Smoking Consequences Questionnaire (Copeland et al., 2007; SCQ-C) was used as a means of assessing smoking outcome expectancies in children between 7-12 years of age and adolescents age 11-19 years of age, respectively. The current study used the Positive Reinforcement (Cronbach's alpha = .58; e.g., "Smoking looks cool.") and the Negative Consequences (Cronbach's alpha = .64; e.g., "Smoking looks dumb." and "Smoking makes people feel sick.") subscales of the SCQ-C. The reliability scores for the current study were similar for Positive Reinforcement (Cronbach's alpha = .52) and Negative Consequences (Cronbach's alpha = .68). The experimenter read the questions aloud to each child and 173 participants responded to the integrated set of questions using a labeled pictorial scale that was on a five-point scale ranging from never to always.

Procedure

Each primary parent arrived at the lab with their child(ren) and completed the informed consent and assent forms, which were read aloud to the children. To maintain confidentiality and encourage the parent and child to respond honestly during interviews, the parent and child were separated for the behavioral tasks and questionnaires. The child first completed the dot probe and AMP tasks, the order of which was counterbalanced. The experimenter guided the children through each of the behavioral tasks and the questionnaires by reading the instructions and questions aloud. Meanwhile in a separate room with another experimenter, the parent responded to questions about their own smoking habits as well as the smoking habits of the child's other parent and/or the primary parent's current partner. Upon completion of the computer tasks and questionnaires, participants were debriefed. The parent was paid $30 for each child who participated and each child received a toy.

Data Analyses

Exclusion Criteria and Group Classification: Of the 174 children recruited, a total of 31 participants were excluded from analyses. Children were excluded if a parent quit smoking more than two years ago but smoked during the child's life (n = 15) or if at least one parent with whom the child currently spent time smoked cigars (n = 7). Children were also excluded if a parent was unsure or provided unclear information regarding the dates as to when they or the other parent had quit smoking and/or how many cigarettes they smoked weekly (n = 4). In addition, participants were excluded if their parent(s) smoked occasionally but less than 20 cigarettes per week (n = 3) or if they spent time regularly with at least one non-parent family member who smoked cigarettes (n = 1) or cigars (n = 1).

Therefore, children were classified as children of smokers (n = 57) if the child had at least one parent who was part of their life who smoked at the time of the study or within the last two years and the parent smoked at least 20 cigarettes per week. Children whose parents did not smoke and who did not regularly spend time with other people who smoked were placed in the non-smoking group (n = 86).

Analyses of Implicit Attention using the Dot Probe: Consistent with previous research (Forestell et al, 2012; Trawalter, Todd, Baird, & Richeson, 2008), only trials on which the child responded correctly on the dot probe were included in the analyses. A relative bias score was calculated for each child by

subtracting the average RT of trials with the dot on the same side as the smoking stimulus from the average RT of trials with the dot on the same side as the non-smoking stimulus. A bias score was calculated for the 500ms and 2000ms blocks (Forestell et al., 2012). Positive scores indicate an attentional bias toward the smoking stimuli relative to the non-smoking stimuli.

Of 143 children who were classified into groups, 141 completed the dot probe task. Seven were excluded from analyses of the dot probe because of missing dot probe data and four were excluded for having average reaction time (RT) scores greater than two standard deviations above the mean. Differences in bias scores between children of smoking parents (n = 50) and children of non-smoking parents (n = 80) were examined using a 2 (Group: Smoking *vs*. Non-smoking) X 2 (Time: 500ms *vs*. 2000ms) X 2 (Stimulus Type: Inactive *vs*. Active) mixed-model analysis of variance (ANOVA), with the first factor as the between-groups variable and the second and third factors as within-subjects variables.

Analyses of Implicit Evaluation using the AMP: Responses to smoking and non-smoking trials were determined as in Payne, McClernon, and Dobbins' (2007) study by calculating the average proportions of pleasant responses from the AMP for smoking and non-smoking trials for each type of stimulus. Of the 143 children classified into groups, 139 children completed this task. Nine were excluded from analyses because they responded on fewer than 20 trials (Haight et al., 2012). Other children were excluded because they were familiar with Asian languages (n = 6), failed to comply with task instructions (i.e., did not respond on any trials; n = 1), or the experimenter made an error (n = 2). In order to determine the differences between children of smoking parents (n = 48) and children of non-smoking parents (n = 73), a 2 (Group: Smoking *vs*. Non-smoking) X 2 (Stimulus Type: Inactive *vs*. Active) X (Stimulus Condition: Smoking *vs*. Non-smoking) mixed-model ANOVA was conducted.

Age as a Moderating Variable: To determine whether age moderated the effects of parental smoking on the implicit and explicit measures in the current study, multiple regression analyses were conducted. The continuous variable of age was mean-centered and parental smoking was dummy coded (Parents smoke = 1; Parents do not smoke = 0; Cohen, West, & Aiken, 2014). Age and parental smoking status were entered into the first step and the interaction term was entered into the second step.

Results

Participant Characteristics

Child participants were on average 10 years old (M = 10.15 years, SD = 1.47 years) and 56.6% female. Their racial background was 75% White, 7% Black, 2.4% Asian (including Chinese, Filipino, and Korean), and 15.7% identified with two or more races. Of these 9% were Hispanic or Latino. Most of the children were accompanied by their mother (88.4%), whereas the remaining children were accompanied by their father (9.9%) or both parents (1.7%). Of the 57 children of smokers, 77.2% had one parent who smoked and 22.8% had two parents who smoked. Primary parents who smoked (n = 27) averaged 23.70 (SD = 43.33) cigarettes per week and began smoking at the age of 17.78 years (SD = 5.94). Secondary parents who smoked (n = 42) averaged 73.85 (SD = 66.65) cigarettes per week and began smoking around the age of 16.68 years (SD = 3.78).

A series of independent t-tests were conducted to determine whether there were significant differences as a function of parental smoking on a variety of measures. As depicted in Table 1, children in the smoking and non-smoking groups did not differ on demographic variables including age or gender or race distribution. Children in the smoking group were exposed to significantly more cigarettes in the home per week than children in the non-smoking group. Analyses examining differences in the characteristics of parents who smoked and those who did not revealed that the two groups differed in parental age with both primary and secondary non-smoking parents being older than smoking parents. In addition, a higher percentage of non-smoking households had incomes over $75,000 annually and higher parental education levels compared to the smoking group.

Implicit Attention to Smoking-related Cues

Analyses of the dot probe data revealed a main effect of Group, $F(1,128) = 5.47$, $p = .021$, $\eta_p^2 = .041$, which indicated that children of smokers showed more attentional bias toward the smoking stimuli (M = 44.36, SE = 19.23) than children with no smoking parents (M = -13.00, SE = 15.21). Additionally, the main effect of group was qualified by a Group x Time x Stimulus Type interaction, $F(1,128) = 5.39$, $p = .022$, $\eta_p^2 = .040$. To explore this interaction, separate Group x Time mixed-model

ANOVAs were conducted for the inactive and active trials. As shown in Figure 3a, there was not a significant Group x Time interaction for the active trials, $F(1,128) = 0.53$, $p = .468$, $\eta_p^2 = .004$. As depicted in Figure 3b, there was a significant interaction for the inactive trials, $F(1,128) = 6.91$, $p = .010$, $\eta_p^2 = .051$. Simple main effects analyses revealed a significant effect for the trials presented at 2000 ms, $t(130) = 2.53$, $p = .013$, but not for trials in which the stimuli were presented at 500 ms, $t(130) = 0.22$, $p = .830$. Thus, children of smokers showed more attentional bias toward the inactive smoking stimuli presented for 2000 ms ($M = 118.48$, $SE = 67.20$) than children of non-smokers ($M = -26.28$, $SE = 16.77$).

When age was examined as a potential moderating variable in the relationship between parental smoking and attentional bias to inactive stimuli at 2000 ms, the overall model was significant, $F(3, 128) = 5.30$, $p = .002$. There was a negative relationship between age and attentional bias, $B = -3.24$, $SE = 1.56$, $\beta = -1.75$, $p = .040$, and a positive relationship between parental smoking and attentional bias, $B = 145.54$, $SE = 56.55$, $\beta = 0.22$, $p = .011$. The interaction term was also significant, $B = -6.70$, $SE = 3.08$, $\beta = -0.25$, $p = .032$, demonstrating that, for children with smoking parents, younger children showed greater attentional bias than older children, $r = -.28$, $p = .048$. Children of non-smokers showed no relationship between age and bias, $r = -.12$, $p = .884$.

Implicit Evaluation of Smoking-related Cues

Analysis of the data obtained from the AMP revealed a main effect of Stimulus Type, $F(1, 119) = 529.38$, $p < .001$, $\eta_p^2 = .816$, such that active pictures ($M = 17.84$, $SD = 0.61$) were rated as more pleasant than inactive pictures ($M = 8.97$, $SD = 0.30$). There was also a main effect of Stimulus Condition, $F(1, 119) = 67.42$, $p < .001$, $\eta_p^2 = .362$, such that smoking stimuli ($M = 9.53$, $SD = 0.76$) were rated as less pleasant than non-smoking stimuli ($M = 17.28$, $SD = 0.50$).

The main effects were qualified by a Stimulus Type x Stimulus Condition interaction, $F(1, 119) = 64.27$, $p < .001$, $\eta_p^2 = .351$. For the inactive stimuli, the smoking cues ($M = 6.68$, $SE = 0.50$) were judged as less pleasant than the non-smoking cues ($M = 11.33$, $SE = 0.36$), $F(1, 119) = 51.20$, $p < .001$, $\eta_p^2 = .299$. Similarly, for the active stimuli, the smoking cues ($M = 12.60$, $SE = 1.02$) were judged as less pleasant than the non-smoking cues ($M = 23.18$, $SE = 0.67$), $F(1, 119) = 72.19$, $p < .001$, $\eta_p^2 = .376$. There

was no main effect of parental smoking status nor did it interact with either of the other variables. Age was unrelated to AMP values and did not interact with parental smoking status in a regression analysis.

Explicit Responses

Self, peer, and sibling smoking behavior. Three of the children reported that they had previously smoked a cigarette; all three were children of smokers. One participant indicated that they thought they would try a cigarette during the next year (this child had a smoking parent), with three reporting they would try a cigarette in the next five years (two had smoking parents; one did not). In terms of their peers, only four participants indicated that one of their three best friends ever smokes cigarettes (three had smoking parents; one did not). Ten participants indicated that they had a sibling who smokes (eight had smoking parents; two did not[1]). When asked if they would try a cigarette if one of their friends offered it to them, 93.7% said definitely not, 4.2% indicated probably not, and 2.1% reported that they maybe would try one.

Perceptions of smoking. Children generally thought that smoking had negative consequences (e.g., that smoking looks dumb and smoking makes people feel sick; $M = 4.03$, $SD = 0.62$). In contrast, they indicated that smoking provided little positive reinforcement (e.g., that smoking looked cool, tasted good, and was fun; $M = 1.14$, $SD = 0.35$).

Children of smokers ($M = 1.13$, $SD = 0.26$) indicated stronger perceptions of smoking being positively reinforcing than children of non-smokers ($M = 1.14$, $SD = 0.40$), $B = -0.97$, $SE = 0.40$, $\beta = -1.36$, $p = .018$. Age was also a significant predictor of positive reinforcement, with older children reporting perceptions of smoking providing less positive reinforcement than younger children, $B = -0.01$, $SE = 0.02$, $\beta = -0.31$, $p = .006$. The interaction term, $B = 0.01$, $SE = 0.00$, $\beta = 2.45$, $p = .017$, was also significant. The interaction demonstrated that there was no relationship between age and positive reinforcement for children of smoking parents. For children of non-smoking parents, older children showed lower perceptions of positive reinforcement than younger children, $r = -.26$, $p = .017$.

[1] Parents reported that these children did not live with their sibling or spend significant time with them.

There was a significant main effect of parental smoking on perceived negative consequences of smoking. Compared to children of non-smokers (M = 4.10, SD = 0.55), children of smokers (M = 3.88, SD = 0.70) felt there were fewer negative consequences of smoking, B = -0.23, SE = 0.11, β = -0.18, p = .039. Older children reported more negative consequences of smoking than younger children, B = 0.01, SE = 0.00, β = 0.26, p = .004. The interaction was also significant, B = 0.01, SE = 0.06, β = 0.25, p = .041. For this interaction, there was no relationship between negative consequences and age for the children of non-smokers but there was a significant positive relationship for children of smokers such that older children showed higher perceptions of negative consequences than younger children, r = .38, p = .003.

Discussion

The current study examined the effect of parental smoking on pre-adolescents' implicit and explicit responses to smoking-related cues. Consistent with previous literature, this sample of 8-12 year old children had negative explicit perceptions of smoking, reporting that smoking was associated with negative consequences and little positive reinforcement. They also implicitly evaluated the smoking stimuli negatively. However, there were important differences between the children of smokers and non-smokers. Children of smokers reported that smoking was more positively reinforcing and yielded fewer negative consequences than children of non-smokers. They also showed stronger implicit attentional bias toward smoking stimuli than children of non-smokers. These findings suggest that parental smoking may influence pre-adolescent children's beliefs about and responses to smoking-related cues. These findings have important implications for understanding the relationship between parental and child smoking.

The finding that children of smokers show stronger attentional biases to smoking cues than children of non-smokers is consistent with previous work with non-smoking college students (Forestell et al., 2012). In this study and in previous work with young adults, this bias occurs only in response to inactive stimuli that were presented for 2000 ms. Thus, children and young adults who have parents who smoke demonstrate greater maintained rather than initial attention to smoking-related cues that do not contain humans. That there was no between group difference in participants' responses to the cues that

contained a human actor suggests that the humans depicted in the pictures may have distracted the participants from the smoking-related stimuli, thereby reducing their attentional biases.

Although none of the children or young adults of smokers in these studies reported smoking, the maintained attentional bias they exhibit is similar to that found in smokers who repeatedly use drugs themselves (Bradley et al., 2003; Pieters et al., 2010). Two explanations may account for this finding in pre-adolescent children of smokers. First, children who have a family history of smoking (or other addictive behaviors) may be genetically predisposed to attend to addictive stimuli. Research has shown that 44% of the variation in smoking initiation can be explained by genetic factors (Vink, Willemsen, & Boomsma, 2005). Second, through frequent exposure to a parent who smokes throughout development, smoking-related stimuli (such as the odor and look of cigarettes) may become associated with early memories (Forestell & Mennella, 2005) and become potent attractors of attention. Previous research has shown that peer smoking behavior also plays a key role in smoking initiation (e.g., Alexander, Piazza, Mekos, & Valente, 2001). In the present study, of the four children who indicated that they had a friend who smoked, three of these participants had parents who smoked. Given their attentional bias for smoking-related cues, children with smoking parents may be drawn to peers who smoke, which may further strengthen their attentional bias to smoking-related cues and their vulnerability for smoking initiation. Future research should examine the relationship between parental smoking, peer smoking, and attentional bias.

The results of the current study also showed that for those in the smoking group, attentional biases followed a developmental trajectory; younger children of smokers had greater attentional biases to smoking-related cues than older children of smokers. If we compare the mean attentional bias score of children of smokers in this study (M = 118.48, SE = 67.20) to that obtained in a prior study with young adults (M = 18.58, SE = 10.29; Forestell et al., 2012) to inactive cues presented for 2000 ms, it appears that attentional biases wane as children mature. However, even as young adults, children of smokers have attentional biases toward smoking-related cues, whereas children of non-smokers show attentional biases away from cigarette-related cues (M = -19.95, SE = 9.56; Forestell et al, 2012). Future research should

continue to probe individual differences in personality and environment to determine whether these factors moderate this developmental trajectory and its relationship to smoking initiation.

Unlike attentional bias, there were no group differences for implicit affective responses. Overall, participants perceived smoking stimuli to be less pleasant than non-smoking cues regardless of parental smoking status. This finding suggests that repeated exposure to parental smoking does not appear to be associated with children's hedonic responses to visual images of smoking-related cues. This is in contrast to previous research that has shown that children of smokers were more likely to indicate that they preferred the odor of cigarette smoke relative to a neutral odor compared to children of non-smokers. Interestingly, this effect was moderated by the emotional context in which children experienced this odor (Forestell & Mennella, 2005). Future research may examine whether the emotional context in which children experience their parents' smoking behavior affects their implicit affective responses to visual smoking-related cues.

Overall children believed that smoking is harmful to people's health and is associated with negative consequences (e.g., looking dumb) but not positive social consequences (e.g., looking cool). However, this finding was moderated by the children's exposure to parental smoking. Consistent with previous research, children of smokers indicated that smokers would experience fewer negative consequences and more positive consequences than children of non-smokers (Amrock & Weitzman, 2016; Chassin et al., 1998; Copeland et al., 2007; Schuck et al., 2012; but see Freeman et al., 2005). These highlight the importance of considering parental smoking when assessing children's perceptions of smoking behavior. Due to the relationship between smoking initiation and beliefs about smoking (e.g., Carvajal et al., 2000), these results have important implications for understanding perceptions that lead to smoking initiation. Our study also examined potential age differences in children's perception of smoking. In contrast to our hypothesis, older children in this study indicated that smoking had fewer positive and more negative consequences than younger children. These results are in contrast to work from Europe with similar age children who were attending Dutch primary schools demonstrating that as

these European children got older they reported more pros of smoking (Schuck et al., 2012). Whether these disparate findings are a result of cultural differences is an important area for future research.

The results of this study underscore the importance of examining both explicit and implicit cognitive mechanisms underlying responses to smoking-related stimuli to examine risk factors for smoking initiation. Relative to explicit measures, implicit measures are less likely to produce response biases as a result of evaluation apprehension and social desirability (e.g., Nosek, Greenwald, & Banaji, 2005) when assessing socially stigmatizing behaviors such as cigarette smoking (Stuber, Galea, & Link, 2008). The value of investigating implicit mechanisms is especially apparent given their predictive nature. Sherman and colleagues (2008) found that children's implicit responses, which were influenced by parental perceptions, predicted their likelihood of smoking initiation 18 months later. Future longitudinal research should examine whether implicit or explicit responses to smoking cues in pre-adolescence predict smoking behavior during adolescence and adulthood. In addition, it is important to consider how explicit and implicit biases towards smoking cues can be altered. Previous work has demonstrated that interventions such as cognitive bias interventions (Wiers, Eberl, Rinck, Becker, & Lindenmeyer, 2011) and media campaigns (Glock, Klapproth, & Muller, 2014) can change the processing of drug-related stimuli; research shows that interventions aimed at changing both explicit and implicit responses are more effective than those aimed at only one (Rydell, McConnell, Mackie, & Strain, 2006).

Although this study revealed some novel findings regarding children's implicit and explicit responses to smoking-related cues, several limitations exist. First, the participants were from middle class and relatively well-educated families. It is possible that children in less educated, less affluent households would hold different implicit and explicit perceptions of smoking as a function of exposure to different environments or people. Second, although we eliminated children whose parents quit smoking more than two years ago, and those who had smoking parents with whom they did not spend time, the children in the smoking group likely varied widely in the quality and the quantity of relationships with smokers and in the extent to which they were exposed to smoking behavior. That we found differences between groups despite this variability suggests that controlling for additional factors would only strengthen our current

findings. Future research should examine whether the relationship children have with parents who smoke affects responses to and perceptions of smoking. Third, this study took place in southeastern Virginia, which is in the mid-Atlantic region of the United States, thus the findings may not generalize to the rest of the country or to other countries. In particular, this area is in the "tobacco belt" of the U.S., a region that has a long history of tobacco production and is currently one of three states that produces the most tobacco in the U.S. Future research should examine whether the current research would be replicated in an area that has less of a cultural association with smoking. Finally, our findings related to age of the participants should be interpreted with caution, as all of our participants were within the relatively small age range of 8-12 years; future research should examine a wider age range.

The current findings add to the existing literature on the mechanisms that may be responsible for the relationship between parental smoking and child smoking initiation. Understanding the environmental mechanisms that lead to smoking initiation and maintenance, particularly in high-risk groups such as children of smokers, is critical for developing effective, evidence-based prevention and intervention programs.

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Table 1. Participant characteristics

Variable	Parents do not smoke (n = 86)	Parents smoke (n = 57)	Test Statistic
Child characteristics			
Age (months)	121.59 ± 16.76[1]	122.06 ± 18.96	$t(141) = 0.16$, $p = .875$
Gender (% Female)	56.98	56.14	$\chi^2(1) = 0.01$, $p = .921$
Race (%)			$\chi^2(6) = 6.01$, $p = .421$
White/Caucasian/European	74.42	72.73	
Black/African-American	4.65	12.73	
Asian	4.65	0.0	
Multiracial/Other	16.28	14.55	
Cigarette exposure (#/week)	0	104.24 ± 75.56	$t(141) = 9.62$, $p < .001$
Primary parent characteristics			
Age (years)	42.20 ± 5.17	36.19 ± 6.43	$t(141) = -6.10$, $p < .001$
Gender (% Female)	57.0	56.1	$\chi^2(1) = 0.01$, $p = .921$
Household Income (% >75K)	67.44	26.45	$\chi^2(1) = 23.67$, $p < .001$
Highest level of Education (% < Bachelor's degree)	18.60	43.64	$\chi^2(4) = 25.09$, $p < .001$
Daily Cigarette Usage			
Primary Parent	0	23.70 (43.33)	$t(141) = 5.07$, $p < .001$
Secondary Parent	0	73.85 (66.65)	$t(141) = 10.24$, $p < .001$

[1] represents standard error of the mean

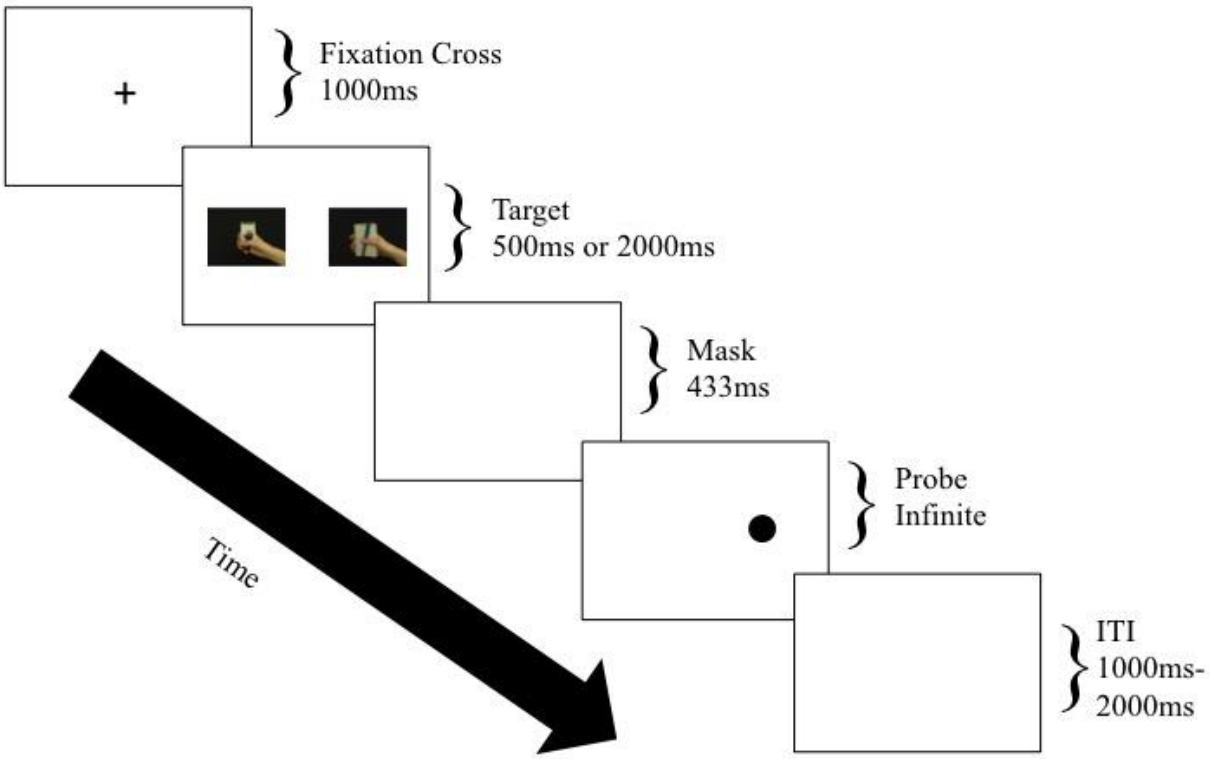

Figure 1. Schematic of the dot probe, with slides presented in chronological order and display duration under each label.

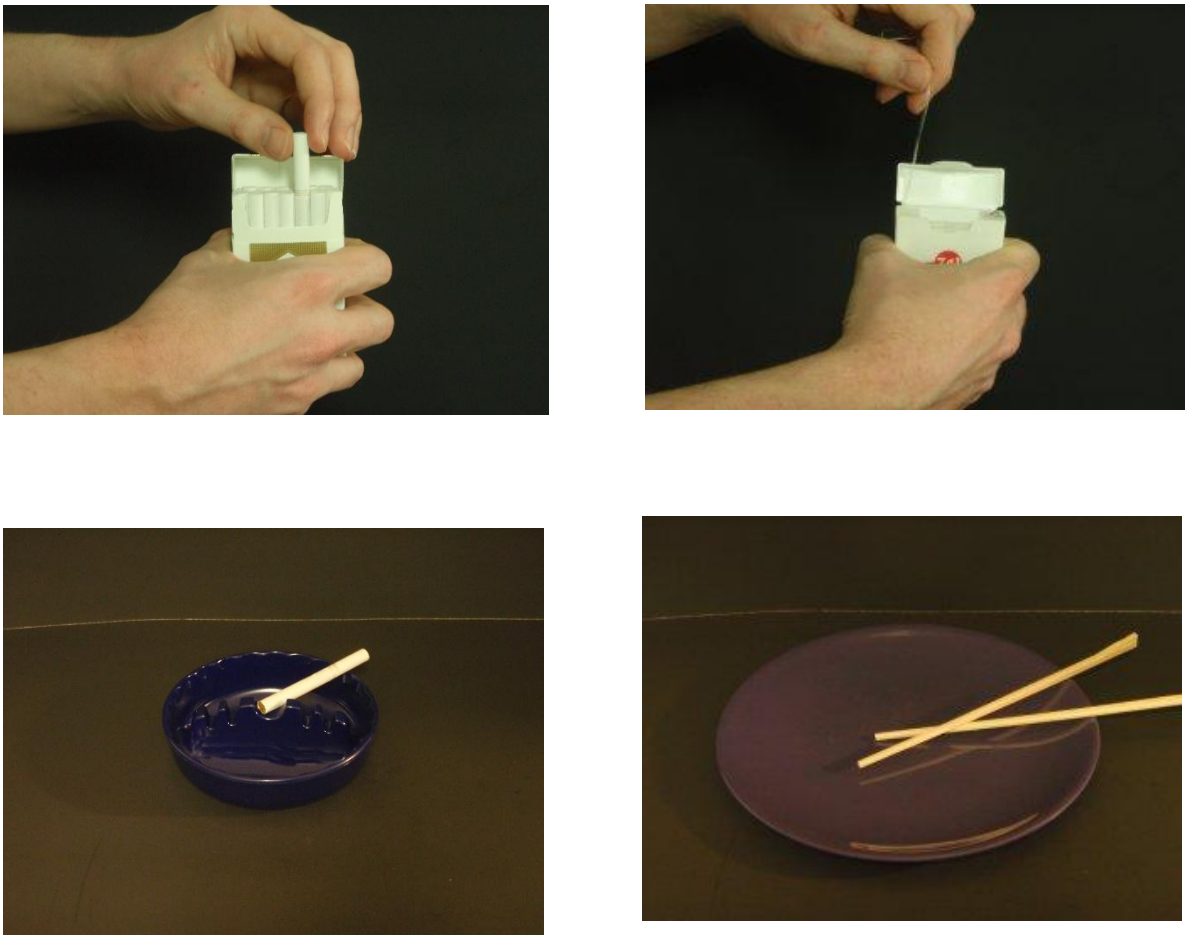

Figure 2. Examples of Smoking-Related and Non-Smoking-Related active and inactive stimuli from the dot probe task.

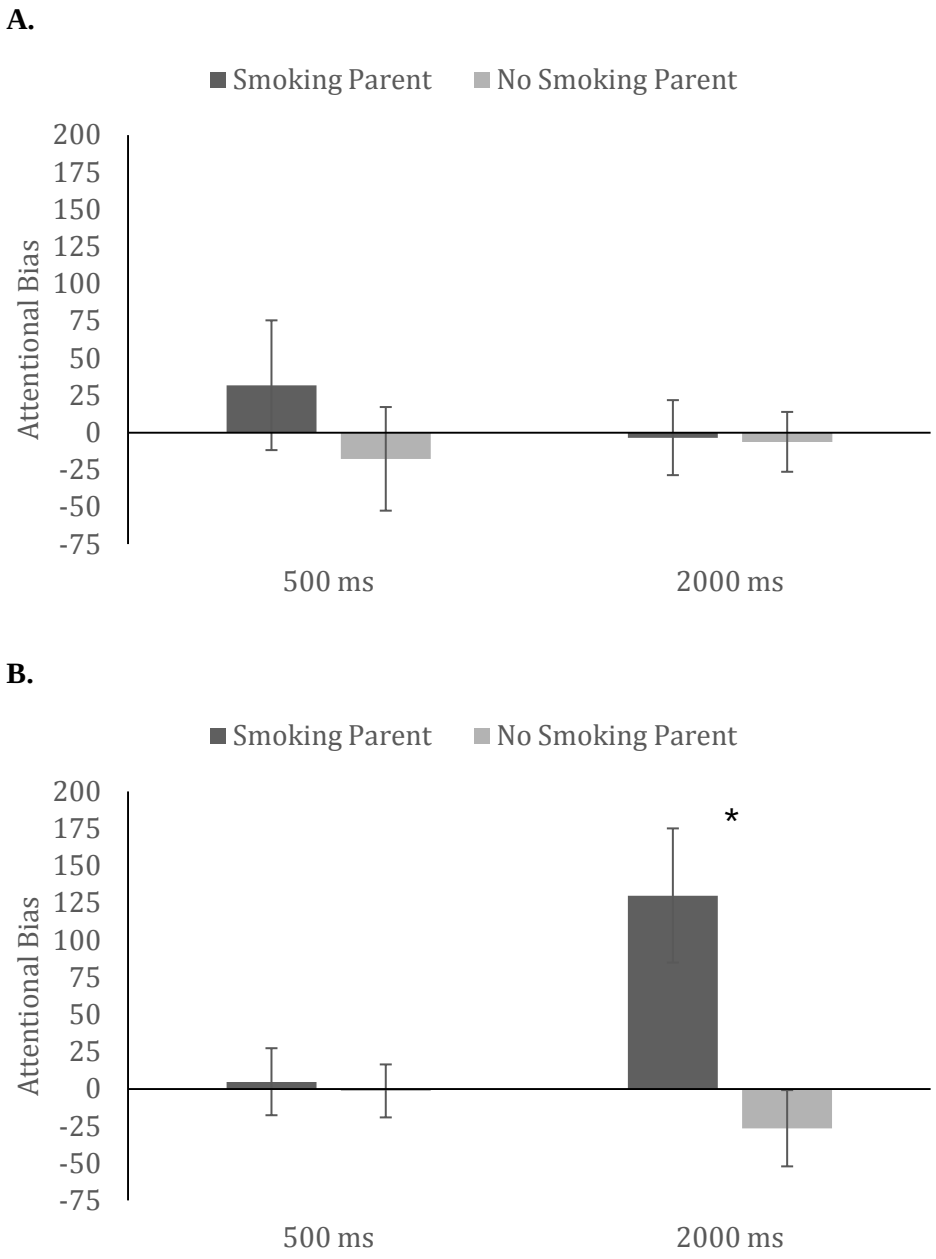

Figure 3. Attentional bias for active smoking trials (panel A) and inactive smoking trials (panel B) as a function of parental smoking and time of presentation. Bars represent standard errors. The asterisk represents a significant difference between means, $p < .05$.