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The Role of Parental Smoking on Children's Attentional Bias to and Evaluation of Smoking-Related Cues

A thesis submitted in partial fulfillment of the requirement for the degree of Bachelor of Science in Neuroscience from The College of William and Mary

by

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Abstract

The goal of the current study was to examine whether exposure to parental smoking affects implicit cognitive mechanisms that may contribute to smoking initiation in children. To achieve this aim, the current study used a dot probe task to measure attentional bias and the Affect Misattribution Procedure (AMP) to measure evaluation of smoking-related cues in 8-12 year-old children. In addition, a modified Smoking Consequences Questionnaire (SCQ) was used to assess smoking outcome expectancies to determine if outcome expectancies related to these implicit measures. Results revealed that children of smokers (n = 67) showed an attentional bias away from smoking-related cues, whereas children of non-smokers (n = 76) did not show an attentional bias. Although all children exhibited a negative implicit affective response to smoking-related cues, children of smokers rated marginally more smoking-stimuli as unpleasant than children of non-smokers. Outcome expectancies largely did not relate to attentional bias or implicit affective responses. These findings suggest that unlike adults with smoking parents, preadolescents who are children of smokers do not show attentional biases toward smoking-related cues, nor do they demonstrate favorable affective responses towards smoking stimuli. Why preadolescent children direct less attention toward and have more negative responses to smoking cues and how these responses are changed or reversed during adolescence are important areas for future research.

The Role of Parental Smoking on Children's Attentional Bias to and Evaluation of Smoking Related Cues

Despite its well-documented adverse effects, smoking continues to be one of the greatest public health concerns. In the United States, cigarette smoking is consistently listed as the number one preventable cause of death (U.S. Department of Health and Human Services, 2014). Nearly six million people die globally every year from smoking-related illnesses, and that number is expected to rise to eight million annually in the next fifteen years (World Health Organization, 2011). Over half of children worldwide live with at least one parent who smokes (European Environment and Health Information System, 2007), and about one in four children in the United States lives with a parent who smokes (Soliman, Pollack, & Warner, 2004).

The prevalence of parents who smoke is concerning given that children of smokers are more likely to become smokers than those whose parents do not smoke (Hill, Hawkins, Catalano, Abbott, & Guo, 2005). While there are certain genetic factors that contribute to smoking, they do not account for all of the variation in smoking behavior, leaving a significant role for environmental factors (Audrain-McGovern, Lerman, Wileyto, Rodriguez, & Shields, 2004; Sullivan & Kendler, 1999). 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. A longitudinal study that followed 808 10-11 year-olds for 10 years showed that parental smoking behaviors predicted the child's risk of daily smoking initiation above any other family-related factors measured, even if the parent expressed disapproval of teen tobacco use and did not involve the child in their smoking behaviors (Hill et al., 2005). Thus, it appears that children's exposure to smoking in the home influences their propensity to smoke. In addition, the likelihood

of smoking initiation increases with the number of smoking parents and duration of exposure (Gilman et al., 2009). Although much research has established the link between parental and children's smoking, the mechanisms responsible for this link are not clear. Researchers investigating possible causes for the link between parent and child smoking behavior have identified early exposure, availability, parental monitoring, and parental imitation as major mediators. However, most of the findings across studies yield inconsistent results, suggesting that other factors may be involved (Avenevoli & Merikangas, 2003), which include a range of cognitive mechanisms.

Previous research has demonstrated gradual developmental shifts in beliefs and attitudes about smoking, with older children holding relatively more positive beliefs about the benefits and less negative beliefs about the consequences of smoking than younger children (Chassin, Presson, Sherman, & McGrew, 1987; Gillmore et al., 2002; O'Connor, Fite, Nowlin, & Colder, 2007). Consistent with these findings, other studies that have examined other substances such as alcohol have supported pre-adolescence and early adolescence as a key period for increasing positive outcome expectancies and decreasing negative outcome expectancies (Copeland, Proctor, Terlecki, Kulesza, & Williamson, 2014). However, some of those beliefs may shift more than once during adolescence; while middle school students' perceptions of the health risks and addictive properties of smoking appeared to decrease over time, high school students perceptions of health risks and beliefs in addictive properties of smoking increased (Chassin, Presson, Rose, & Sherman, 2001).

In addition to age-related changes in smoking expectancies, exposure to smoking via parental and/or peer smoking may shape beliefs about smoking. In one study, 7-12 year-old children who had family members or peers who smoked perceived smoking to have more

positive and fewer negative consequences than children with no smoking family members or peers (Copeland et al., 2007). This study suggested that perception of the positive reinforcement of smoking related to age, but unlike the studies discussed above, older children reported fewer positive and more negative consequences. When modifying the SCQ for 11-19 year-old adolescents, non-smokers endorsed fewer factors related to the negative affect reduction, boredom reduction, social facilitation, and positive taste/sensorimotor aspects of smoking than smokers (Lewis-Esquerre, Rodrigue, & Kahler, 2005). Teens who intended to smoke in the next five years scored higher on taste/sensorimotor aspects of smoking, belief that smoking provides positive social consequences, and belief that smoking can reduce negative affect. Furthermore, parental smoking lead to lower endorsement of the negative physical feelings associated with smoking and higher endorsement of smoking reducing negative affect.

While explicit measures, such as those measured in the studies reported above, typically involve self-report in the form of questionnaires that can be subject to bias, implicit assessments reflect automatic and involuntary judgments, and reactions over which participants have little if any control. As a result, they are less likely to produce response biases due to evaluation apprehension and social desirability, which are particularly salient when measuring explicit responses about socially stigmatizing behaviors such as cigarette smoking (Stuber, Galea, & Link, 2008). Using methods that minimize response bias is essential if we are to understand the cognitive mechanisms that may play a role in smoking initiation. The value of investigating implicit mechanisms is further underscored by the predictive significance of implicit measures; Stacy (1997) showed that implicit measures predicted marijuana use, a socially stigmatized behavior, while explicit measures predicted alcohol use, a socially acceptable behavior. In a review of studies examining addictive behaviors, Tiffany (1990) suggested that addictive

behaviors are largely a result of automatic processes. This model would support focusing on stimuli and the responses they unconsciously evoke that might contribute to the activation of action schemata that are difficult to disrupt and lead to smoking behaviors.

Attentional bias, a widely used implicit measure, is thought to play a role in smoking initiation and maintenance (Field & Cox, 2008). Increased implicit attention to smoking-related cues that are ubiquitous in the environment is one mechanism that might activate these schemas proposed by Tiffany (1990) and lead to smoking behavior. Attention is a cognitive process that allows selective processing of environmental information, attenuating irrelevant information while enhancing responses to and perceptions of other sensations, cues, and information. This biased processing shapes one's perception of the environment and may subsequently influence behavior. Implicit attentional bias has been studied in the context of addiction-related cues to examine the extent to which an individual unconsciously focuses preferentially on a specific type of stimulus over another stimulus. Attentional bias is assessed through a variety of tasks, including the dot probe task (MacLeod, Mathews & Tata, 1986), where two images briefly appear on a screen before disappearing, with a dot appearing where one of the pictures was previously located. Participants are asked to indicate where the dot appears, and by measuring reaction time via a button press, experimenters can predict where the participant was directing their relative implicit attention, with faster reaction times when the dot replaces the image on which the participant was focused.

When compared to non-smokers, smokers show an attentional bias towards smoking-related stimuli during the dot probe task when the images are displayed for 500ms, likely reflecting initial shifts in attention (Ehram et al., 2002). Smokers have also shown this attentional bias with a visual probe when the cue was displayed for 2000ms, likely reflecting maintained

attention (Bradley, Field, Mogg, & De Houwer, 2004; Bradley, Mogg, Wright, & Field, 2003). This was supported by a study that directly measured the direction and duration of gaze in visual probe tasks. In these studies, smokers maintain their gaze longer on smoking-related than control images, detect probes that replace smoking-related cues faster than non-smoking-related cues, and are more likely to initially look at smoking-related cues than non-smoking-related cues (Mogg, Bradley, Field & De Houwer, 2003). Non-smokers did not show these biases. There is some evidence that attentional bias can vary in smokers as a result of particular smoking behaviors. When divided by the number of cigarettes smoked per day, light smokers (20 cigarettes or fewer per day) showed an attentional bias towards smoking-related cues, while heavy smokers showed no attentional bias (Hogarth, Mogg, Bradley, Duka, & Dickinson, 2003).

In addition to studying attention, examining implicit positive and negative associations with addiction-related stimuli can provide valuable information about addictive behaviors and can inform interventions. Implicitly associating smoking-related cues with positive attributes may contribute to the formulation of smoking as good or “not so bad”. Given that this is an automatic association, it may be difficult to change because of lack of awareness or control. The premise in the Implicit Association Task (Greenwald, McGhee, & Schwartz, 1998; IAT) is that an implicit association can be measured through reaction times to a paired target (e.g., “cigarettes”) and an evaluative measure (e.g., “bad”). Paired cues that align with one’s mental associations should elicit faster reaction times than incompatible pairs. These automatic associative properties may relate to behavior; for instance, people who exhibit a more negative attitude towards Blacks than Whites on an IAT assessing race also demonstrate more negative social interactions with Blacks than with Whites (McConnell & Leibold, 2001).

The IAT (Greenwald et al.,1998) has been used in several studies with smokers to assess implicit attitudes towards and associations with smoking-related cues. Although smokers typically show a slightly negative IAT effect (i.e., respond more quickly when the smoking cues are paired with negative cues than positive cues; Waters et al., 2007), this is significantly more positive than the effect shown in non-smokers (Sherman, Rose, Koch, Presson, & Chassin, 2003). When using a personalized version of the IAT that is designed to reduce the influence of societal norms, smokers may exhibit positive implicit attitudes (De Houwer, Custers, & De Clercq, 2006). Responses to the IAT have been shown to be associated with measures of craving and dependence (Waters et al., 2007).

Some studies have used the IAT with children to assess implicit associations with smoking cues (Andrews, Hampson, Greenwald, Gordon & Widdop, 2010). For fifth-grade students, children of smokers showed more positive implicit associations with smoking-related cues than children of non-smokers. Most importantly, a recent study suggested that not only are explicit attitudes regarding smoking transmissible from parents to children, but that implicit attitudes as measured by an IAT are also transmissible from parents to children (Sherman, Chassin, Presson, Seo & Macy, 2009). Implicit attitudes of mothers predicted implicit attitudes in children, and in turn, the implicit attitudes of children predicted their likelihood of smoking initiation 18 months later. This study also found only a modest correlation between implicit and explicit scores, underscoring the need for further research specifically regarding implicit cognitive mechanisms underlying substance use in children.

While the IAT is commonly used in assessing smoking associations, particularly in adults, it is also critiqued for being susceptible to deliberate faking (Fiedler, Messner, & Bluemke, 2006). The Affect Misattribution Procedure (Payne, Cheng, Govorun & Stewart, 2005;

AMP), however, relies on an implicit measure of affect. Affect reflects a basic pleasant or unpleasant reaction and is one component of attitudes (Olson & Zanna, 1993). The AMP serves as an important implicit measure of affect because people may be unable or unwilling to accurately convey their own feelings regarding socially stigmatized behaviors (Stacy, 1997). Additionally, the AMP may relate more consistently to addictive behaviors than the IAT (e.g., alcohol consumption; Payne, Govorun, & Arbuckle, 2008). The AMP relies on categorization of a neutral stimulus as pleasant or unpleasant after a prime rather than how quickly a participant matches the target with the correct behavior. The lack of a "correct" response is thought to mean that the participant is relying upon internally generated cues from the prime to respond to the target (Payne et al., 2008).

The AMP (Payne et al., 2005) has been used to measure implicit affective responses to smoking-related cues. While non-smokers show negative affective responses to smoking-related cues, their responses depend on experience of withdrawal symptoms and motivation to smoke (Payne, McClernon & Dobbins, 2007). Smokers experiencing withdrawal symptoms and those who are motivated to smoke evaluate smoking-related cues more positively, while smokers not experiencing withdrawal symptoms or minimal motivation to smoke evaluate smoking-related cues more negatively. The automatic emotional response to a stimulus in both magnitude and valence may influence behavioral responses to that stimulus; for instance, experiencing positive affective responses to smoking stimuli may motivate a person to engage with smoking paraphernalia.

Although this research provides valuable information about the implicit cognitive mechanisms behind smoking initiation and maintenance, studies examining explicit cognitive constructs dominate the literature due to their relative ease of administration and longer history.

Explicit studies with smokers have shown that, compared to non-smokers, smokers show more positive and less negative beliefs about the outcomes of smoking, and stronger endorsement of smoking as a method of regulating affect (Cohen, McCarthy, Brown, & Myers, 2002; Wetter et al., 2004). Within smokers, ex-smokers and smokers intending to quit have higher beliefs in the negative consequences, health risks, and negative social impressions of smoking than smokers with no intention to quit (Copeland, Brandon, & Quinn, 1995). Additionally, daily smokers have a higher endorsement of the negative reinforcement relative to positive reinforcement properties of smoking when compared to occasional smokers (Matthew et al., 2014).

To date there has been almost no research that has focused on children's implicit responses to smoking related cues as a function of their parent's smoking behavior. Given the association between attentional bias and smoking behavior, it is of interest to understand whether such biases develop as a consequence of one's own smoking behavior or as a function of early exposure to parental smoking. A recent study conducted in our lab suggests the latter. Forestell, Dickter, Wright, & Young (2012) showed that non-smoking college students exhibited an attentional bias towards smoking-related cues if they reported having a smoking parent. This extension of previous research on attentional bias in substance users demonstrates that parental smoking behaviors may influence implicit attentional processes regardless of one's own smoking behaviors. This finding suggests that early experience with a parent who smokes may cause children to develop an attentional bias for smoking related cues. However, research has largely failed to investigate whether other implicit responses, such as evaluation of smoking cues, can be shifted through early experience with a parent who smokes. To address the aforementioned gap in the literature, the current study investigated 8-12 year-old children's perceptions of cigarette smoking and smoking-related images with a combination of explicit and implicit measures.

Based on previous research done with children and adolescents, it was hypothesized that children of smokers would have more positive outcome expectancies about smoking than children of non-smokers, as measured by negative affect reduction, negative consequences, positive reinforcement, social facilitation, boredom reduction, and attributes of peer smokers. We hypothesized that children of smokers would show a greater attentional bias towards smoking-related cues than children of non-smokers, similar to the bias shown by adult non-smokers with smoking parents (Forestell et al., 2012). Finally, it was predicted that children of smokers would show more positive implicit affect towards smoking-related images than children of non-smokers, consistent with previous work on implicit attitudes towards smoking in fifth-grade children (Andrews et al., 2010).

Methods

Participants

One hundred seventy four 8-12 year old children (100 female) and one of their parents (124 females, 16 males) were recruited through online postings and through flyers in the community advertising a study that examined responses to smoking- and alcohol-related images. Of these 174 children, 52 participated with one other sibling and 12 participated with two other siblings. Child participants were 75% White, 7% of Black or of African descent, 2.4% Asian (including Chinese, Filipino, and Korean), and 15.7% identified with two or more races. 9% were Hispanic or Latino. Written informed assent for the child and written informed consent for the parent were obtained at the beginning of each study. All testing procedures were approved by and in accordance with the ethical standards of the Protection of Human Subjects Committee at the College of William and Mary.

Materials

Stimuli. Dot probe stimuli consisted of 20 original color images, 10 of which included smoking-related content such as cigarettes, ashtrays, or lighters (Appendix 1), and 10 of which included color, size, and shape-matched non-smoking images of everyday common items (Appendix 2). These images were previously pilot tested with 9 children 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 and the remaining photos only contained the stimulus. AMP stimuli consisted of 120 images, 60 of which had smoking-related content and 60 of which were images of matched everyday objects, such as staplers or hairbrushes (Payne et al., 2007; Appendices 3 and 4, respectively). For each of these sets of 60, 40 images were active scene images, depicting a person's entire face and part of their torso and a visible background, while the other 20 depicted only part of the hands or lower face.

Dot Probe. To assess participants' relative attentional allocation toward smoking and non-smoking-related stimuli, all participants completed the dot probe task (MacLeod et al., 1986). As seen 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 non-smoking-related, appeared side by side. Both images remained on the screen for either 500ms or 2000ms depending on the block. Within each block the order of the stimuli was randomized, and the order of the blocks was counterbalanced across conditions. The paired stimuli 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 had 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.

AMP. To assess the degree to which participants find certain images pleasant, all children completed the Affect Misattribution Procedure (Payne et al., 2005; AMP). Participants were told that the first image was of a real-life photo (one of the stimuli described above) but that they only needed to respond to the second picture, which was of a Chinese pictograph. The Chinese pictograph is considered to be a neutral stimulus onto which the participant will project the positive or negative affect induced by priming from the real-life image. Participants were instructed to indicate as quickly as possible whether they found the Chinese symbol more pleasant or unpleasant than the average Chinese symbol by pressing one of two keys. The designated keys were counterbalanced across conditions. As seen in Figure 2, the trials began with the appearance of the prime slide for 75ms, which was then replaced by a blank black screen for 125ms. A picture of a Chinese pictograph appeared for 100ms, and then a black and white pattern mask appeared on the screen, remaining there until the participant responded to the image by pressing one of two designated keys (counterbalanced across participants). Participants completed 120 trials, with 60 prime images containing smoking stimuli and 60 prime images containing neutral stimuli. The proportion of pleasant responses for each condition was calculated as number of pleasant responses in a condition over the sum of pleasant and unpleasant responses to that condition. Higher proportions reflected more positive affective responses to stimuli in that condition.

Questionnaires. Parents were asked open-ended questions about their smoking behaviors, including how frequently they smoke, how many cigarettes they smoke, when they first started smoking, and how long it has been since they have last smoked a cigarette if they do not currently smoke. The parent also reported similar information on the smoking habits of the child's non-participating parent and/or step parent, including whether they or another parent had smoked during the child's life and how old they were when they first began smoking. The parents also reported all smoking members of the household, whether or not the child is currently around anyone who smokes, and whether the child was around anyone who smoked in the past. In addition, children were asked to complete several validated questionnaires to assess their attitudes towards smoking, smoking outcome expectancies, and their susceptibility to smoking, which are described below.

One hundred forty three children completed a brief smoking outcomes questionnaire adopted from Anderson, Pollak, and Wetter (2002) to determine their susceptibility to smoking. Participants were asked if any of their three best friends smoked cigarettes; and if not, how likely their three best friends would be to smoke a cigarette; 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; and if they thought they would try a cigarette during the next year or five years. To be classified as not susceptible to smoking, the participant had to respond that they had never tried a cigarette, they would "definitely not" to try a cigarette if one of their best friends offered it to them (from "definitely not," "probably not," "maybe," "probably," and "definitely"), and that they did not think they would smoke in the next year. The experimenter read the questions aloud to the child,

and the child had a scale with the possible answers for the smoking outcome questionnaire (Appendix 5).

The Child Smoking Consequences Questionnaire (Copeland et al., 2007; SCQ-C) and the Adolescent Smoking Consequences Questionnaire (Lewis-Esquerre et al., 2005; SCQ-A) were developed as a means of assessing smoking outcome expectancies in children age 7-12 and adolescents age 11-19, respectively. The current study used the Positive Reinforcement (α = .58) and Negative Consequences (α = .64) but not the Appetite/Weight Control subscales from the SCQ-C. It also used the Negative Affect Reduction (α = .88), Taste/Sensorimotor (α = .78), Social Facilitation (α = .77), and Boredom Reduction (α = .63) subscales but not the Weight Control, Negative Physical Feelings, or Negative Social Impressions subscales from SCQ-A. Participants responded to the integrated set of questions on a five-point scale, with 1 corresponding to “never”, 2 to “rarely”, 3 to “sometimes”, 4 to “often”, and 5 to “always.” The experimenter read the questions aloud to the child, and the child had a labeled pictorial scale for the SCQ (Appendix 6). Possible ranges for the subscales were as follows: Positive Reinforcement (3-15), Negative Consequences (10-50), Negative Affect Reduction (8-40), Taste/Sensorimotor (2-10), Social Facilitation (6-30), and Boredom Reduction (1-5).

Children also responded to an extended questionnaire to assess perceptions of peer smoking (Andrews et al., 2010). Participants (n = 143) responded to 12 questions in the format “Do you think kids who smoke are ____?” There were six positive adjective (popular, cool, exciting, smart, tough, brave) and six negative adjectives (dumb, dull, mean, ugly, wimpy, cowardly). The participant responded on a five-point scale, where 1 = not at all, 2 = a little, 3 = somewhat, 4 = very, and 5 = extremely. The experimenter read the questions aloud to the child. The child had a scale with the possible answers for the modified peer smoking questionnaire

(Appendix 5). The two subscales, positive and negative, were summed independently so that each child had two scores that could range from 6-30.

Procedure

After completion of the informed consent and assent forms, a research assistant measured the child's height and weight. 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. After the child completed each of the behavioral tasks, which included the AMP followed by the dot probe, the experimenter guided the child through each questionnaire in the following order: the smoking outcome questionnaire, the smoking consequences questionnaire, and a modified peer smoking questionnaire. Meanwhile, in a separate room with another experimenter, the parent who came in with the child (hereafter referred to as "primary parent") responded to questions about their smoking habits and the smoking habits of the child's other parent and/or current partner (hereafter referred to as "secondary parent"). The parent then completed general demographic information online. After all computer tasks and questionnaires were completed, the parent and child were debriefed. The parent was paid $30 for each child who participated and each child received a toy.

Results

Participant Characteristics and Classification of Groups

Children were placed into groups based on the smoking behavior of both of their parents, as well as their step-parents. Those children who had at least one parent (or step-parent) who smoked cigarettes during the last two years were placed in the smoking group (n = 67). The child's exposure to cigarettes was calculated as the total number of cigarettes per week that the child's parents smoked at the time of the study or, if the parents had quit in the last two years, the

number of cigarettes per week the parents smoked before quitting. Children whose parents did not smoke during the child's life were placed in the non-smoking group (*n* = 76). Children who did not fit into either group were excluded. The final sample of 143 children (and 112 parents) included 23 sibling pairs and 4 sibling triads. Child participants were on average 10 years (*M* = 121.78, *SD* = 17.60 months) old and 56.6% female.

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 such as child's age, body mass index (BMI [kg/m2]), primary parent's age, secondary parent's age, and household cigarette use. Pearson chi-square analyses were also performed to determine whether there were group differences in sex ratio, race, income, and highest level of parental education as a function of parental smoking habits. As depicted in Table 1, children in the smoking and non-smoking groups did not differ on demographic variables including age, gender distribution, race, or BMI. However, the two groups differed on family income and parental education, with a higher percentage of children in the non-smoking group from households with incomes over $75,000 annually and higher parental education levels compared to the smoking group. Additionally, the parents of children in the non-smoking group were significantly older than the parents of children in the smoking group.

Dot Probe

Of the 143 children, those whose accuracy in identifying the location of the dot during the task was less than 75% (*n* = 7) were removed from analyses leaving 136 participants. For each of these participants, only reaction times (RT) from trials where children accurately identified the location of the dot were included. Additionally, trials more than three standard deviations above or below the participant's mean were removed, as were trials for which RT

were longer than 1000ms, as done in Hogarth et al. (2003), which helped to ensure that the RT was a result of implicit attention. 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. Positive scores indicate an attentional bias towards the smoking stimuli relative to the non-smoking stimuli. A bias score was calculated for the 500ms and 2000ms blocks.

Differences in bias scores between children with smoking parents (n = 63) and children with non-smoking parents (n = 72) were examined using a 2 (Group: Smoking v. Non-smoking) X 2 (Time Block: 500ms vs. 2000ms) mixed-model analysis of variance (ANOVA), with the first factor as the between-groups variable and the second factor as the within-subjects variable. This analysis revealed a main effect of parental smoking status, $F(1,133) = 4.66$, $p = .03$, $\eta^2 = .034$. As shown in Figure 3, children with at least one parent who smoked in the last two years showed an attentional bias away from the smoking stimuli (M = -20.60, SEM = 7.75), and children with non-smoking parents showed no attentional bias (M = .09, SEM = 5.86). There was no significant interaction between parental smoking status and time block.

AMP

Data from participants who selected the same key at least 50 times in a row (n = 5) or who had at least 90% of response selections from the same key (n = 2) were excluded, leaving 136 participants for analysis. Removing these cases helped to ensure that only participants who were attentive to the task were included in subsequent analyses. The affective response was determined by calculating an AMP score, which was the proportion of smoking and non-smoking stimuli categorized as pleasant.

To examine whether children of smoking parents (n = 63) and children of non-smoking parents (n = 73) demonstrated differences in affective responses to the stimuli, a Group (Smoking vs. Non-smoking) X Stimulus (Smoking Content vs. Non-Smoking Content) mixed-model ANOVA was conducted. As shown in Figure 4, this analysis revealed a main effect of Stimulus Content, with participants rating fewer smoking-related stimuli as pleasant than non-smoking-related stimuli, $F(1,134) = 3.98$ $p < .001$, $\eta^2 = .35$. This main effect was qualified by a marginally significant Group X Stimuli Content interaction, $F(1,134) = 3.24$, $p = .07$, $\eta^2 = .02$. Child participants with at least one parent who smoked rated marginally fewer smoking stimuli as pleasant ($M = .26$, $SEM = .03$) than children of non-smokers ($M = .33$, $SEM = .03$), $t(134) = -1.77$, $p = .08$. The proportion of non-smoking-related images rated as pleasant did not differ between groups; proportions for the non-smoking stimuli were similar for children of smokers ($M = .56$, $SEM = .02$) and children of non-smokers ($M = .53$, $SEM = .02$), $t(134) = .78$, $p = .44$.

Questionnaires

Does parental smoking and child age predict scores on the Peer Smoking Questionnaire? A multiple linear regression analysis was conducted to predict positive and negative peer smoking perceptions based on parent smoking status and child age (Model 1) and the interaction of parent smoking status and child age (Model 2). Neither Model 1 nor Model 2 was significant for either subscale. Overall means for positive and negative subscales are in Table 2.

Does parental smoking and child age predict scores on the Smoking Consequences Questionnaire (SCQ-C and SCQ-A)? A multiple linear regression analysis was conducted to predict each of the SCQ subscales based on parent smoking status and child age (Model 1) and the interaction of parent smoking status and child age (Model 2). For the Negative Consequences subscale, Model 1 was significant, $R^2 = .06$, $F(2,140) = 5.50$, $p < .01$. There was a marginal

effect of parent smoking status such that children of smokers scored marginally lower on the Negative Consequences subscale than children of non-smokers, (β = -.15, p = .07). There was a significant effect of child age, with a positive correlation between age and Negative Consequences subscale (β = .22, p < .01). However, Model 2, did not predict significantly more variance, R^2 = .07, p > .12, indicating that there was not a significant interaction between parent smoking status and child age.

In the Negative Affect Reduction subscale, Model 1 was significant, R^2 = .05, F(2,139) = 3.55, p = .03. There was a significant effect of child age, with older children scoring higher on the Negative Affect Reduction subscale (β = .21, p = .01), but no effect of parent smoking status (p = .47). Model 2 did not predict significantly more variance in Negative Affect Reduction, R^2 = .05, p = .51, indicating that the interaction between parent smoking status and child age was not significant.

For the Social Facilitation subscale, Model 1 was marginally significant, R^2 = .04, F(2,139) = 2.93, p = .06, with a trend towards a positive correlation between child age and Social Facilitation subscale (β = .15, p .07). However, the addition of the parent smoking status x child age interaction in Model 2 did not predict significantly more variance in Social Facilitation, R^2 = .04, p = .84, indicating that the interaction between parent smoking status and child age was not significant. Neither Model 1 nor Model 2 was significant for the Positive Reinforcement, Taste/Sensorimotor, or Boredom Reduction subscales (ps > .20 for all models). Overall means for the SCQ-C and SCQ-A can be found in Table 2.

Does parental smoking and SCQ-C and SCQ-A predict children's dot probe bias scores? A series of multiple linear regression analyses were calculated to predict dot probe bias score based on parent smoking status and each of the six SCQ subscales or positive and negative Peer

Smoking subscales (Model 1) and the interaction of parent smoking status and the subscale score (Model 2). For the Taste/Sensorimotor subscale, Model 1 was significant, $R^2 = .05$, $F(2,131) = 3.32$, $p = .04$; parent smoking status emerged as a significant predictor ($\beta = -.18$, $p = .04$), with children of smokers having more negative bias scores, indicating a bias away from the smoking-related stimuli. Model 2 did not predict significantly more variance, $R^2 = .05$, $p = .46$. For the Negative Affect Reduction subscale, Model 1 was marginally significant, $R^2 = .04$, $F(2,131) = 2.67$, $p = .07$, with a significant effect of parent smoking status ($\beta = -18$, $p = .04$). The addition of the interaction in Model 2 was marginally significant, $R^2 = .06$, $p = .07$. In the second model, the interaction approached significance ($\beta = .22$, $p = .07$), with higher Negative Affect Reduction scores predicting a greater attentional bias towards the smoking-related stimuli in children who had smoking parents. Finally, the Social Facilitation subscale and parent smoking status were only marginally significant in Model 1, $R^2 = .04$, $F(2,131) = 2.72$, $p = .07$, and the addition of the interaction in Model 2 was not significant, $R^2 = .06$, $p = .11$. Neither Model 1 nor Model 2 significantly predicted dot probe score for the Positive Reinforcement, Negative Consequences, Boredom Reduction, Positive Peer Smoking, or Negative Peer Smoking subscales.

Does parental smoking and SCQ-C and SCQ-A predict children's AMP scores? A series of multiple linear regression analyses were conducted to predict AMP score based on parent smoking status and each of the six SCQ subscales or positive and negative Peer Smoking subscales (Model 1) and their interaction (Model 2). For the Negative Affect Reduction subscale, Model 1 was not significant, $R^2 = .03$, $F(2,132) = 2.19$, $p = .12$, but the addition of the interaction of parent smoking status and Negative Affect Reduction score in Model 2 was marginally more significant, $R^2 = .06$, $p = .07$, with higher Negative Affect Reduction scores for children of smokers predicting a higher proportion of smoking-related stimuli as pleasant. For the Positive

Reinforcement, Taste/Sensorimotor, Negative Consequences, Social Facilitation, Boredom Reduction, and Positive and Negative Peer Smoking subscales, neither Model 1 nor Model 2 significantly predicted AMP scores.

Discussion

The present study is the first to examine attentional biases and affective responses to smoking-related cues in 8-12 year-old children of smoking and non-smoking parents. This study revealed that children of smokers demonstrated an attentional bias away from smoking-related cues regardless of stimulus presentation time, whereas children of non-smokers did not exhibit an attentional bias to smoking-related cues. Moreover, children of smokers tended to rate a lower proportion of smoking stimuli as pleasant when compared to children of non-smokers. In addition to their implicit responses, this study also examined children's outcome expectancies about smoking behavior (Copeland et al., 2007; Lewis-Esquerre et al., 2005) and assessed the relationship of those expectancies with the implicit measures. Children's smoking outcome expectancies generally did not differ as a function parent smoking status, with the exception of their perceptions of the negative consequences of smoking. For this subscale, children of non-smokers rated the negative consequences of smoking as marginally more likely than children of smokers. As children got older, they began to recognize more of the negative consequences of smoking but also that smoking can reduce negative affect. Their smoking outcome expectancies were largely unrelated to their attentional bias or implicit affective responses to smoking stimuli. However, we did find that negative affect reduction tended to moderate with the AMP and the dot probe scores for children of smokers. For these children, higher expectancies of negative affect reduction predicted a higher proportion of smoking-related stimuli rated as pleasant and

more attentional bias toward smoking, suggesting that children's expectancies may moderate the association between early experiences with tobacco and there implicit responses.

Overall, however, the findings from this study did not support the hypothesis that children of smokers have an attentional bias towards smoking related cues, which has been found with non-smoking college students (Forestell et al., 2012). Instead, this study suggests that children with smoking parents show an attentional bias away from smoking stimuli that children with non-smoking parents do not exhibit. This finding is inconsistent with the only other study investigating attention towards smoking-related cues in children (Lochbuehler, Otten, Voogd, & Engels, 2012). This study tracked eye movements while watching movie clips that contained smoking and non-smoking scenes. Lochbuehler et al. (2012) found that 10-13 year-old children of smokers focused more often and longer on smoking cues than children of non-smokers. Although the findings from the current study do not support this previous study, there are a number of differences in methodology between these two studies that may account for some of these differences, such as the different tasks (eye-tracking versus dot probe), and the content and delivery mode of the visual stimuli. For instance, while the display duration of the static stimuli was fixed at 500ms or 2000ms in the current study, the smoking scenes from the movie clips varied from 560ms to over 11 seconds in duration, and over half of children had seen the movies before. Given that smokers consistently show an attentional bias towards smoking related cues (Bradley et al., 2003; Ehram et al., 2002; Mogg et al., 2003) and that non-smoking college students with smoking parents show an attentional bias towards smoking related cues (Forestell et al., 2012), the early and sustained bias away from smoking-related cues that children of smokers demonstrate is particularly significant.

In the current study, children of smokers tended to evaluate the smoking-related cues more negatively than children of non-smokers. While their overall negative affective responses to smoking stimuli are consistent with findings that adults smokers and non-smokers more readily associate smoking-related stimuli with negative cues than with positive cues (Sherman et al., 2003; Waters et al., 2007), smokers typically show a more positive association for smoking-related cues than non-smokers (Sherman et al. 2003), and children of smokers have been shown to have more positive associations for smoking-related cues in the IAT than children of non-smokers (Andrews et al., 2010). The difference between children of smokers and children of non-smokers in the current study, while marginally significant, was in the opposite direction from what was hypothesized based on previous research with adults (Payne et al., 2007). Although these findings deviate from previous studies, they emphasize the utility of a variety of tasks, including the AMP, to assess implicit attitudes, and reiterate that children's implicit attitudes may not be consistent with their parents' attitudes or across subsets of attitude measurement.

The negative attentional bias and negative affective responses in children of smokers may relate to the emotional contexts in which these children's parents smoke. Previous research has shown that while 3-8 year-old children of smokers are more likely than children of non-smokers to prefer the odor of cigarette smoke over neutral or unfamiliar odors, for children of smokers, their preference for cigarette odor was related to their mothers' mood disturbance and depression scores (Forestell & Mennella, 2005). Those children who had mothers with higher mood disturbance scores were less likely to indicate that they liked the odor of cigarette relative to neutral odors than children whose mothers had low mood disturbance scores. These authors suggested that early sensory experiences with the odor of cigarette became associated with the

emotional context of those experiences. Therefore, if a child has a mother who smokes when she is anxious, the child may learn to associate the cigarette with this negative emotional state. The results from the present study suggest that this may in turn lead to attentional avoidance of cigarette related cues. Given that earlier findings from our laboratory indicated that college students who reported having parents who smoked demonstrated attentional biases *toward* smoking related cues (Forestell et al., 2012), it is possible that this cognitive mechanism follows a developmental trend.

Indeed, this explanation is consistent with findings in the present study that demonstrated that older children score higher than younger children on the Negative Affect Reduction subscale of the SCQ, suggesting an increased understanding of the complex emotional states surrounding smoking and motivations to smoke. This finding is consistent with a study that assessed beliefs about smoking in second- and fifth-grade children via open-ended questions and showed that the older children were more likely than younger children to believe that smoking could decrease stress and reduce negative mood states (Freeman, Brucks, & Wallendorf, 2005). Similar to our findings, Freeman et al. (2005) also found no effect of having a smoking member of the household on this association. However, despite the awareness that smoking decreases stress and anxiety, older children in the present study also scored higher on the Negative Consequences subscale than younger children, consistent with the idea that older children may be more aware of the effects of smoking (Copeland et al., 2007).

Although young children show an attentional bias away from smoking related cues, as they get older they likely develop more complex cognitive schemas about smoking behavior that include an understanding that smoking causes relief from stress and tension, and this in turn may contribute to the development of an attentional bias towards smoking related cues. Recognizing

the relationship between smoking and mood state on smoking behaviors may influence attention; conversely, attention to smoking stimuli may shape the development of certain outcome expectancies. Why this specific area but not any of the other outcome expectancies related to attention for children of smokers but not children of non-smokers should be investigated in future studies. Overall, these results are largely consistent with previous findings indicating that explicit measures may not be predictive of implicit measures (Sherman et al., 2003), especially for socially stigmatized behaviors such as smoking (Lochbuehler et al., 2012; Stacy, 1997).

The marginally significant interaction of parent smoking status and the expectancy that smoking reduces negative affect in predicting implicit affect suggests that for children of smokers, an understanding of smoking as a means of relief from negative mood states may predict a more positive implicit affective response to smoking-related stimuli. This relationship between an explicit understanding of smoking as reducing negative affect and an increasingly positive implicit affective response to smoking-related stimuli requires further investigation, but may play a role in smoking initiation, as negative mood has been shown to relate to adolescent smoking (Audrain-McGovern, Rodriguez, & Kassel, 2009; Weinstein & Mermelstein, 2013), and beliefs in the negative affect reduction properties of smoking relates to increased smoking initiation and escalation in adolescents (Heinz, Kassel, Berbaum, & Mermelstein, 2010).

Surprisingly, there was little difference between children of smokers and those of non-smokers on most of the smoking outcome expectancy scales; the only exception was that children of smokers scored marginally lower on the Negative Consequences subscale than children of non-smokers. It is appears children of smokers minimize the health risks of smoking, perhaps because some risks are not immediate or visible, or because they do not want to consider the possibility that smoking is placing their parents at risk. This minimization of the negative

health consequences of smoking may make them more likely to smoke than those who recognize and are potentially deterred by the negative health risks of smoking. However, for all of the differences in smoking outcome expectancies found in the current study, effect sizes were relatively small.

Although the findings in this study were unexpected, there are factors that lend strength to the legitimacy of these findings. Firstly, the stimuli used were carefully matched to control for color, size, and shape, and they were pilot-tested with children to ensure that the images were identifiable as smoking- or non-smoking-related. Secondly, although tasks like the dot probe and the AMP have been used less frequently with children than with adults, they have been used successfully (e.g., Briggs-Gowan et al., 2015; Williams, 2012), and in the current study, less than 5% of cases were removed in these implicit tasks, indicating that the child participants were able to successfully complete these tasks. Additionally, due to the lack of research on cognitive processes related to smoking in children, the hypotheses in this study were based off of findings in adult smokers and adults with smoking parents. It is not unreasonable to expect that preadolescent children of smokers may have different implicit reactions to smoking stimuli than young adults with smoking parents.

Despite the well-structured nature of the study, there are a few limitations. First and foremost, the quasi-experimental design prevents full attribution of differences found between the two groups to the parents' smoking status. Furthermore, while the selection of 500ms and 2000ms in the dot probe was intended to capture an early and delayed attentional bias, respectively, it is not a comprehensive exploration of attentional bias, leaving space for changes during time periods not measured. Testing shorter display durations in future studies could evaluate any early changes in attention towards smoking-related stimuli in children of smokers.

The need for further assessment of early attention is supported by evidence that an even shorter time frame, such as 200ms or less, may be needed to assess automatic orienting (Field & Cox, 2008). Studies with alcohol abusers in treatment, who are likely motivated to avoid alcohol-related stimuli, show an attentional bias towards alcohol-related cues with display durations 100ms and under but show an attentional bias away from these alcohol-related cues at 500ms (Noel et al., 2006; Stormark, Field, Hugdahl, & Horowitz, 1997). Stormark et al. (1997) suggested an approach-avoidance conflict in these abstaining alcoholics, with the alcohol cues eliciting emotional associations that interrupt attention once the object has been identified. Future studies with children of smokers should examine if they show a similar pattern of orienting towards smoking-related stimuli displayed for less than 500ms. Evaluating initial attentional biases is also valuable because there is evidence to suggest that there are developmental changes in alerting that may make children's preliminary responses characteristically different from adults' (Mullane, Lawrence, Corkum, Klein, & McLaughlin, 2016).

Moreover, children's explicit evaluations of the emotional valence of AMP and dot probe cues were not assessed. Those responses could provide valuable information in future studies that might indicate if children of smokers are aware of their negative affective responses towards smoking-related cues, and if so, to what they attribute that negative affective response (e.g., sensory aspects of cigarettes, negative mood states, etc.).

Due to a lack of power, this study was unable to investigate differences between more specific parent-smoking subgroups, such as one parent currently smokes, both parents currently smoke, and parents who recently quit smoking. An investigation of these different subgroups might reveal further differences within the broader "smoking" classification used in the current

study. Compared to ex-smokers, current smokers express greater beliefs in the negative affect reduction of smoking and minimize the health risks of smoking (Chapman, Wong, & Smith, 1993; Copeland et al., 1995; Eiser, Sutton, & Wober, 1979). Some of these beliefs may be transmitted to their children, creating more diverse conceptualizations of smoking within the overarching group of "children of smokers."

These findings emphasize the importance of investigating factors related to smoking behaviors in pre-adolescents because these children may be qualitatively different from adolescents and adults in their implicit responses to smoking-related stimuli. Children of smokers exhibited a significantly greater attentional bias away from smoking-related stimuli and a marginally more negative affective response to smoking-related cues than children of non-smokers. If the findings from the current study represent a point in the developmental trajectory of smoking behaviors, they could indicate critical time periods and methods for smoking prevention. Tiffany's (1990) model of addictive behaviors would emphasize examining when and how attentional biases away from smoking-related cues shift to attentional biases towards smoking related cues, because the formation of these automatic processes may also relate to the activation of schemas that are involved in smoking behaviors. Future studies should track changes in implicit affect and attentional bias towards smoking-related cues in children through adolescence to assess their impact on and relationship with smoking initiation and maintenance. While the causes of the responses found in children of smokers are currently unidentified, studies such as those that examine how negative mood states are associated with smoking might provide places for initial investigation. Overall, these results underscore the influence of early exposure to cigarette smoking, particularly on some cognitive mechanisms related to attention and affect. Given the minor differences in the smoking outcome expectancies between children of smokers

and children of non-smokers and the more significant findings on the implicit studies, this study also reiterates the value of implicit measures. The novelty of the current study and the unexpected findings make it an area that merits further investigation.

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Table 1
Participant Characteristics by Parent Smoking Status

Variable	Non-smoking Parents (n = 76)	Smoking Parents (n = 67)	Test Statistic
Age months	121.67 ± 16.69	121.59 ± 18.66	$t(140) = -.03$
Gender (% Female)	55.3	58.2	$\chi^2(1) = 0.13$
Primary parent's age (years)	42.20 ± 5.17	36.19 ± 6.43	$t(141) = -6.10$**
Secondary parent's age (years)	43.01 ± 5.88	38.70 ± 7.10	$t(133) = -3.86$**
Race (%)			$\chi^2(6) = 6.01$
White/Caucasian/European	75.0	72.3	
Black/African-American	5.3	10.8	
Asian	5.2	0.0	
Multi/Other	14.5	16.9	
Household Income (%)			$\chi^2(1) = 23.36$**
Under 75K	28.9	72.3	
Over 75K	71.1	27.7	
Highest Parental Education (%)			$\chi^2(4) = 25.03$**
Graduated high school or completed GED	0	6.2	
Some college	11.8	32.3	
Associate's degree	3.9	15.4	
Bachelor's degree or higher	84.2	46.2	
Body mass index (kg/m^2)	18.99 ± 4.63	19.29 ± 4.86	$t(134) = .38$
Household cigarettes per week	0	102.75 ± 76.72	

Note. Values presented as mean ± standard deviation, unless otherwise specified.
$^+$ Denotes marginal effects at $p < .10$ * Denotes statistical significance at $p < .05$ ** Denotes statistical significance at $p < .01$

Table 2

Responses to Child Questionnaires by Parent Smoking Status

Variable	Non-smoking Parents (n = 76)	Smoking Parents (n = 67)	Test Statistic
Percent susceptible	3.9%	13.4%	$\chi^2(1) = 4.17^+$
SCQ-C and SCQ-A			
Positive Reinforcement	3.38 ± 1.06	3.48 ± .97	$t(141) = .56$
Negative Consequences	41.14 ± 5.19	39.25 ± 7.10	$t(141) = -1.83^+$
Negative Affect Reduction	14.22 ± 6.10	14.95 ± 6.68	$t(140) = .68$
Taste/Sensorimotor	2.39 ± 1.33	2.23 ± .63	$t(140) = -.94$
Social Facilitation	10.04 ± 3.04	11.17 ± 5.28	$t(140) = 1.59$
Boredom Reduction	1.76 ± 1.03	1.59 ± .91	$t(140) = -1.05$
Peer Smoking			
Positive	10.08 ± 2.86	10.50 ± 3.24	$t(139) = .82$
Negative	17.27 ± 5.14	16.51 ± 5.44	$t(138) = -.85$

Note. Values presented as mean ± standard deviation, unless otherwise specified.
$^+$ Denotes marginal effects at $p < .10$ * Denotes statistical significance at $p < .05$ ** Denotes statistical significance at $p < .01$

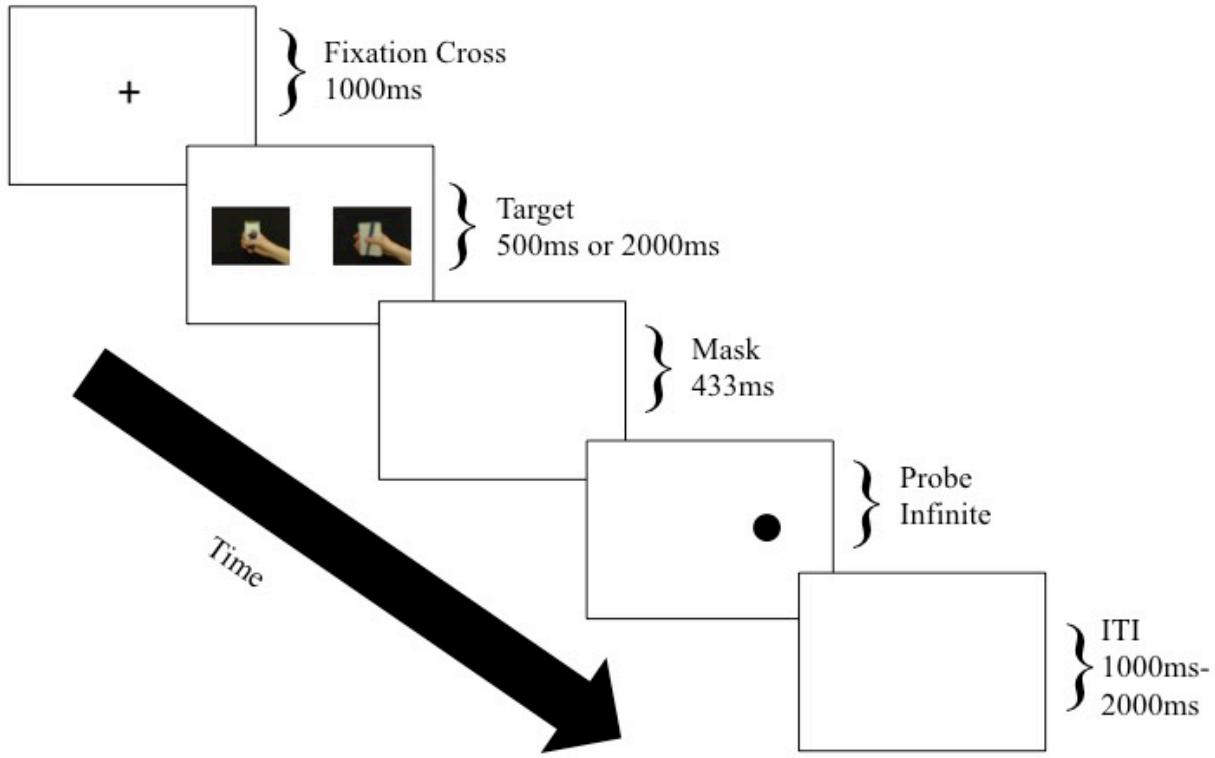


Figure 1. Schematic of the dot probe. Slides are presented in chronological order and display duration is under each label.

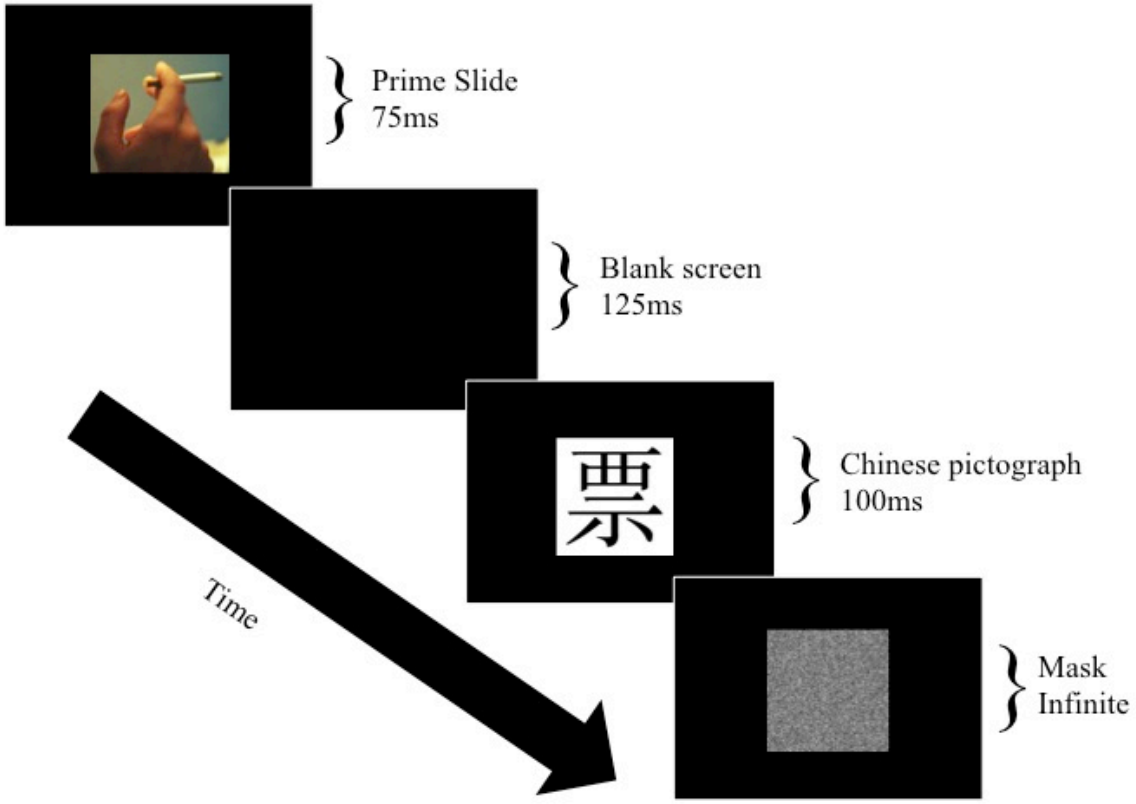


Figure 2. Schematic of the AMP. Slides are presented in chronological order and display duration is under each label.

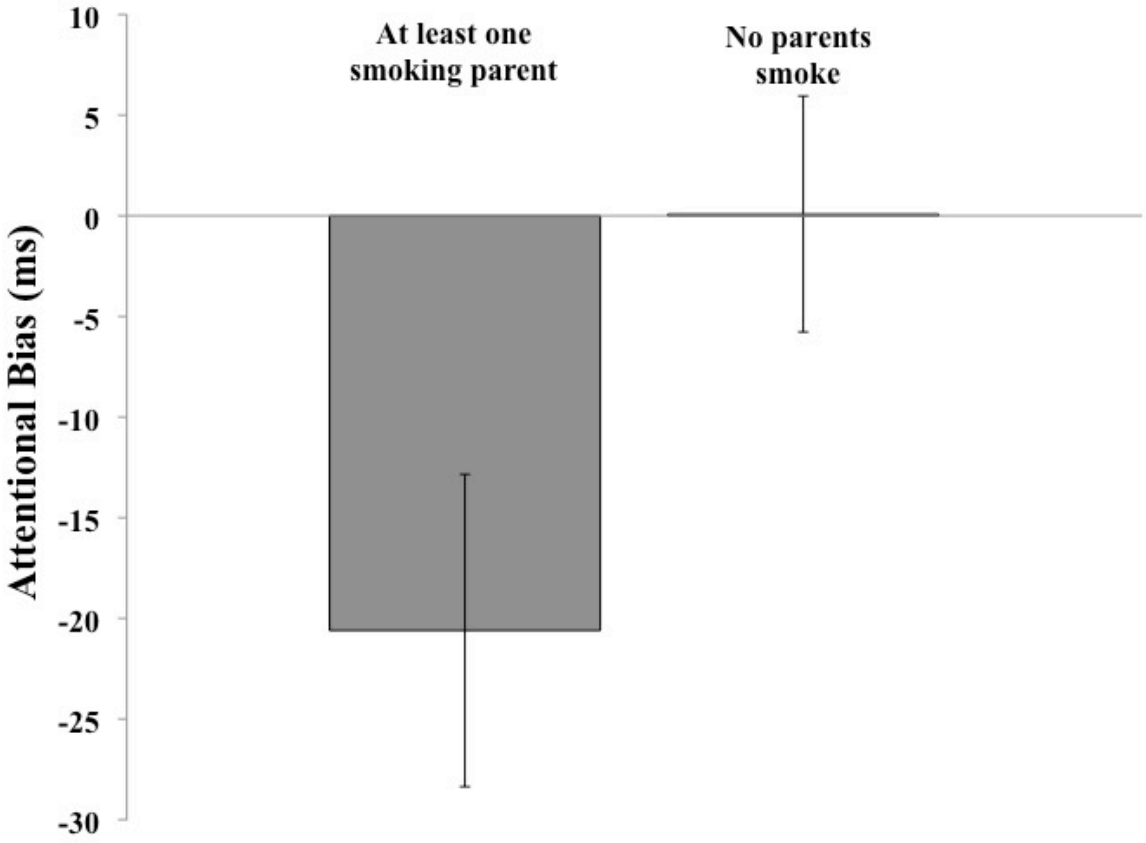


Figure 3. Mean attentional bias scores (±SEM) for children with at least one parent who has smoked cigarettes in the last two years and children who have no parents who have smoked during the child's lifetime. Negative scores indicate bias away from smoking-related stimuli.

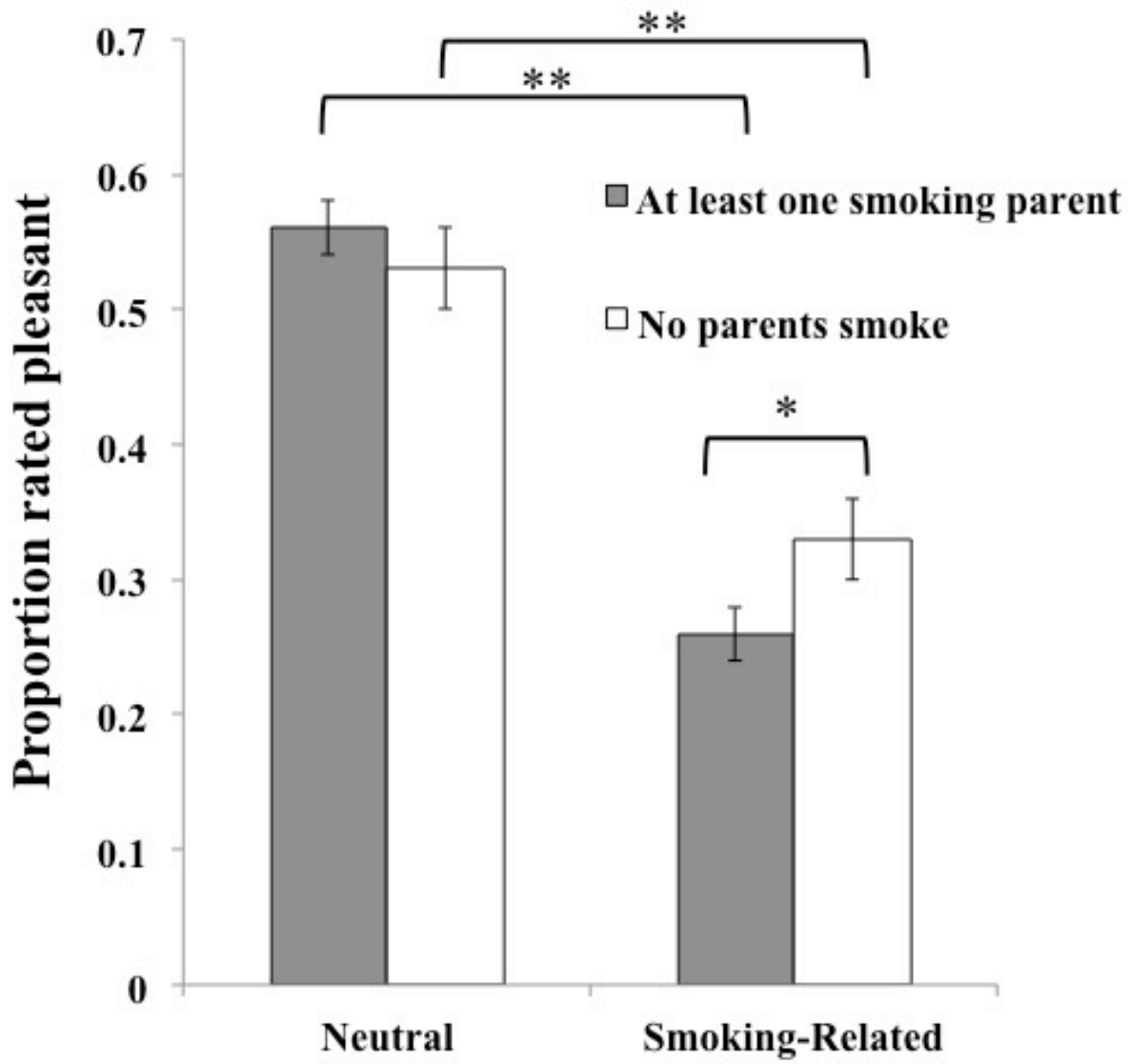
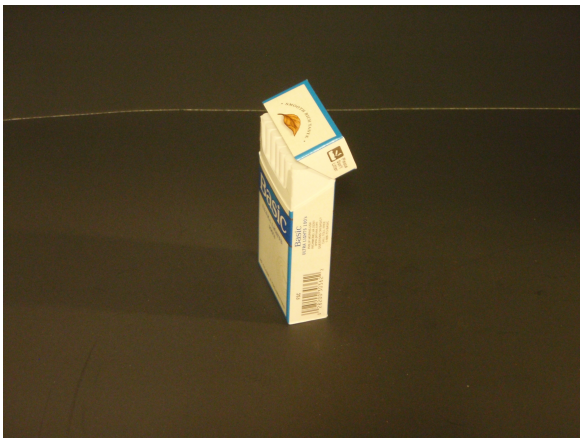


Figure 4. Mean proportion of AMP stimuli rated pleasant (±SEM) with smoking-related and neutral primes, for children with at least one parent who has smoked cigarettes in the last two years and children who have no parents who have smoked during the child's lifetime.

* Denotes marginal effects at $p < .10$ ** Denotes statistical significance at $p < .001$

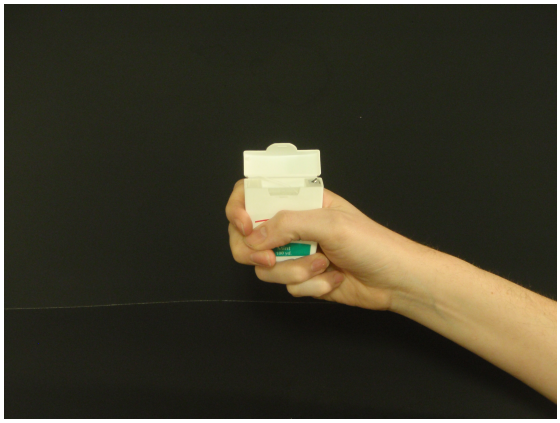
Appendix 1

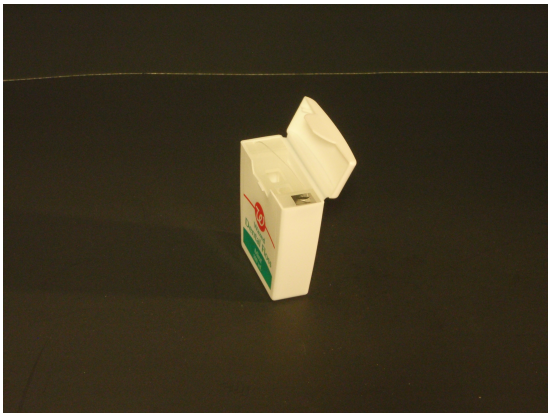
Examples of Smoking-Related Stimuli from the Dot Probe



Appendix 2

Examples of Non-smoking-Related Stimuli from the Dot Probe





Appendix 3

Examples of Smoking-Related Stimuli from the AMP

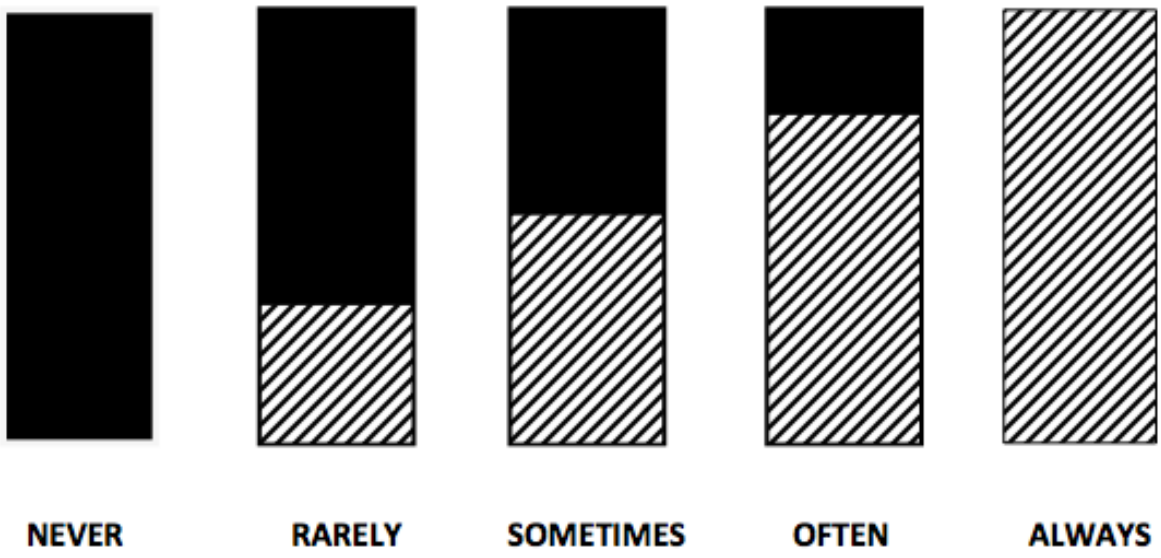
Appendix 4

Examples of Non-smoking-Related Stimuli from the AMP

APPENDIX 5

Scale with possible answers to smoking susceptibility and peer smoking questionnaire

VERY UNLIKELY	**UNLIKELY**	**MAYBE**	**LIKELY**	**VERY LIKELY**
DEFINITELY NOT	**PROBABLY NOT**	**MAYBE**	**PROBABLY WOULD**	**DEFINITELY WOULD**
NOT AT ALL	**A LITTLE**	**SOMEWHAT**	**VERY**	**EXTREMELY**

APPENDIX 6

Scale with possible answers to smoking outcome expectancy questions for children