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Children's Hedonic Judgments of Cigarette Smoke Odor: Effects of Parental Smoking and Maternal Mood

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Abstract

Age-appropriate tasks were used to assess 3- to 8-year-old children's liking, identification, and preference for a variety of odors, including that of exhaled cigarette smoke. Children whose parents smoke took longer to decide whether they liked the cigarette odor and were significantly more likely to prefer the odor of cigarette to the neutral and unfamiliar odor of green tea compared with children of nonsmokers. Among children of smokers, relative preferences for the cigarette odor were related to maternal mood disturbance and depression scores. These findings suggest that some early learning about cigarette smoke odor is based on sensory experiences at home and anchors it to the emotional context in which their mothers smoke.

Keywords

cigarette; development; mother-child interactions; olfaction; tobacco

Approximately one quarter of children in the United States (Soliman, Pollack, & Warner, 2004) and Canada (Health Canada, n.d.) and half of children worldwide (World Health Organization [WHO], 1999) live in a household in which one or both parents smoke cigarettes. Such exposure to environmental tobacco smoke puts children at higher risk for a wide variety of adverse health effects, including lower respiratory tract infections such as pneumonia and bronchitis, coughing and wheezing, worsening of asthma, and ear infections (WHO, 1999). These children are also significantly more likely to experiment with smoking during adolescence (Bauman, Foshee, Linzer, & Koch, 1990; Chassin, Presson, Rose, Sherman, & Prost, 2002; den Exter Blokland, Engels, Hale, Meeus, & Willemsen, 2004; Osler, Clausen, Ibsen, & Jensen, 1995), increasing their risk of becoming habitual smokers like their parents.

Although genetics makes a strong contribution, environmental and social factors also contribute to both smoking initiation (True et al., 1999) and nicotine dependence (Sullivan & Kendler, 1999; True et al., 1999). To be sure, the factors that predispose one to smoking initiation (e.g., genetics, parental smoking behaviors and attitudes) appear to overlap substantially, but not completely, with those of nicotine dependence (Kendler et al., 1999; Sullivan & Kendler, 1999).

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From an early age, children begin to acquire a broad understanding of the nature of smoking. Preschoolers know that adults smoke more than children and are aware of the significant health risks associated with smoking (Porcellato, Dugdill, Springett, & Sanderson, 1999). Likewise, children between the ages of 7 and 9 years continue to view cigarette smoking as “wrong, boring, and bad for one’s health” (Oei & Burton, 1990). However, as adolescence approaches, their attitudes became more positive (Pisano & Rooney, 1988), making this a period of increased vulnerability to smoking initiation (Baker, Brandon, & Chassin, 2004). Whether children initiate smoking at an early age appears to be, in part, a function of the antismoking attitudes and behaviors of their parents. In one study (Andersen et al., 2002), the number of children who began smoking by 12th grade was reduced by approximately 50% if, by the time the child was 8 years old, their mothers communicated to them strong antismoking attitudes. However, such communications by the mother did not have a protective effect if she or the father was a smoker. Thus, it appears that maternal attitudes and concerns regarding smoking influence smoking initiation when they are consistently expressed to children from a young age, provided that parental smoking habits are consistent with these attitudes.

That early learning extends beyond the realm of purely verbal and media exposure to sensory experience is suggested by prior studies on olfactory learning in children. Because of the strong emotional component of odors (Herz & Cupchik, 1995), they can be effective memory cues for children when smelled during emotionally salient situations (Epple & Herz, 1999; Mennella & Garcia, 2000). For example, children whose parents drank alcohol to escape problems were more likely to dislike the odor of beer compared with similarly aged children whose parents did not drink to escape (Mennella & Garcia). These findings suggest that some early learning about alcohol is based on associations between the child’s sensory experiences at home and the emotional context in which parents consume alcohol. The current study followed from these findings and tested the hypothesis that children’s hedonic response to the odor of cigarette smoke would be related to their parents’ smoking habits and the context of such experience. We hypothesized that children of smokers would like the cigarette odor and prefer it relative to a neutral odor more than children of nonsmokers. Moreover, we hypothesized that children’s preference for cigarette odor would be attenuated if their mothers experienced cigarettes in a negative emotional context.

Method

Participants

Mothers of 3-to 8-year-old children ($N = 296$) were recruited from advertisements in local newspapers. During the telephone interview, mothers were told that we were recruiting participants for a smell study in which they and their children would be asked to judge a variety of odors of everyday items, including foods and beverages. The mothers and children were unaware of the hypothesis of the study. One hundred seventy-five of the children were 3 to 4 years of age, 90 were 5 to 6 years, and the remaining 31 were between the ages of 7 and 8 years. Forty-six of these children were excluded from the sample because they were deemed by an uninformed observer to not understand the first task. Although 42 of these excluded children were between the ages of 3 and 4 years, it should be emphasized that 133 (or 76%) of the 3-to 4-year-old children tested did understand the task and were included in Task 1 data analysis. An additional 40 children were excluded because they did not understand Task 2 (see later discussion).

Because it is unknown whether olfactory memories of cigarette odor are long-lived, we excluded 4 children because, although the mothers had smoked during their child’s lifetime, they had quit smoking more than 3 to 4 years before testing. Nine additional children were also excluded from analysis because the fathers’ smoking status was ambiguous ($n = 3$) or they

were from households in which their parents were nonsmokers but there were other family members in the house who smoked (e.g., grandparents, siblings; $n = 6$).

The final sample of 237 children (and 203 mothers) included 28 sibling pairs and 3 sibling triads in Task 1. The racial background of these children was as follows: Caucasian, 42.6%; African American, 38%; Hispanic, 0.4%; Asian, 1.3%; and admixed-other, 17.7%. All testing procedures were approved by the Office of Regulatory Affairs at the University of Pennsylvania. Informed consent was obtained from each mother and assent from each child who was 8 years of age.

Test Stimuli

The test stimuli included a variety of odors that differed in hedonic valence, one of which was the odor of cigarette smoke (hereafter referred to as cigarette odor). Each odor stimulus was presented individually in foil-covered, 250-mL polyethylene plastic squeeze bottles with flip-up caps. The odors, approximately matched for perceived intensity by adults, included bubblegum (5 ml of a 0.03% solution; Takasago, Kanagawa, Japan); strawberry (3 ml of a 0.06% solution; Takasago); chocolate (5 ml of a 0.02% solution; IFF, New York); cola (5 ml of Coca Cola); coffee (2 g of Maxwell House coffee grounds); green tea (5 ml of a 0.10% solution; Takasago); pyridine, which has the odor of spoiled milk (3 ml of a 0.03% solution; ACROS, Morris Plains, NJ); tuna (5 ml of a 0.02% solution; Takasago); cigarette odor (the exhaled smoke of one half of a cigarette from a female smoker, which was directed into a squeeze bottle containing 5 ml mineral oil; see Grüsser, Heinz, & Flor, 2000); and a blank bottle (5 ml of mineral oil). We also assess the children's responses to the odors of beer and whiskey; these data are presented in a separate study.

Testing Procedures

Age-appropriate tasks embedded in the context of games that were fun for children and minimized the impact of language development (Schmidt & Beauchamp, 1988; Mennella & Garcia, 2000) were used to assess children's hedonic responses to odors. During Task 1, children were presented with individual odors that varied in hedonic valence to determine their liking or disliking of odors, whereas in Task 2 they were presented with pairs of odors to determine relative preference (see later discussion). Each task revealed different aspects of hedonic judgment in young children (see Popper & Kroll, 2003).

Children and their mothers were tested in a closed room with a high-air-turnover ventilation system specifically designed for sensory testing. Each participant sat at a small table specially designed for children on which two "Sesame Street" character toys, Big Bird and Oscar the Grouch, were placed; the position of the characters (i.e., right vs. left) was randomized. During each trial, the experimenter presented the odors by holding the stimulus bottle about 3 cm from the participant's nose and gently delivered three puffs of air to the nostrils; the interstimulus interval was approximately 60 s. Because previous research revealed that children were reluctant to participate in a research study when the first odor stimulus was unpleasant (Schmidt & Beauchamp, 1988), trials began with either the bubblegum or strawberry odor. Otherwise, the order of stimulus presentation was randomized.

During testing, each mother sat approximately 2 ft behind her child, out of the child's view. This distance was chosen because previous work in our laboratory revealed that individuals could not smell the contents of the squeeze bottles when seated this far away from the odor source (Mennella & Garcia, 2000). Mothers were asked to refrain from talking during the test session. They wore a mask to prevent them from smelling the odors, and they listened to music with headphones to prevent them from hearing their children's answers. After the children completed both tasks, the mothers' liking and identification of the odors were determined using

procedures identical to those used for the children (Task 1). The entire session was videotaped, and trained observers who were unaware of the experimental hypotheses later analyzed the videotapes to assess the children's comprehension of the task and measured the time it took them to make hedonic decisions about the odors (hereafter referred to as response times). On completion of testing, children received \$3 and a Beanie Baby, and the mothers received \$50.

Task 1: Odor liking and identification.—After participants acclimated to the room and personnel, they were told that they were going to play a smell game (Mennella & Garcia, 2000; Schmidt & Beauchamp, 1988). In brief, children were told that if they liked the smell inside the bottle, they should give it to a stuffed toy of Big Bird (a likable, well-known TV character), but if they did not like the smell, they should give it to another well-known character, Oscar the Grouch, “so that he can throw it in his trash can.” Before beginning the smell game, the experimenter ascertained whether or not the child comprehended the task by asking him or her to point to which character should receive the bottle if it smelled “yucky” and which character should receive the bottle if it smelled “good.” The experimenter proceeded with the game only after the child pointed to the correct characters in these two imagined situations. After children determined whether they liked or disliked each of the individual odors (e.g., gave the bottle containing the odor to one of the two characters), they were asked to identify the odor. The participant's response was categorized as correct (see Desor & Beauchamp, 1974; Mennella & Garcia, 2000) if it was either an exact designation of the stimulus or an item that is in the same narrow class as the stimulus (e.g., “smoke,” “ash tray,” “fire,” “trash” for cigarette; “rotten food” for pyridine; “candy” for bubblegum; and “air” for the blank).

Task 2: Relative preference for odors.—After a 5-min break, children were asked to play a second smell game. In this task, only Big Bird was placed in the center of the table. During each trial, children were presented with two bottles, one of which contained the cigarette odor and the other the odor of either bubblegum, coffee, pyridine, chocolate, cola, or green tea odor. These comparison odors ranged in both odor hedonics and familiarity. Children were told to give the bottle they liked better to Big Bird.

Videotape Analyses

Videotapes were coded by trained observers, who were unaware of the experimental hypotheses of the study. For Task 1, we determined the response times (the number of seconds from the moment when the experimenter placed the bottle on the table to the moment when the participant made a hedonic judgment for each of the odors; i.e., by pointing to Big Bird or Oscar, verbally indicating that it smelled good or bad, or placing the bottle in front of one of the characters). Similarly, in Task 2, response times were measured from the moment the experimenter placed the second bottle onto the table until the child indicated his or her preference (i.e., by pointing to the bottle that smelled better, verbally indicating which bottle smelled better, or placing one of the bottles in front of Big Bird). A response time score of 0 was assigned if the child indicated a liking for the odor (Task 1) or an odor preference (Task 2) before the experimenter placed the bottle on the table. Interrater reliability, which was determined by correlating two raters' determinations of the response times of a random sample of 122 trials, was 99% ($p < .0001$).

Questionnaires

Each mother completed a variety of questionnaires to assess her cigarette and alcohol use, level of depression and mood state, her child's temperament and eating habits, as well as her own eating habits.

Smoking habits.—Each mother was asked to indicate whether she or the child's father or stepfather currently smokes or had smoked in the past. For those mothers who smoked during

their child's lifetime, they reported their current daily cigarette usage or, if they had quit since the child's birth, the age at which they quit smoking and their daily cigarette usage at the time of quitting. Similar information was collected for the child's father (and/or stepfather), other members of the household, and those with whom the child spent time on a daily basis.

Mood states.—All but 3 mothers completed the 65-item Profile of Mood States (POMS; McNair, Lorr, & Droppleman, 1992), which measures six independent, transient mood states: Tension (rating range = 0-36), Depression (rating range = 0-60), Anger (rating range = 0-48), Vigor (rating range = 0-32), Fatigue (rating range = 0-28), and Confusion (rating range = 0-28). Higher scores reflect higher intensity of the mood states. Additionally, a total mood disturbance score, which is considered a global measure of mood disturbance, was calculated by subtracting the one positive mood (Vigor) from the sum of the remaining five negative mood scores. All but 5 of the mothers also completed the 21-item Beck Depression Inventory (BDI), which measures characteristic attitudes and symptoms of depression (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961). Scores could range from 0 to 63; scores greater than 18 were considered indicative of moderate to severe depression.

Child temperament and eating habits.—Because many of the test odors were of food items, the mothers were asked to report how often per week they and their children ate the foods or beverages associated with odors under study. All but 7 of the mothers also completed a 10-item food neophobia scale that measured her propensity to approach or avoid novel foods, and all but 6 completed an eight-item general neophobia scale that measured her preferences for familiar situations and people versus a willingness to experience new situations and people (Pliner & Hobden, 1992). They also completed the Child Eating Behavior Questionnaire, which consists of five subscales that assess shyness, emotionality, activity, negative reactions to foods, and food neophobia in children (Pliner & Loewen, 1997).

Data Analyses

Classification of groups.—Children were placed in one of two groups based on the smoking status of the mother (mother smoker vs. mother nonsmoker). Of the 237 children, 174 had a mother who was classified as a nonsmoker because she never smoked during the child's lifetime, whereas 63 of the children had a mother who either currently smokes cigarettes ($n = 54$) or had quit smoking less than 2 years before testing ($n = 9$). All of the mothers in the smoking group reported smoking since the birth of the child and for at least 60% of the child's life.

Two subgroups were then formed based on the smoking status of the father (father smoker vs. father nonsmoker). Those children who did not live with their biological father were included in the father nonsmoker category if the household was occupied only by the mother and they did not see their father regularly ($n = 47$). The remaining children were classified according to the smoking status of the mother's current husband or partner (hereafter referred to as stepfather) if they had no contact with their biological father ($n = 10$) or if their biological father did not smoke ($n = 6$). Sixty-two of the children had a father ($n = 56$) or stepfather ($n = 6$) who smokes, whereas 128 had a father or stepfather who does not smoke.

As shown in Table 1, children were also grouped according to the smoking habits of both parents. Such groupings resulted in 135 children who lived in a household in which neither parent smokes and 102 of the children who lived in a household in which one or both of the parents smoke.

Participant characteristics.—A series of 2×2 analyses of variance (ANOVAs) were conducted to determine whether there were significant differences as a function of parental

smoking (i.e., Maternal Smoking Status $\times$ Paternal Smoking Status) on a variety of measures such as child's age, body mass index (BMI [kg/m^2]), and temperament; mother's age, daily cigarette use, and POMS and BDI scores; and father's age and daily cigarette use. Pearson chi-square analyses were also performed to determine whether there were group differences in sex ratio and ethnicity as a function of paternal or maternal smoking habits. For the analysis of ethnicity, Hispanic and Asian children were categorized into the "other ethnic" group because of the small numbers (< 5) in these cells.

Task 1: Odor liking, identification, and response times.—The percentage of participants who classified each odor as pleasant (i.e., gave it to Big Bird) or unpleasant (i.e., gave it to Oscar the Grouch) and who correctly identified each odor from Task 1 was determined. Cochran's Q tests were performed to determine whether their liking and their ability to identify the odors varied as a function of odor quality. Children's liking of the odors was also compared with that of their mothers using Spearman's ranked correlation (see Schmidt & Beauchamp, 1988). Pearson chi-square tests were then performed to determine whether odor liking and identification varied as a function of odor quality and parental smoking (neither parent smokes vs. one or both parents smoke). Similar analyses were also conducted to determine whether children's hedonic judgments of the odors varied as a function of their ability to identify the odors. Yates's correction factor was applied when cell frequencies were less than five. To determine whether the length of time it took each child to make a hedonic judgment was affected by parental smoking, we conducted mixed 2×2 ANOVAs with odor liking (like vs. dislike) as the within-subjects factor and parental smoking (neither parent smokes vs. one or both parents smoke) as the between-subjects factor.

Task 2: Odor preferences.—To determine whether there were significant differences among the groups in their preference for the cigarette odor as a function of parental smoking habits (one or both parents smoke vs. neither parent smokes), the percentage of children who chose the cigarette odor relative to the comparison odors was calculated. Separate t tests were conducted to determine whether children's preferences differed as a function of parental smoking and their preference for cigarette odor relative to the comparison odors.

To determine whether maternal mood interacted with the smoking status of mothers on children's preferences for the cigarette odor, separate 2×2 ANOVAs were conducted with mothers' smoking status and children's preference for the cigarette odor relative to each of the comparison odors as between-subjects variables and maternal scores on the POMS and BDI as dependent variables. Simple-effects analyses were then conducted with t tests to break down any significant interactions. All summary statistics reported here are expressed as means $\pm$ *SEM*, and all p values represent two-tailed tests.

Results

Participant Characteristics

Salient characteristics of the mother-child pairs are presented in Table 1. There were no significant effects of maternal and paternal smoking on the children's ages, sex ratio, and BMI or on the mothers' and fathers' ages (all $ps > .10$). However, parental smoking was related to significant differences in the child temperament measures of emotionality and shyness. That is, mothers who smoke rated their children as being more emotional than mothers who did not smoke, $F(1, 225) = 4.39, p < .04$. For shyness, there was a significant Maternal Smoking Status $\times$ Paternal Smoking Status interaction, $F(1, 228) = 3.97, p < .05$. Children of two smoking parents were rated by their mothers as more shy compared with ratings of children who had only a smoking father, $t(58) = 2.00, p < .05$.

Mothers who smoke reported smoking 8.0 ± 0.5 cigarettes per day, and the age at which they had their first cigarette was, on average, 14.7 ± 0.5 years. Fathers who smoke were reported to smoke approximately 13.0 ± 0.9 cigarettes daily. Mothers who smoke had significantly higher mood disturbance scores compared with nonsmoking mothers, as measured by the total POMS, $F(1, 196) = 8.06, p < .01$, and all of the POMS subscales—Tension, $F(1, 196) = 11.60, p < .001$; Depression, $F(1, 196) = 6.59, p < .02$; Anger, $F(1, 196) = 4.58, p < .05$; and Confusion, $F(1, 196) = 7.05, p < .01$ — except Fatigue, $F(1, 196) = 2.98, p = .09$, and Vigor, $F(1, 196) = 1.26, p = .26$. They also scored significantly higher on the BDI, $F(1, 194) = 9.53, p < .005$, and were significantly more likely to be classified as moderately to severely depressed (23.0%) compared with nonsmoking mothers (7.5%), $\chi^2(1, N = 198) = 9.02, p < .005$. There was no significant relationship between number of cigarettes smoked per day and total POMS score ($r = -.08, p = .56$) or BDI scores ($r = -.07, p = .63$) for the smoking mothers. Recall that a small number of the mothers who were included in the smoking group reported quitting recently ($n = 9$). These women did not significantly differ on their total POMS mood disturbance score, $t(50) = 0.08, p = .93$, or on any of the POMS subscales from the mothers who were current smokers (all $ps > .10$). Mothers who recently quit smoking reported smoking significantly more cigarettes (16.0 ± 5.4 cigarettes per day) before quitting compared with those who currently smoke (9.3 ± 1.1 cigarettes per day), $t(50) = 2.04, p < .05$.

There were no significant differences between the two groups (mother smoker vs. mother nonsmoker) in mothers' self-reported food neophobia, $t(194) = 0.95, p > .05$, or general neophobia scores, $t(195) = 0.01, p > .05$. Likewise, there was no difference between these two groups of mothers and their children in the consumption of bubblegum-, strawberry-, coffee-, green tea-, pyridine-, or tuna-flavored foods (all $ps > .10$). Women who smoke reported that they consumed more cola (smoker vs. non-smoker: 1 vs. 0.5 8-oz servings of colas per day), $t(187) = 2.12, p < .05$, as did their children (children of smokers vs. nonsmokers: 2.5 vs. 1.2 colas per week), $t(232) = 2.99, p < .005$, compared with nonsmokers. Mothers who smoke also reported eating more chocolate (smoker vs. nonsmoker: three vs. two bars per week), $t(184) = 2.22, p < .05$ and drinking more alcoholic beverages (smoker vs. nonsmoker: eight vs. three standardized drinks during the previous 3 weeks), $t(186) = 4.08, p < .0001$, compared with those who did not smoke.

Children's Odor Identification Versus Liking

Children's ability to identify the odor, $Q(9) = 304.0, p < .0001$, varied as a function of odor quality. As a group, children had difficulty identifying the odors. However, they were better able to identify some of the odors (e.g., chocolate, 32% correctly identified; coffee, 27%; bubblegum, 24%; strawberry, 19%; cola, 11%; cigarette, 9%; tuna, 3%; pyridine, 1%). Only 1 child correctly identified the green tea odor, suggesting that it was a relatively unfamiliar odor. Children's liking of the odors also varied as a function of odor quality, $Q(9) = 486.0, p < .0001$. As shown in Figure 1, the majority of children liked the strawberry (84%), bubblegum (78%), cola (68%), and chocolate (67%) odors. Fewer children liked the green tea (41%), tuna (30%), coffee (35%), pyridine (23%), and cigarette (22%) odors.

Children were more likely to indicate that they liked the odors of bubblegum, $\chi^2(1, N = 233) = 15.87, p < .001$, and chocolate, $\chi^2(1, N = 227) = 19.39, p < .0001$, if they correctly identified them. However, this was not the case for the odors of strawberry, coffee, pyridine, cola, and cigarette (all $ps > .10$). Approximately 77% of the children, regardless of whether they correctly identified the odor of cigarette or not, disliked its smell. Whether identifying the odors of green tea or tuna modified liking of each of these odors could not be determined because only 1 child correctly identified the green tea odor and only 7 identified the tuna odor.

Children's Odor Liking and Preferences: Effect of Parental Smoking

As shown in Figure 2, when children were presented with the individual odors in Task 1, only the liking of the cola odor differed as a function of parental smoking status, $\chi^2(1, N = 233) = 10.23, p < .002$. Those children whose parents do not smoke liked the odor of cola better than those whose parents smoke. No difference was observed when children were presented with the cigarette odor; the liking for this odor was similar among children whose parents smoke (21%) compared with those whose parents do not smoke (22%), $\chi^2(1, N = 231) = 0.08, p = .78$.

There was a significant interaction between parental smoking and the amount of time it took the children to decide whether they liked or disliked the cigarette odor, $F(1, 220) = 13.99, p < .001$. As shown in Figure 3, children whose parents smoke took significantly longer to make a hedonic judgment if they liked the cigarette odor compared with the remaining children (all $ps < .001$). This effect did not generalize to any of the other odors and was specific to the cigarette odor.

When children were asked to indicate whether they preferred the cigarette odor to another odor in Task 2, we found that preference for the cigarette odor relative to the neutral odor of green tea significantly varied as a function of parental smoking habits, $\chi^2(1, N = 179) = 9.56, p < .002$, and tended to vary as a function of maternal smoking habits, $\chi^2(1, N = 179) = 3.57, p < .06$. Significantly more children (71.4%) whose parents smoke preferred the cigarette odor relative to green tea odor compared with children who came from nonsmoking households (48.7%; $p < .002$). This effect of parental smoking was not significant when the cigarette odor was presented with any of the other odors in Task 2: bubblegum, $\chi^2(1, N = 182) = 0.09$; chocolate, $\chi^2(1, N = 179) = 0.04$; cola, $\chi^2(1, N = 179) = 0.67$; coffee, $\chi^2(1, N = 184) = 0.69$; pyridine, $\chi^2(1, N = 180) = 0.05$, all $ps > .10$.

Relationship Between Mothers' Mood and Smoking Habits and Children's Odor Preferences

There was a significant interaction between maternal smoking status and children's relative preference for the cigarette odor on mothers' mood disturbance scores, as measured by the total POMS, $F(1, 172) = 19.50, p < .001$. For children whose mothers smoke, those who preferred the cigarette relative to the green tea odor had mothers with significantly lower mood disturbance scores compared with those children of smokers who preferred the green tea odor, $t(44) = 2.82, p < .005$ (Figure 4). No such differences were observed among the children of nonsmoking mothers (all $ps > .10$). With the exception of Vigor, a similar pattern of results was observed for each of the POMS subscales—Tension, $F(1, 172) = 22.41, p < .001$; Depression, $F(1, 172) = 23.05, p < .001$; Anxiety, $F(1, 172) = 15.32, p < .001$; Confusion, $F(1, 172) = 13.10, p < .001$; Fatigue, $F(1, 172) = 10.53, p < .002$ —and for the BDI, $F(1, 171) = 7.06, p < .01$. Further analysis revealed that the mothers of children who preferred the cigarette odor to the green tea odor did not differ in the number of cigarettes smoked per day or in the amount of green tea consumed daily compared with smoking mothers whose children preferred the odor of green tea (all $ps > .10$).

Mothers' Odor Identification and Liking

The mothers' ranking patterns of odor liking (Spearman's $r(8) = .93, p < .001$) and odor identification (Spearman's $r(8) = 0.95, p < .001$) were similar to those of the children. As a group, the mothers were better able to correctly identify some of the odors relative to others (chocolate, 84% correctly identified; coffee, 74%; strawberry, 67%; bubblegum, 61%; cigarette, 55%. cola, 24%; pyridine, 8%; tuna, 6%; green tea, 0%). Like children, mothers were significantly more likely to indicate that they liked the chocolate if they could identify it, $\chi^2(1, N = 202) = 17.28, p < .001$. Similar patterns were also observed for the coffee, $\chi^2(1, N = 202) = 36.00, p < .0001$, and cola, $\chi^2(1, N = 202) = 16.21, p < .001$, odors. However, unlike children,

mothers who correctly identified the cigarette were significantly more likely to indicate that they disliked this odor, $\chi^2(1, N = 202) = 4.41, p < .05$. Approximately 97% of the mothers who identified the cigarette odor disliked it, whereas 89% of those who failed to identify the cigarette odor disliked it.

Mothers' smoking status did not affect their ability to identify any of the odors (all $ps > .10$), including that of cigarette, $\chi^2(1, N = 202) = 0.08, p = .77$. In addition, the two groups of mothers (smokers vs. nonsmokers) did not significantly differ in their liking of bubblegum, $\chi^2(1, N = 202) = 1.02, p = .31$; strawberry, $\chi^2(1, N = 202) = 0.11, p = .74$; chocolate, $\chi^2(1, N = 202) = 0.06, p = .81$; cola, $\chi^2(1, N = 202) = 1.68, p = .20$; green tea, $\chi^2(1, N = 202) = 0.07, p = .79$; coffee, $\chi^2(1, N = 202) = 0.44, p = .51$; pyridine, $\chi^2(1, N = 202) = 0.09, p = .77$; tuna, $\chi^2(1, N = 202) = 2.98, p = .08$; or cigarette, $\chi^2(1, N = 202) = 2.85, p = .09$. Eighty-nine percent of the mothers who smoke and 95% of nonsmokers indicated they disliked the cigarette odor.

Discussion

Children of smokers took longer to decide whether they liked the cigarette odor and were significantly more likely to prefer it to the neutral and unfamiliar odor of green tea compared with children of nonsmokers. Moreover, their preference for the cigarette odor was related to their mothers' mood disturbance and depression scores, thus suggesting that hedonic judgment of cigarette odor depends not only on parental smoking habits but also on the emotional context in which their mothers smoke.

Two types of tasks were used to assess olfactory hedonic judgments: One measured odor liking (Task 1), whereas the other measured odor preference (Task 2). These tasks revealed different information about the children's hedonic response to odors. In the first task, in which odors were presented individually, children's liking of the cigarette odor did not differ as a function of parental smoking habits. In general, children disliked the odor of cigarette smoke and were unable to correctly identify it. However, differences emerged when we analyzed the response time to make a hedonic judgment. Children of smokers, who liked the cigarette odor, took significantly longer to decide whether they liked the odor compared with the other children.

Two explanations, not mutually exclusive, may account for this difference in response times to the cigarette odor. First, prior research revealed that unpleasant odors are processed more quickly than pleasant odors when adults make hedonic decisions (Bensafi et al., 2003; Bensafi, Rouby, Farget, Vigouroux, & Hol-ley, 2002). Thus, children of smokers who classified the odor of cigarettes as pleasant may process the odor more slowly than those who classified it as unpleasant. However, no such differences were observed among the children whose parents did not smoke. Second, the longer time to make a hedonic judgment may reflect the occurrence of conflict resolution in children whose parents smoke. Response times are commonly used in attitude and belief research to measure automatic subconscious associations people have between an object and an evaluation, whereas explicit attitudes are thought to reflect more deliberative responding (Rudman, 2004). Because it takes longer to express explicit attitudes when they are incongruent with implicit attitudes (Greenwald & Banaji, 1995), our observation that children whose parents smoke are slower to classify cigarette odor as good suggests that their explicit positive hedonic judgments are inconsistent with their implicit judgments of cigarette odor. Prior research has revealed that implicit attitudes are extremely persistent (Rudman, 2004). Although adults' explicit attitudes toward smoking were consistent with their recent experiences with smoking, their underlying implicit attitudes were correlated with their earliest experiences with smoking.

In Task 2, differences as a function of parental smoking also emerged when children were asked to indicate whether they preferred cigarette odor relative to other odors that differed in both familiarity and hedonics. When the odor of cigarette was presented with a highly positive

odor such as bubblegum, most children preferred bubblegum regardless of whether their parents smoke. Likewise, when cigarette odor was presented with an aversive odor such as pyridine, children, regardless of whether their parents smoke, were as likely to dislike pyridine as they were the cigarette odor. However, when the cigarette odor was presented with a relatively neutral, unfamiliar odor such as green tea, children whose parents smoke were significantly more likely to prefer the odor of cigarette relative to the green tea odor compared with children of nonsmokers. Moreover, children of smokers who preferred cigarette odor had mothers with mood disturbance and depression levels similar to those of nonsmoking mothers, whereas those who preferred the green tea to the cigarette odor had mothers with elevated mood disturbance and depression scores.

As expected, children and adults liked the odors that were more familiar to them. In general, stimuli that are more familiar tend to be more preferred (Stein, Nagai, Nakagawa, & Beauchamp, 2003). However, for the cigarette odor, children were just as likely to indicate they liked this odor regardless of whether they could identify it, thus indicating that they understood the task. Although there was no significant difference in the ability to identify the odor of cola, liking of the cola odor differed as a function of parental smoking habits. That is, children of smokers disliked the cola odor compared with children of nonsmokers. Because adults who smoke consumed more colas, a finding that is consistent with previous research showing that people who smoke consume more soft drinks (Ma, Hampl, & Betts, 2000), children of smokers may associate cola with parental smoking. This finding warrants further investigation.

Although the current study is one of the few that addresses the effect of prior experience on children's hedonic responses to the cigarette odor, several factors may limit the interpretation of the results. First, self-report measures can be inaccurate (Stevens & Munoz, 2004); mothers may have been inaccurate in their assessment of their own smoking as well as that of the child's father. Because cotinine levels in children are highly correlated with actual environmental cigarette smoke exposure (Dhar, 2004), future research in this area should include such physiological measures in addition to the mothers' reports of the child's exposure to environmental tobacco smoke to assess exposure levels (Cornelius, Goldschmidt, & Dempsey, 2003; Stevens & Munoz, 2004). Second, the relationship between the child's response to cigarette odor and maternal mood states, as assessed by both the POMS and BDI, suggests that children are less likely to prefer the odor of cigarette if their mother smokes while experiencing negative moods states. However, it should be emphasized that mood changes that may occur when the mother smokes were not directly measured in the current study. Nor did we directly assess the mother's motivation for smoking to determine whether she smokes to escape aversive states or for reward. Future studies should assess the mother's motivation for smoking as well as her changes in mood during smoking.

The results of the current study are consistent with previous findings on parental drinking and children's hedonic response to the odor of alcohol (Mennella & Garcia, 2000). In both cases, children who experienced the target odor (either cigarette odor or alcohol) during negative emotional situations (e.g., with either a smoking mother who was depressed and tense or with a mother who drinks alcohol to escape tensions and worries) had lower preferences for the target odor compared with the remaining children who experienced the target odor in neutral or positive emotional contexts. These findings suggest that children's hedonic judgment of odors can be shifted either upward or downward depending on the hedonic valence of the odor. When an odor, which is generally liked by most children (e.g., the odor of beer), is associated with negative consequences such as parental stress and tensions, their liking for this odor decreases. In the current study, the cigarette odor was generally disliked by most children. Only when the odor was associated with positive consequences (such as relaxed mothers, low mood disturbance) does it become preferred by children. Given that people who smoke tend to drink

more than nonsmokers, ongoing studies in our laboratory aim to determine children's hedonic responses to alcohol odors as a function of parental smoking.

The particular context (or situational cue) that motivates people to smoke is highly individual (Shiffman, 1993). Whereas anxiety or depression may elicit smoking in one person, social situations may motivate smoking in others (e.g., Coan, 1973; McKennell, 1970; Shiffman, 1993). Therefore, for some, but not all, smokers, smoking may serve as a coping mechanism that facilitates general mood regulation (Ikard, Green, & Horn, 1969; Khantzian, 1997; Wills & Shiffman, 1985). Because children are extremely sensitive to their mother's mood states (e.g., Dawson et al., 2003; Elgar, Curtis, McGrath, Waschbusch, & Stewart, 2003), we hypothesize that children's hedonic response to the odor of cigarettes was a result of learned associations between the smell of cigarettes and the emotions they observe when their mother smokes. Alternatively, children of smoking mothers who are not mood disturbed may experience their mothers' smoking in relatively positive emotional contexts and learn to prefer the odor of cigarette to that of other neutral stimuli.

To be sure, associative learning in the context of emotionally salient conditions is a powerful mechanism by which odors acquire personal significance. Memories evoked by odors are more emotionally charged than those evoked by other sensory stimuli (Herz, 2004; Herz & Cupchik, 1995; Herz, Eliassen, Beland, & Souza, 2004) possibly as a result of direct connections between the olfactory and limbic systems (Cahill, Babinsky, Markowitsch, & McGaugh, 1995), the latter of which is necessary for the expression and experience of emotion (Aggleton & Mishkin, 1986). Like children whose parents drink to escape from their dysphoric mood, children whose mothers smoke to reduce mood disturbance may be learning that their parents tend to smoke during negative rather than positive social situations.

Conclusion

Odors that acquire specific meaning early in life have longlasting effects (Lawless & Engen, 1977). The current findings suggest that early learning about the sensory aspects of smoking is anchored to children's experiences at home and the emotional context in which their mothers smoke. However, it is not clear how variation in the timing and amount of exposure to cigarette smoke during childhood affects the formation and persistence of such olfactory associations. If these odor associations persist throughout childhood into adolescence, our data may suggest that children who experience cigarette smoke in the context of a relaxed mother may have more positive associations with smoking, whereas those who experience the odor with a mother who smokes to reduce tension may have more negative associations. Whether such associations (either positive or negative) affect children's risk for smoking initiation is not known. The long-term effects of early hedonic judgments about cigarette odor are important areas for future research.

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Figure 1. Percentage of children who liked each of the odors (i.e., gave the odor to Big Bird rather than to Oscar) as a function of whether they identified the odor correctly (solid bars) or incorrectly (gray bars). The children's responses were categorized as correct if they were either exact designations of the stimuli or items that were in the same narrow class as the stimuli (see Method section). The asterisks indicate significant differences between groups at $p < .05$.

Figure 2.

Percentage of children who liked each of the odors (i.e., gave the odor to Big Bird rather than to Oscar). One group of children lived in a household in which neither parent smokes (solid bars), whereas the other group lived in a household in which one or both parents smoke (gray bars). The asterisk indicates a significant difference between groups at $p < .05$.

Figure 3.

The length of time (in seconds, $\pm$ SEM) that it took children to indicate whether they liked or disliked the cigarette odor as a function of whether neither parent smokes (solid bars) or one or both parents smoke (gray bars). The asterisk indicates a significant difference between groups at $p < .05$.

Figure 4. Mothers' total mood disturbance scores ($\pm$ SEM) as assessed by the Profile of Mood States (POMS) and the smoking status of the mothers (smoker vs. nonsmoker) as a function of whether their children preferred the cigarette odor relative to the neutral, unfamiliar odor of green tea (solid bars) or preferred the green tea to the cigarette odor (gray bars). The asterisk indicates a significant difference between groups at $p < .05$.

Table 1
Participant Characteristics

Variable	Parents do not smoke	One or both parents smoke		
		Smoking mother, Nonsmoking father	nonsmoking mother, smoking father	Smoking mother and father
Children				
Total number (girls:boys)	74:61	24:16	18:21	13:10
Age (years)	5.02 ± 0.12	5.25 ± 0.21	5.25 ± 0.22	5.43 ± 0.28
Body mass index (kg/m ²)	16.04 ± 0.22	16.71 ± 0.40	16.04 ± 0.40	16.45 ± 0.52
Child temperament measures				
Shyness ^a	2.26 ± 0.07	2.18 ± 0.13	2.06 ± 0.13	2.57 ± 0.18
Emotional ^b	2.78 ± 0.08	3.06 ± 0.15	2.81 ± 0.16	3.30 ± 0.21
Sociable	3.11 ± 0.05	3.22 ± 0.09	3.32 ± 0.09	3.34 ± 0.12
Negative food	3.33 ± 0.18	3.39 ± 0.33	2.99 ± 0.33	3.45 ± 0.44
Active	3.05 ± 0.04	3.08 ± 0.07	3.25 ± 0.07	3.08 ± 0.10
Food neophobia	3.15 ± 0.06	3.02 ± 0.11	3.01 ± 0.11	3.21 ± 0.14
Mothers				
Total number	115	32	35	21
Age (years)	33.1 ± 0.6	33.2 ± 1.1	32.1 ± 1.1	33.6 ± 1.4
Beck Depression Inventory ^b	5.45 ± 0.6	9.41 ± 1.24	6.35 ± 1.18	9.71 ± 1.50
Profile of Mood States				
Tension ^b	6.53 ± 0.52	9.90 ± 0.98	8.02 ± 0.93	11.05 ± 1.19
Depression ^b	5.48 ± 0.75	9.19 ± 1.43	7.00 ± 1.35	10.29 ± 1.74
Anger ^b	5.30 ± 0.58	7.81 ± 1.11	6.62 ± 1.05	8.67 ± 1.33
Confusion ^b	4.83 ± 0.36	6.13 ± 0.69	5.60 ± 0.65	7.81 ± 0.84
Fatigue	6.34 ± 0.52	7.28 ± 1.06	7.10 ± 0.97	8.95 ± 1.16
Vigor	17.25 ± 0.59	17.36 ± 1.20	16.93 ± 1.10	14.33 ± 1.31
Total mood disturbance score ^b	11.61 ± 2.60	23.58 ± 4.96	17.51 ± 4.67	32.43 ± 6.03
Daily cigarette usage				
Mothers	0	7.2 ± 0.7	0	8.8 ± 0.8
Mothers' husband/partner	0	0	11.6 ± 1.5	14.8 ± 1.3

Note. The nonsmoking father category includes children whose fathers do not smoke as well as those whose fathers are absent. If a stepfather is present, children are categorized according to the smoking habits of their mother and stepfather.

^aSignificant Maternal × Paternal Smoking Status interaction.

^bSignificant main effects for maternal smoking status on each of these variables.