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# Effects of Smoking on Heart Rate, Anxiety, and Feelings of Success During Social Interaction

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*The effects of smoking on heart rate (HR) and emotional processes during social interactions were assessed in 12 smokers. Smoking was associated with less anxiety and with enhanced feelings of being successful both in changing the opinions of others and in expressing one's own point of view. These findings are consistent with others in the literature. The increase in HR during social interactions in which the participants smoked was similar in magnitude to the HR increase associated with speaking versus listening during conversation. The effects of smoking and social interaction on HR appeared to be additive. Smoking during the social interaction increased HR only about half as much as is typically reported for smokers seated quietly in nonsocial situations*

**KEY WORDS:** anxiety; heart rate; smoking; social; speech.

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## INTRODUCTION

It is commonly reported that smoking a single cigarette produces large increases in heart rate (HR), blood pressure, and a variety of stress-related hormones, including cortisol and epinepherine (see review by Pomerleau and Pomerleau, 1984). HR increases associated with smoking a single cigarette have been reported to be about 15 beats per minute (bpm) (Ague, 1973). However, most studies in which such increases were found used smoking-deprived subjects who were required to remain silent while seated in situations allowing little or no movement (Gilbert, 1979). It was reported in a recent study that cigarette smoking (compared to abstaining) increased HR 7 bpm during the morning but had no significant effects during the afternoon and evening. These time-dependent effects of nicotine on HR may have been owing to smoking deprivation, i.e., not smoking while sleeping (Benowitz *et al.*, 1984). In contrast, in the small number of investigations in which the effects of ad libitum smoking during normal daily activities were monitored, there is only minimal evidence of smoking-related HR changes (Benowitz *et al.*, 1984; Erwin, 1971; Turpin, 1982).

A number of laboratory studies have reported that smoking reduces subjective stress (reviewed by Gilbert, 1979; Pomerleau and Pomerleau, 1984). Evaluation of the effects of smoking in social situations would contribute to a better understanding of the influence of smoking on emotional and physiological processes, but the effects of smoking on HR and emotional reactions in social situations have apparently not been investigated. The present study investigated the effects of smoking on HR, anxiety, and positive emotional reactions during a mildly stressful, structured social interaction in 1-hr smoking-deprived smokers.

## METHOD

*Subjects.* Six male and six female smokers participated in the study. The males were employees at the research center where the study was conducted. The females were recruited from the local community by an independent marketing research company and were paid for their participation. All participants had smoked 10 or more cigarettes per day for the past year. Smokers of cigarettes less than 7 mg Federal Trade Commission "tar" were excluded. All subjects were requested not to smoke for the hour preceding their scheduled experimental sessions.

*Social Interaction Situation.* To make the social conversation situation at least moderately stressful, each subject was matched with a partner of the same sex whose views on selected topics differed. The attitude matching proce-

dure was based on the subjects' responses to a questionnaire designed to assess attitudes on 26 different controversial topics (e.g., abortion, capital punishment). The matching procedure required that both partners felt moderately to strongly (3 or higher on a 5-point scale) about the topic to be discussed and had moderate to large disagreements on the particular topic (item) chosen for discussion (difference of 2 or more points of a potential 4-point difference).

*Self-Report Measures and Equipment.* A 23-item Self-Report Questionnaire was devised to assess how subjects felt during the social interaction (see Table II). Emotional status (anxiety, anger, depression, and arousal), perceived social effectiveness, and cognitive processes were assessed. How nervous or anxious the subjects became during the discussion was of primary interest. In responding to the question, "How nervous or anxious did you get during this discussion?", subjects rated themselves on the following 5-point scale: 1 = "not at all nervous or anxious"; 5 = "very nervous or anxious." The other self-report questions were framed in a similar manner, using the same 5-point response format.

*Heart Rate.* HR was measured by means of a Beckman R-612 Dynograph cardiotachometer (Model 985) triggered by the subject's R wave after its amplification by a Beckman voltage coupler (Model 9853H). Output from the cardiotachometer was digitized using a Hewlett-Packard Model 2240A microprocessor controlled by a HP1000 computer. HR was sampled at a rate of 10 Hz. The computer program also controlled stimulus tone and light presentations and included criteria for HR artifact rejection.

*Procedure.* The smokers were tested in pairs. They were told that the purpose of the study was to evaluate the relationship between smoking and physiological activity but were not given any information about the goal of the study to evaluate the relationship among mood, smoking, and heart rate. Each pair (partners) participated in three experimental sessions, conducted on different days over a period of 3 to 20 days. Immediately after arrival for the first session, the participants were asked to read and sign an informed consent form. Electrocardiogram electrodes were then attached to the lower left and lower right sides of the rib cage by an individual of the same sex as the subject.

After electrode placement, the subjects were seated in a sound-attenuated, electrically shielded room (8.3 ft wide by 9 ft long by 6.5 ft high). They sat in padded chairs, placed directly across from each other at 45° angles, separated by approximately 3 ft. This arrangement allowed the subjects to engage in conversation without looking directly at one another, which might have led to subjective discomfort. A video camera attached to a tripod in the corner of the room focused on the two subjects from their waists up. A red light controlled by the computer was placed at knee level, equidis-

tant and about 3 ft from the subjects. The interaction was recorded on a video recorder in an adjoining room. The subjects were aware that their activities were being recorded.

At the beginning of each session, participants were handed 3 × 5-in. white cards, on which was typed a single topic on which they disagreed. They were instructed to sit quietly for 10 min and think about what they wanted to say during the subsequent discussion. After 10 min, a tone signaled the partner identified as No. 1 to begin expressing his/her feelings on the issue. A minute later, the tone sounded again to signal subject 1 to stop speaking and listen, while subject 2 spoke until the tone sounded again a minute later. The subjects alternated speaking and listening in this manner at 1-min intervals signaled by the tone. After 10 min of social interaction, the red light came on to signal both subjects to discontinue speaking and remain quiet until the experimenter entered the room.

The subjects did not smoke during the first session, which was run primarily to familiarize them with the experimental procedures. One partner smoked during the second session, and the other in the third session. Except for whether or not one of the subjects smoked during the session, the procedures during the three sessions were identical. During each smoking session, one of the subjects was instructed to light up and begin smoking at the onset of the second of his/her five speaking turns (3 min into the conversation). Subjects smoked 0.8 mg FTC nicotine delivery commercial brand cigarettes, either mentholated or nonmentholated, depending on their preference. The subjects were instructed to smoke their cigarettes down to a point 3 mm from the filter by the end of the 10-min social interaction.

Heart rate was recorded during each of the three experimental sessions. The computer collected a baseline HR, beginning 1 min before the first tone signaled the subjects to start speaking, and continued to collect HR data throughout the social interaction. HR data were also obtained during a 1-min "recovery" period, beginning 2 min after the termination of the interaction. Immediately following the recovery period, the subjects responded to the Self-Report Questionnaire, which inquired about their behavior and feelings during the social interaction.

## RESULTS

The results of the study are presented in three sections: the effects of smoking on HR during social interaction, the effects of speaking versus listening on HR during smoking and nonsmoking conditions, and the effects of smoking on mood and feelings during social interaction.

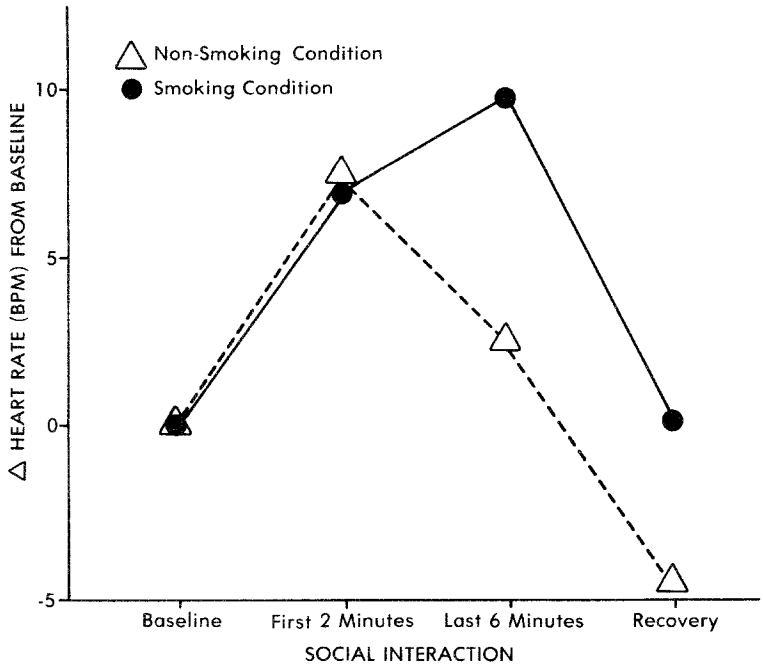


**Fig. 1.** Mean heart rate change from baseline for smoking and nonsmoking conditions. Baseline, period prior to social interaction; recovery, period from 2 to 3 min after the end of the interaction. The onset of smoking in the smoking condition occurred during the last 7 min of the 10-min social interaction. The heart rates during the social interaction are means of equal numbers of speaking and listening epochs.

## Smoking and HR During Social Interaction

The HR of smokers when they smoked was compared with their HR when they did not smoke. Figure 1 shows the heart-rate change scores (difference from baseline) across time during the smoking and nonsmoking conditions. A repeated-measures analysis of variance (ANOVA) of the HR data compared the effects of smoking versus not smoking on HR during the experimental sessions. The repeated measures were smoking versus nonsmoking condition and time periods within a given experimental session. The time periods for which HR measures were obtained were (1) baseline; (2) first 2 min of social interaction during which subjects did not smoke; (3) last 6 min of social interaction during which subjects smoked; and (4) "recovery" period, which was from min 3 to min 4 after the end of the social interaction.

ANOVA results showed a significant main effect of Time [$F(3,33) = 25.09$, $P < 0.0001$] and a significant Smoking × Time interaction [$F(3,33) = 2.99$, $P < 0.05$]. The Time main effect indicated differences in mean HR across the four time periods. The Smoking × Time interaction reflected the increase in HR in the smoking condition during the period in which the subjects smoked (last 6 min of social interaction), whereas HR decreased in the nonsmoking condition during this period. In the recovery period, HR remained higher in the smoking condition even though the subjects had not smoked for several minutes.

Student's $t$ tests for matched pairs was used to evaluate differences in HR change in the smoking and nonsmoking conditions. The HR change from the baseline to the last 6 min of the social interaction in the smoking condition was 8.90 bpm, but only 2.55 bpm in the nonsmoking sessions ($t = 2.14$, $P < 0.05$). In the smoking condition, the mean HR increased 2.0 bpm from the first 2 min of the interaction (prior to smoking) to the last 6 min of interaction (while smoking). In contrast, HR decreased during the session in which subjects did not smoke ($-4.86$ bpm), and the difference in HR between these conditions was significant ($t = 5.02$, $P < 0.001$). The mean change in HR from the preconversation baseline to the postconversation recovery level was minimal in the smoking condition ($+0.07$ bpm) and decreased markedly in the nonsmoking condition ($-4.68$ bpm) ($t = 2.61$, $P < 0.02$), probably as a result of adaptation to the experimental session.

## Effects of Speaking on HR

The analysis of the effects of speaking versus listening on HR was assessed in the smoking condition and in the two conditions in which subjects did not smoke by means of a 2 (speaking vs. listening) × 3 [no smoking (first session) vs. nonsmoking (second or third session) vs. smoking (second or third session)] repeated-measures ANOVA. This analysis was limited to the last 6-min of the social interaction, the period during which subjects in the smoking condition smoked. ANOVA results showed a highly significant main effect of speaking versus listening [$F(1,11) = 44.25$, $P < 0.0001$] but no significant main effect for session or speaker–listener × session interaction. The speaker versus listener main effect reflected consistently higher heart rates (from 6.2 to 7.6 bpm) while speaking then listening in each of the three sessions (one smoking and two nonsmoking; see Table I).

## Effects of Smoking on Reported Feelings

The data in Table II are the mean Self-Report Questionnaire ratings of anxiety and social competence for the smoking and nonsmoking condi-

**Table I.** Mean Heart Rate (bpm) as a Function of Experimental Condition During the Smoking and Nonsmoking Sessions[a]

| | Session 1, no smoking | | Session 2 and 3 | | | |
|---|---|---|---|---|---|---|
| | | | Nonsmoking | | Smoking | |
| | *Mean* | *SD* | *Mean* | *SD* | *Mean* | *SD* |
| Speaker | 81.3 | 9.6 | 86.0 | 12.2 | 87.6 | 8.8 |
| Listener | 75.1 | 8.3 | 78.4 | 11.4 | 80.8 | 7.5 |

[a]Speaking and listening values are those of the last 6 min of the social interaction, the period during which subjects in the smoking condition smoked.

tions. Five of the smoking versus not-smoking comparisons were statistically significant (one-tailed paired $t$ test, $P < 0.05$). Smoking, in contrast to not smoking, was associated with lower levels of anxiety, greater feelings of success in changing the other's opinion and in expressing one's own opin-

**Table II.** Smoking Versus Nonsmoking Condition Comparisons of Subjective Experience During the Social Conversation[a]

| | Session | |
|---|---|---|
| | Smoking | Nonsmoking |
| Nervous or anxious | 1.41 | 2.00* |
| Success in changing other person's opinion | 3.25 | 1.92** |
| Other person did not understand your opinion | 1.33 | 1.92* |
| Other person not successful in expressing their view | 1.25 | 1.67* |
| Other person did not listen to you | 1.25 | 1.67* |
| Spent time developing counterarguments | 2.25 | 2.42 |
| Thought about what was wrong with what other person was saying | 3.63 | 2.90 |
| Other person won debate | 2.18 | 2.64 |
| Argued vigorously | 3.08 | 3.33 |
| Other person was emotionally aroused | 1.83 | 2.08 |
| Emotionally aroused | 2.08 | 2.25 |
| Did not pay good attention to other person's view | 1.17 | 1.00 |
| Strong urge to interrupt other person | 2.92 | 2.50 |
| Other person responded to what you said | 1.83 | 1.75 |
| Other person's arguments made sense | 3.83 | 3.92 |
| Got angry | 1.08 | 1.25 |
| Got confused | 1.17 | 1.33 |
| Felt pleasant | 3.75 | 3.58 |
| Felt sad or depressed | 1.17 | 1.00 |
| Felt interested | 3.75 | 4.00 |
| Felt disgusted | 1.25 | 1.17 |
| Felt good at end of discussion | 4.25 | 4.25 |
| Did not understand other person's view | 1.50 | 1.50 |

[a]Ratings for all items were as follows: 5 = "very much so"; 1 = "not at all."

*$P < 0.05$.

**$P < 0.01$.

ion, and a greater belief that the other person listened the entire time during the social interaction.

## DISCUSSION

Subjects' HRs were elevated and their moods were improved in the smoking condition relative to the nonsmoking condition. The findings indicate that smoking has similar, but smaller, effects on HR during social conversation than in the quiescent-state conditions used in most previous studies (Gilbert, 1979).

The heart-rate increase associated with smoking in the present study was about the same magnitude as that associated with speaking as opposed to listening and was only about half as large as the increased HR typically reported to be associated with smoking by deprived smokers in quiescent experimental situations. Mean HR differences between smoking and nonsmoking conditions were consistently less than 7 bpm, whereas the quiescent-state HR responses of deprived smokers to cigarettes of similar nicotine delivery are usually in the range of 10 to 20 bpm (Ague, 1973).

This attenuation of HR increases during social interaction may be related to one of two processes. First, elevated HR levels associated with movement and/or emotional responses during the social interaction may counteract the HR increases associated with smoking under quiescent conditions. Heightened initial levels of physiological activity are frequently associated with diminished response magnitude (Wilder, 1967). Second, smokers may smoke differently in social situations than they do in isolation in laboratory situations. In most quiescent-state laboratory studies, the act of smoking is the smoker's primary task and focus of attention. Given this smoking-task orientation, smokers may take larger and/or more frequent puffs, thus absorbing more nicotine. This process could produce a larger increase in HR than would be experienced under more naturalistic conditions, such as the present social interaction. In a recent study of smokers giving an anxiety-producing speech, HRs of speakers who smoked a 1.3 mg FTC nicotine delivery cigarette prior to the speech were no higher than those of speakers who smoked a very low (0.1-mg)-nicotine cigarette (Hatch *et al.*, 1983).

Previous studies have shown that talking increases HR and blood pressure, but the interactive effects of smoking and talking on HR and blood pressure have not been previously investigated (Lynch *et al.*, 1981). The findings in the present investigation suggest that the effects on HR of smoking a typical cigarette in 1-hr smoking-deprived subjects are about the same magnitude as the act of speaking. This finding suggests that smoking's effects on HR may vary as a function of the length of deprivation, the nature of

the social interaction, the subject posture, and the verbal and emotional content of the conversation.

It should be noted that the effects of tobacco smoking on the amount and nature of spontaneous verbalizations in a social context have not been reported in the literature. The social interaction in the present study was structured so that subjects had to talk for exactly 5 min and listen for 5 min. Thus, the effects of smoking on how much subjects spoke was not assessed. Smoking effects on natural verbal behavior could either amplify or attenuate the cardiovascular effects noted in the present study. For example, smoking-induced reductions in the amount of time spent talking might reduce the net effects of smoking on heart rate.

It was hypothesized that, in contrast to abstaining, smoking would be associated with less anxiety and with a stronger belief that things went well during their social interaction. The results generally supported these hypotheses. These findings of less anxiety and greater feelings of social competence are consistent with a growing number of investigations in which smoking improved mood (Gilbert, 1979; Pomerleau and Pomerleau, 1984). Since the nicotine delivery of the cigarettes was not manipulated in the present study, we cannot determine whether the improved mood in the smoking condition was due to nicotine or to some other aspect of smoking. In future studies cigarettes with different nicotine deliveries should be used to evaluate the effects of nicotine and smoking on behavioral as well as self-reported measures of emotion.

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