EFFECTS OF SMOKING ON VISUAL AND AUDITORY REACTION TIME

EPHANTUS N. WAHOME
DEPARTMENT OF PHYSICAL EDUCATION
KENYATTA UNIVERSITY
BOX 43844, NAIROBI, KENYA

ABSTRACT

This study was conducted to determine the effects of three different levels of nicotine (low, medium and high) on visual and auditory reaction time of twenty regular male University smokers aged 18 and 42 years. Subjects participated in three sessions with an Automatic Performance Analyzer used to record the reaction time. During the first session, the subjects were tested using low nicotine level. The second session involved the use of medium nicotine level, while the third session consisted of the use of high nicotine level. One-way analysis of variance (ANOVA) was used to determine if a significant difference existed among the means of low, medium and high nicotine levels in both light and sound variables. Significant F-ratios of 7.48 and 3.803 were found for the light and sound variables, respectively (p< 0.05). In both variables Duncan's multiple range was used to follow up the significance. This means that three different levels of nicotine affected both visual and auditory reaction times. The medium level was found to have a faster reaction time than both low and high nicotine levels. Pearson correlation was used to determine the relationship between the reaction time for light and sound variables. A probability value of 0.054 found was not statistically significant, which means there is some relationship between the visual and auditory reaction time scores at three different levels of nicotine i.e. the reaction time for the sound variable is faster than for light variable at all the three different levels of nicotine.

Key words: Reaction time, smokers, low, medium and high nicotine levels.

INTRODUCTION

The most important chemical which gives immediate satisfaction after smoking and which initiates and maintains the smoking habit is nicotine. When injected into the bloodstream nicotine causes vomiting, weak and rapid pulse rate and even death according to Sarachan (1981). Nicotine stimulates the acetylcholine receptors in the neuromuscular ganglia of the autonomic nervous system, hence, the name "nicotinic" receptors as reported by Goldstein, Aronow and Kalman (Sarachan, 1981). However, the (nicotine) has a nonganglionic action on peripheral sympathetic nerves, which results in a pilomotor response, contraction of the isolated nictitating membrane of the cat and construction of peripheral vessels as noted by Burger (1967). Burger (1967) reported that the stimulatory effect of nicotine, which is as a result of interaction between the nicotine analogues and acetylcholine is decreased during the phase of depression, which supervene after one has smoked. This depression phase in which the smoker starts
showing withdrawal reactions force him or her to take another dose of nicotine (smoker) to maintain the state of alertness. The work of Krylov, which is documented by Anichov and Belenkii indicate that continued administration of nicotine resulted in a loss of sensitivity of the chemoreceptors to acetylcholine (Burger, 1967). This phenomenon may explain the increased dose intake and nicotine tolerance through smoking high nicotine cigarettes, increased number of cigarettes per day and deep inhalation.

"Reaction time (RT) is a measure of the time from the arrival of a suddenly presented and unanticipated signal to the beginning of the response to it" (Schmidt, 1982). It involves transmission of the impulses through the sensory neurons to the brain and processing of the impulses through the motor neurons to the muscle. "Movement time is usually defined as the time from the initiation of the response (the end of reaction time) to the completion of the movement", (Schmidt, 1982). It begins when movement of the body terminates the task as noted by Sage (1977). "Response time is a combined time of both reaction time and movement time" (Sage, 1977), i.e. it is the total time taken from the presentation of the stimulus to the completion of the task. In track races, the time from the firing of the starter's pistol until the runners make their first movement from the starting blocks is the reaction time (RT). The time taken from the first movement until the runners break the tape is their movement time (M.T.) and the time taken from the firing of the starter's gun to the breaking of the tape (finishing) is the response time. This is the time, which is recorded at athletic meetings.

To a smoker who is hooked (addicted) to nicotine, a small amount of nicotine has a stimulatory effect and conversely a positive effect on reaction time, while larger doses have an inhibitory effect on reaction time, thereby exerting a negative effect on reaction time. Nicotine can stimulate and inhibit at the same time as has been reported by Goldstein, Aronow and Kalman (Sarachan, 1981). According to these authors, nicotine initially excites the autonomic ganglion cells and then blocks them so that they can no longer respond to various agonists, including nicotine itself. The same authors also reported that nicotine insecticides have caused death in agricultural workers through percutaneous absorption. This may be due to paralysis of the nervous system. Adverse effects (inhibitory) of nicotine have been reported in Krylov's work where he showed that continued administration of nicotine resulted in a loss of sensitivity of the chemoreceptors to acetycholine (Golding and Phil, 1982).

Domino and Baumgarten (1968), as cited in Science Digest (1968), reported that smoking of a high nicotine content cigarette by a young college student can depress his patellar reflex (knee jerk) by up to 67 percent while the depressive effect usually lasts for 15-30 minutes from the beginning of smoking. They concluded the depressant effect on the human skeletal motor system seems to be directly related to nicotine content of the
cigarette. This supports the theory long held by athletics coaches and doctors "that smoking lowers muscular activity". In the same study, they reported that smoking a low nicotine cigarette lowered the reflex activity by 45 percent while depression occurred when student smokers smoked no nicotine cigarettes (Science Digest, 1968). That means that to an addicted smoker (regular smoker) a certain level of nicotine is required for the skeletal system to function normally and that when this level fluctuates, performance is negatively affected.

In another study by Golding and Phil (1982) on the effect of cigarette smoking on measures of arousal, response-suppression and excitation-inhibition, they found that smokers who smoked the middle-nicotine cigarettes (1.3 mg) showed a decreased arousal, accelerated habituation rate and fewer spontaneous fluctuations to the auditory stimuli, while no significant effects were recorded on the low-nicotine group (0.6 mg) (Bierner et al., 1972). In a study on the effect of tobacco on time on task and stimulus speed on judgment of velocity and time, Tong, Booker and Knott (1978) reported that tobacco resulted in an under estimation of velocity and time judgment particularly in the early stage of the task for the slowest stimulus speed. Leight, Ton and Ague attributed the under-production of time intervals on time judgment tasks to nicotine via tobacco which appears to facilitate the brain stem arousal system (Booker et al., 1978). Bierner, Gunderson and Rake (1972) reported that smokers may be less physically fit because of unfavourable attitudes towards sport and physical conditioning. They found that smoking and very strongly favourable attitudes towards sport appear to be incompatible. In her studies on the relationship and influence of three selected variables on the aerobic capacity of citizens of an urban Canadian Community, Arthur (1974) reported low aerobic capacity among the smokers.

METHODS

The subjects for this study were 20 volunteer male college students who were regular smokers (between 10-20 cigarettes a day) attending Frostburg State University during 1983-84 academic year. They were shown how to use the Automatic Performance Analyzer, which was used to measure both visual and auditory reaction times.

TESTING PROCEDURE

The first test was a low nicotine level session, which was conducted in the morning after the subject had woken up and had not smoked any cigarettes. Schachter and Coworkers (1977) found that heavy smokers show withdrawal symptoms if they are not given their usual dose of nicotine. The symptoms included increased irritability and poor concentration (Time Magazine, 1977). During the same session (low nicotine level), the subjects were shown how to respond to both light and sound stimuli using the Automatic Performance Analyzer and were given five practices in each
stimulus. Each subject was actually tested thrice on each stimulus. In each case the average of the three readings was taken as the final reading for the reaction time and was recorded in hundredths of a second.

The second test, which comprised medium nicotine level was conducted during the normal working hours (about eight hours since the subject had woken up, and had been smoking normally) when he does not have the urge to smoke. It was assumed that during this time the nicotine was at its optimal level for normal functioning i.e. not too low or too high. Mirking (1981) noted that one feels calm and concentrates better when the nicotine was at its best level (Family Life Magazine, 1981). Ikard and Tomkins (1983) also noted that the optimal nicotine level results in relaxation and relieving of nervous tension (World Press Review, 1983). During this session (middle nicotine level) the same testing procedure for low nicotine level was repeated but the subjects were given three practice trials.

The third session (high nicotine level) was administered immediately after the second session and after the subject had smoked two cigarettes (Marlboro regular) consecutively. It was the test administrator's opinion that of the subjects that the two cigarettes had a relatively higher nicotine level, which could raise the nicotine level in the body beyond the desired level. Golding and Phil (1982) noted that a relatively high nicotine level caused decreased arousal, accelerated habituation rate and fewer spontaneous fluctuations to auditory stimuli. Also Baumgarten, Edward and Domino (1968) noted that high nicotine cigarettes could depress the patellar reflex (knee jerk) of the human being. They concluded that the depressant effect on the human skeletal motor system appears to be directly related to nicotine content of the cigarette. During this session (high nicotine level) the testing procedure of the second session was repeated.

**Data Analysis**

This study was set to test the effects of three levels of nicotine (low, medium and high) on reaction time using light and sound stimuli. The reaction times for the two variables i.e. light and sound were analyzed using a one-way analysis of variance (ANOVA). Three means in each variable (light and sound) were analyzed at p< 0.05 level of significance. Duncan’s multiple range test was used to follow-up a significant F-ratio. Pearson Correlation was also used to determine the relationship between the values for the two variables (light and Sound).

**RESULTS**

The means for low, medium and high nicotine levels for the light variable were 21.55, 15.75 and 19.06, respectively. When the data were further analysed, an F-ratio of 7.84 was found to be significant at (P<0.05). Duncan’s multiple range test was used to follow-up this significance. It was found that for a regular male smoker, medium nicotine level is desirable for
fast visual reaction time, and if this level drops down or when it goes up, visual reaction time is slowed down. The means for low, medium and high nicotine levels for sound stimulus were 16.13, 13.40 and 15.10, respectively. An F-ratio of 3.8 was found to be significant at P<0.05. When the Duncan's multiple range test was applied it was found that for a regular male smoker, medium nicotine level is desirable for fast auditory reaction time and if this level drops or goes up auditory reaction time is slowed down.

The Pearson correlation method was used to determine whether there was any relationship between the mean reaction times for the visual and auditory stimuli at three different levels of nicotine (low, medium and high). The data reflected a positive relationship between the visual and auditory reaction times. A coefficient of 0.2098 indicates a positive but non-significant relationship (p=0.054). Further analysis appears warranted, insofar as the probability value approaches a point of being significant. A closer look at the data indicated that the mean reaction times for the sound stimulus were faster than light reaction times. The reaction time was faster at medium nicotine level with both visual (light) and auditory (sound) stimuli. Low and high nicotine levels had a slower reaction time.

DISCUSSION

Nicotine stimulates the nicotinic receptors at neuromuscular junctions and autonomic ganglia (Goldstein, Arnow and Kolman, 1974) to release norepinephrine. Nicotine can activate the "reward centre" in the brain by increasing the release of morepinephrine (Stepney, 1983). Nicotine also stimulates the flow of adrenalin, serotonin and release of catecholamines, which are nerve transmitters used in every thought and movement according to Bannister (1977). Medium nicotine level causes the release of these chemicals, which makes a smoker feel alert and conversely have a faster reaction time.

A low nicotine level causes the decline of these chemicals, and this results in a depressant effect, which slows down the reaction time. Domino and Baumagarten (1968) demonstrated that when a regular smoker is deprived of nicotine, his skeletal motor system is depressed. Schneider (1968) noted that regular smokers could not write coherently, lack concentration and like shaking hands when deprived of nicotine. Due to the depressant effect on motor systems, when a regular smoker is deprived of nicotine, reaction time is slowed. High nicotine levels have a depressant effect also, according to Stepney (1993). Goldstein, Aronow and Kalman (1974) demonstrated that high nicotine levels have an inhibitory effect on the autonomic ganglion cells. The inhibitory effects of high nicotine level gave also been demonstrated by Domino and Baumgarten (1981) who showed that continued administration of nicotine resulted in loss of sensitivity of chemoreceptors to acetylcholine. They showed that smoking of a high nicotine content cigarette by a young college student could depress his
patellar reflex (knee jerk). The inhibitory effect may slow down the reaction time.

These findings may indicate that medium levels of nicotine are desirable for a regular smoker to maintain a state of alertness and a faster reaction time. When this level goes up or down the reaction time is impaired.

IMPLICATIONS OF THE FINDINGS

The information about the effects of nicotine on reaction time would be valuable to the physical education teacher and sports coach when dealing with athletes who are cigarettes addicts. It would also be helpful to supervisors who deal with problems of smoking at work places. Counsellors and clinical psychologists who conduct "quit smoking clinics" would also find the above information helpful. In summary, cigarette smoking is dangerous to one's health, it has adverse effects on athletic performance, and reaction time of a regular smoker is adversely impaired by low or high nicotine level. To maintain a state of alertness, a regular smoker has to maintain a medium level of nicotine, which also has a faster reaction time.

BIBLIOGRAPHY


"Cigarette, a security blanket?" *Science Digest* 1972, August p. 53-54.


Ibid p, 6 16-18, 75 and 227.


