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THE USE OF THE FREIRI SLAVE SMOKER  
TO INVESTIGATE CHANGES IN SMOKING BEHAVIOUR:  
PART II  
Research Laboratory Report No. 146

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RESEARCH & DEVELOPMENT DIVISION  
MONTREAL

THE USE OF THE FREIRI SLAVE SMOKER  
TO INVESTIGATE CHANGES IN SMOKING BEHAVIOUR:

PART II

Authors: E.R. Freiesleben & P.J. Dunn

Project: T-8077

ISSUED BY: Dr. T.A. Smith

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THE USE OF THE FREIRI SLAVE SMOKER  
TO INVESTIGATE CHANGES IN SMOKING BEHAVIOUR

PART II

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#### SUMMARY

In monitoring the smoking habits of six Matinée King-Size smokers as they encounter different cigarettes, smoke levels appear to be adjusted such that yields of nicotine, and not TPM, are maintained. By the incorporation of ventilation in cigarettes of specific tobacco blend, a level of nicotine closely matching that of their normal cigarette is maintained, at the same time greatly reducing the amount of TPM delivered to the smoker.

When these Matinée smokers take either Players Filter Regular or du Maurier King Size cigarettes, the added benefit of reduced total smoke volume along with reduced TPM cannot be overlooked. At the same time, the nicotine expectations of the smokers are met.

If the hypothesis is true that nicotine is a major contributor to smoking behaviour, these alterations would be of benefit to the Matinée King Size smoker. Although it would appear from this study that governmental recommendations of switching to a lower TPM, lower nicotine cigarette may not be advantageous, much further study in this area is required.

One of the limitations of these studies has been that the monitoring of smoking patterns of one new cigarette per day is probably not representative of the smoking patterns established over a prolonged period. As well, the limited number of people in each study was of disadvantage. This will hopefully be corrected in the future.

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The above results are presently being supplemented by studies measuring the degree of inhalation and overall smoke intake during smoking, to more validly assess this issue.

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Introduction

In the previous report from this laboratory (1), the results suggested that an acceptable smoke was obtained when a consistent level of nicotine was maintained. However, the role played by TPM with regard to changing smoking habits was perhaps minimized. Thus, it was decided to assess the effects on the smoker, of changing the TPM delivery of the cigarette.

Previous studies (2,3,4) which demonstrated little alteration in smoking habits and in cigarette consumption as a result of reduced tar delivery, while maintaining consistent nicotine delivery, have been questioned. A more recent study however has noted that, when a cigarette of reduced TPM is smoked, some compensation for this reduced delivery may have occurred (5). This compensation was accounted for by increased residence time of the smoke in the mouth and lungs.

Although it is difficult to separate specific components of the smoke and find them accountable for changes in human smoking parameters, it was decided to assess these parameters in reference to human and standard machine TPM and nicotine yields. Since it is well established that puffing shapes affect smoke delivery and thus TPM/nicotine ratio (6), a study of smoking habits of Matinée King Size smokers was conducted, using experimental cigarettes, where TPM to nicotine balance was altered (i.e. more available nicotine with less TPM). This is reported in Section A. This study is later extended in Section B to include cigarettes of excess nicotine and TPM availability (as assessed by standard machine results in comparison with smokers' conventional brand).

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The Matinée Study

The purpose of this study was to investigate any changes in smoking behaviour of a series of volunteers, when changing from their normal Matinée King Size cigarette to a cigarette with lower TPM delivery. The experimental cigarettes included the regular length Matinée, with its lower TPM and nicotine yield, and two other types of cigarettes designed to reduce TPM yields while maintaining nicotine yields.

Subjects and Method

Six ITL staff members, 5 women and 1 man, volunteered to take part in this comparative study. All were Matinée King Size smokers, averaging 20-25 cigarettes per day. Each volunteer smoked one cigarette, at the same time each day, while being monitored by the Slave-Smoking machine. The procedure, as outlined in the previous report, was followed (1). After studying the patterns established from the smoking of 10 conventional cigarettes, the experimental cigarettes were given to the volunteers, and the same study repeated.

A tobacco blend of higher nicotine content than the control was used for the two experimental cigarettes, but with the incorporation of ventilation, the same smoke deliveries were approached. This ventilation was accomplished by filter design (porous plug wrap and porous tipping paper) and also alterations in cigarette paper porosity.

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Observations and Discussion

Cigarette parameters and smoke yields, obtained under standard smoking conditions, are seen in Table 1.

Table 1

Product Data for Cigarettes Used

Cigarette Type	Matinée K.S. control	Matinée Regular	Experimental Regular	Experimental King Size
Length (mm)	84	72	72	84
Paper Porosity	High	High	Very High	Very High
Filter Length (mm)	17	15	15	17
Filter P.D. in H <sub>2</sub> O	2.0	2.9	2.9	2.0
Total P.D. in H <sub>2</sub> O	5.5	5.6	4.9*	4.3*
% Total Alkaloids in blend	1.26	1.26	1.77	1.77
Smoke:				
Butt Length (mm)	30	30	30	30
Puff No.	8.8	6.9	7.1	7.1
Nicotine mg/cig.	0.65	0.52	0.60	0.87
TPM mg/cig.	13.6	10.8	8.8	12.7
Ratio: TPM/Nicotine	20.9	20.9	14.7	14.6

\* Measured at 10 mm insertion

It is immediately noted that the TPM/nicotine ratio for the ventilated cigarettes is markedly less (30%) than for the unaltered cigarettes. Because of the ventilation, the pressure drop was considerably reduced, and the number of puffs increased.

Human smoking parameters, obtained from the Slave Smoking machine are seen in Table II.

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TABLE II

Smoking Parameters for Cigarettes Obtained from the  
"Freira" Slave Smoking Machine

Cigarette Type	Matinée K.S. control		Matinée Filter Reg.		Experimental Regular		Experimental King Size	
	Mean Value	Range	Mean Value	Range	Mean Value	Range	Mean Value	Range
Total time alight (sec.)	448	295-615	330	206-442	381	249-536	495	255-600
Puff No.	10.3	7-15	9.4	6-15	10.2	7-17	11.2	7-17
Puff Interval (sec)	48	15-86	39	18-76	41	13-93	48	14-85
Puff Duration (sec)	2.1	1.4-3.5	1.9	1.5-2.1	2.0	1.6-3.0	2.2	1.4-3.4
Total Puff Vol. (ml)	385	-	333	-	402	-	425	-
Puff Volume (ml)	37.3	27-58	35.4	25-49	39.4	27-52	37.9	26-58
Ave. Puff Velocity (ml/min)	1065	660-1575	1118	667-1368	1182	628-1400	1006	575-1600
Max. Pressure Drop (in. H <sub>2</sub> O)	5.5	4.1-7.5	5.8	5.1-6.3	4.4	4.0-5.4	3.6	3.0-4.0
Butt Length (mm)	31	20-36	27	20-35	28	21-34	30	22-35
Tobacco Length Smoked (mm)	53	-	45	-	46	-	54	-
Nicotine (mg/cig.)	0.93	0.52-1.31	0.93	0.52-1.35	0.93	0.47-1.30	1.06	0.40-1.50
TPM (mg/cig.)	20.7	11.7-26.0	18.7	11.0-28.6	15.5	9.9-22.0	17.2	11.5-23.0
Ratio: TPM/Nicotine	22.2	-	20.1	-	16.6	-	16.2	-

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It will be noted that the average amounts of nicotine taken from all cigarettes were very similar.

For the Matinée Regular cigarette during human smoking, 8 mm less tobacco was smoked with fewer puffs of lesser volume and duration than the control. Despite these changes, nicotine yield was equivalent (0.93 mg) to the K.S. Control cigarette. The greater smoke delivery per unit volume of this regular length cigarette, could be due to a higher smoke transfer as a consequence of smoking to a shorter butt length, and perhaps reduced puff interval.

Standard machine smoking deliveries indicated that both the TPM and nicotine yields from the Matinée Regular cigarette were 20% less than from the Matinée King Size control. While the Matinée regular nicotine yield was duplicated relative to the control in human smoking, the smoker obtained an average of 10% less TPM.

For the other experimental cigarettes, the ventilation effects were reflected in decreases in average maximum pressure drop during puffing, 1.1 inch and 1.9 inch for the ventilated Regular, and ventilated King Size cigarettes respectively, relative to the Matinée King Size control. The lower pressure drops observed, may indicate that less effort was required of the smoker to achieve equivalent smoke yield.

With the experimental ventilated Regular length cigarette, the smoker draws larger puff volumes than from the King Size control. Again,

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as with the Matinée Regular cigarette, reduced smoking interval, puff duration and a shorter butt length were observed, compared to the King Size control, though not to the same extent. It was with these manipulations that, even though there was a reduction of 25% in TPM, it was possible for the smoker to duplicate once again his nicotine yield.

In the case of the experimental King Size ventilated cigarette, there were very few changes in human smoking parameters relative to the King Size control. With an increase of one puff, it was observed that, of the extra 34% nicotine available, as judged by standard machine smoking, the smoker took advantage of only 14%. However, he obtained 17% less TPM from this cigarette than from the control.

From these comparisons, it is seen that even though cigarette construction differed, similar smoke nicotine deliveries could be achieved, with little modification in smoking parameters. Nicotine levels, similar to the Matinée K.S. control were maintained, apparently without concern for the drop in TPM. No doubt, some of the observed smoking parameters resulted from the effect of ventilation. But, on the basis of this limited study, it would appear that the smoker may benefit from the reduced tar to nicotine ratio, having a lower tar intake, while maintaining his normal nicotine intake from these different cigarettes.

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B) Brand Change Influence on Matinée K.S. Smokers

Purpose

In Section A, it was noted that TPM reduction apparently did not influence smoking behaviour, when nicotine levels were maintained. Thus it was decided to assess behaviour of smokers when confronted with cigarettes of almost double TPM and nicotine yields, as assessed from standard machine results, compared to the level of their preferred brand, in order to ascertain the preference of these two major smoke components.

Subjects and Method

Three of the 6 participants of the previous study, all Matinée King Size smokers, volunteered to take part in this further investigation. The same procedure as in the previous study was followed. The subjects were asked to smoke Player's Filter Regular, a cigarette of 31% lower pressure drop, and after this study (of 10 cigarettes smoked) was completed, du Maurier K.S., a cigarette with pressure drop similar to the control, was smoked.

Observations and Discussion

Product data for the cigarettes included in these comparative studies are seen in Table III.

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Table III

Product Data for Cigarettes Used

Cigarette Type	Matinée King Size (control)	Player's Filter Reg.	Du Maurier K.S.
Cigarette Length (mm)	84	72	84
Filter Length (mm)	17	11	17
Filter Pressure Drop in. H <sub>2</sub> O	2.0	1.0	2.0
Total Pressure Drop in. H <sub>2</sub> O	5.5	3.8	5.4
Butt Length (mm)	30	30	30
Puff Number	8.8	7.9	9.5
Nicotine Delivery mg/cig.	0.65	1.40	1.25
TPM Delivery mg/cig.	13.6	25.3	23.2
Ratio TPM/Nic.	20.9	18.1	18.6

When smoked at standard machine conditions, the Player's Filter Regular brand yielded increases of 115% and 86% in nicotine and TPM respectively, while for the du Maurier K.S., the respective increases were 86% and 71% above the Matinée K.S. control.

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Data collected from the Slave Smoker concerning these cigarettes are recorded in Table IV.

Table IV  
Human Smoking Parameters for Cigarettes Obtained From  
Freiri Slave Smoking Machine

Cigarette Type (Mean Values of)	Matinée K.S. (control)		Player's Filter Reg.		Du Maurier K.S.	
	Mean Value	Range	Mean * Value	Range	Mean * Value	Range
Total Time Alight (sec)	448	295-615	365	285-556	386	235-693
Puff Number	10.3	7-16	9.3	6-14	11.3	8-17
Puff Interval (sec)	48	15-86	46	15-144	43	10-143
Puff Duration (sec)	2.1	1.4-3.5	1.6	3.8-0.9	1.7	0.7-2.8
Total Puff Volume (ml)	385	-	282	-	325	-
Puff Volume (ml)	37.3	27-58	30.3	13.0-48.5	28.8	14.5-46.5
Av. Puff Velocity (ml/min)	1065	660-1575	1129	650-1468	1028	742-1550
Max. Pressure Drop in. H <sub>2</sub> O	5.5	4.1-7.5	3.7	3.0-4.5	5.6	3.6-7.0
Butt Length (mm)	31	20-36	37	29-52	39	30-50
Nicotine Delivery (mg/cig)	0.93	0.52-1.31	1.10	0.5-1.6	1.11	0.6-1.7
TPM Delivery (mg/cig)	20.7	11.7-26.0	17.0	8.5-26.0	16.7	11.0-26.0
Ratio TPM/Nic.	22.2		15.5		15.0	

\* All individual values from this limited study show the same trend.

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Even though the smoker decreased his puff number by one for the Player's Filter Regular, relative to the control, and increased it by one, for the du Maurier King Size, the other smoking parameters varied in a consistent way. The mean percentage changes in these smoking parameters, relative to the Matinée King Size control, are seen in Table V.

Table V

Changes in Smoking Parameters From Matinée K.S. Control

Smoking Parameter (Overall Mean)	Player's Filter Reg. (%)	Du Maurier K.S. (%)
Decreased Smoking Time	19	14
Decreased Puff Duration	24	19
Decreased Total Volume	27	16
Increased Butt Length	19	26

The changes in puff volume and duration, through the smoking cycle, are illustrated graphically in Figure 1 and Figure 2 respectively, and here it can better be appreciated that there is a marked reduction in these parameters, relative to the control.

With regard to puff interval, there were decreases of 5% and 10% for the Player's Filter Regular and the Du Maurier King Size respectively. Related to this decline in puff interval is the much reduced puff volume of the new cigarettes, the main contributor to smoke yield.

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However, these human reactions would appear to be related to nicotine yield, which in turn is affected by tobacco, cigarette construction, and/or pressure drop. The trend of pressure drop changes for the three cigarettes is illustrated in Figure 3, with the smoker closely duplicating the expected pressure drop of the unlit cigarette.

In the previous study (Section A), the smoker was able to increase his nicotine yield much above the values obtained under standard machine conditions. However, in the present comparison, the smoker decreased nicotine yields by 27% and 13% for the Player's Filter Regular and du Maurier King Size cigarettes from those obtained under standard machine conditions. At the same time, the TPM yields are decreased by 49% and 39% for the respective cigarettes.

With his normal Matinée King Size cigarette, the smoker obtained a TPM yield which had been elevated from 13.6 mg under standard smoking conditions, to 20.7 mg, an increase of 52%. If, in fact he were smoking for TPM, one might expect a similarity in the TPM yields from the different cigarettes. But the smoker actually attained a TPM level approximately 19% below the level of his normal control cigarette.

It would appear however, that the smoker tried to obtain the same nicotine yield from the new cigarettes, as from the control, but actually he increased the nicotine amount 18% above this level. However, this is minimal, considering the fact that there was approximately 100% more nicotine (as measured by standard machine smoking) available in both new cigarettes.

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Thus it would appear, from this limited study, that, with an excess of both TPM and nicotine, the smoker attempted to duplicate the nicotine yield, but actually reduced the amount of TPM. In so doing, he decreased his total smoke intake, making these cigarettes perhaps less hazardous than his normal Matinée K.S. brand.

Conclusions

Two studies have been described which show that a small group of Matinée King Size smokers, when smoking one different cigarette per day, change their smoking pattern.

When a modified version of their normal cigarette is encountered (a stronger tobacco blend, but with much increased ventilation), these smokers maintain a nicotine level, while reducing TPM, compared to their normal cigarette. With much stronger cigarettes (Player's Filter Regular or du Maurier King Size), the additional benefit of greatly reduced total smoke volume cannot be overlooked.

If nicotine proves to be a major motivator for smoking, these results, appreciating their limitations, would suggest that the Matinée King Size smoker would benefit by changing to a stronger brand, contrary to current governmental recommendations of switching to a brand of lower tar and nicotine.

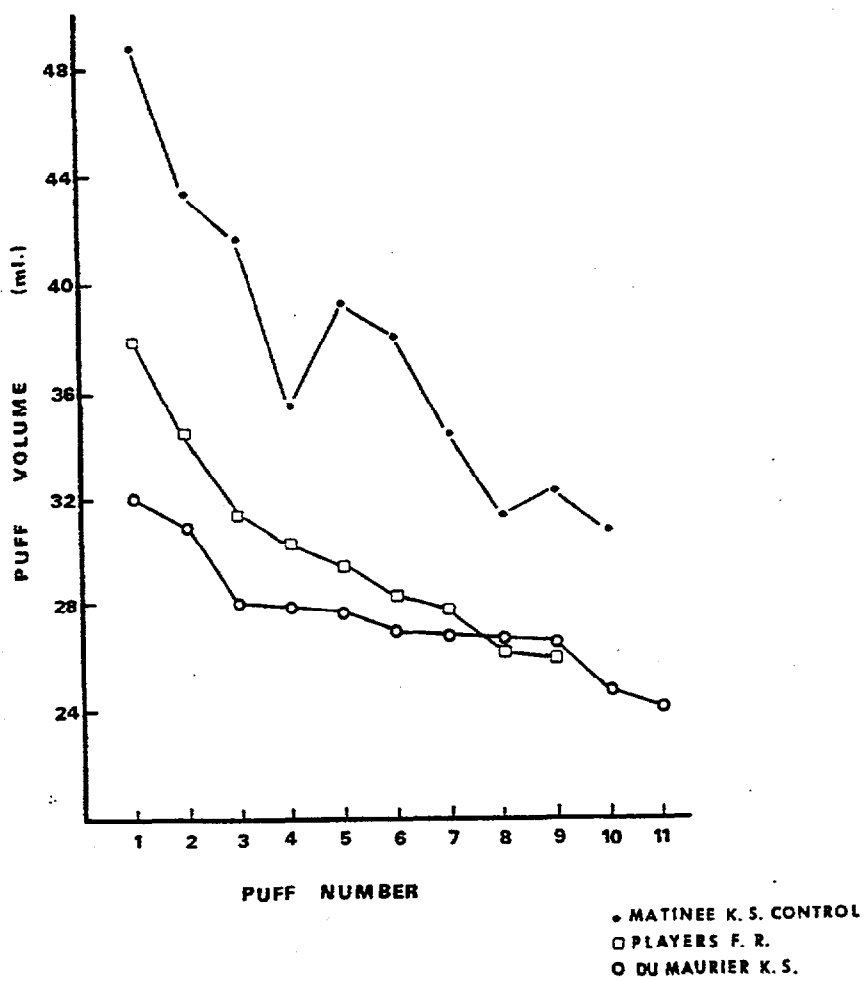
This work is now being extended by studies measuring the degree of inhalation and overall smoke intake during smoking, to get a truer picture of the effects of changing to a new cigarette.

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1. Freiesleben, E.R., Dunn, P.J., ITL Research Laboratory Report No. 145-  
March, 1975.
2. Imperial Tobacco Group Report, Nov. 1971.
3. Wakeham H. "The Reasons for Taking Up or Giving Up Smoking",  
University of Kentucky Community Medicine Grand Rounds, Jan. 22,  
1970; this was quoted by P.M. Moody, R.B. Griffith and J.H. Averitt,  
University of Kentucky Tobacco and Health Institute Workshop  
Conference, January, 1972.
4. Creighton D., McGillivray, L.M., Gp. R & DC., Report R.D. 837- R.  
Nov. 3, 1971.
5. Creighton, D.E., Watts, B.M., B.A.T. Research Laboratory  
Report No. RD 1144-R, Sept. 1974.
6. Frisch, A.F., Brown & Williamson Tobacco Corp. Research Laboratory  
Report No. 68-1R, Jan. 1968.

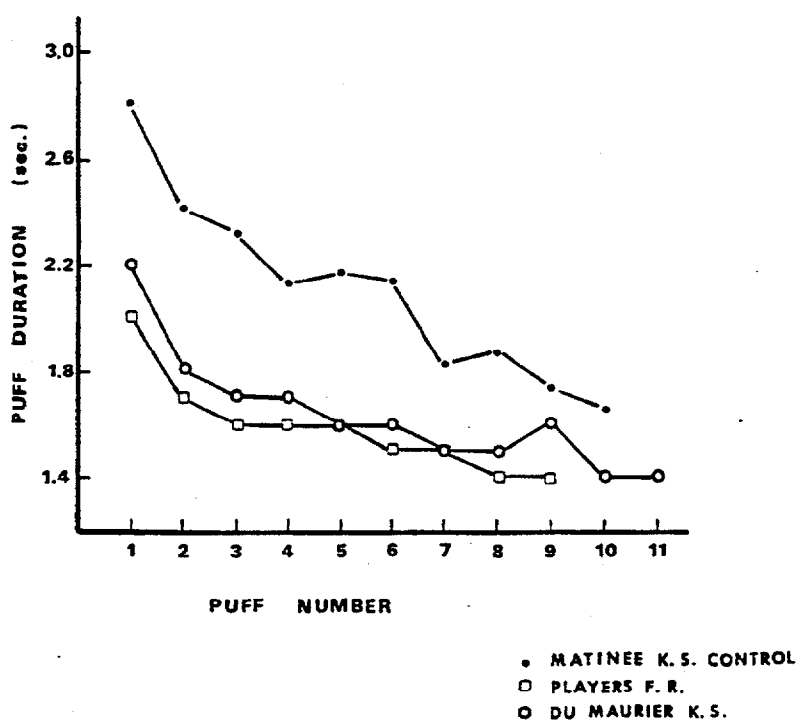
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Figure 1



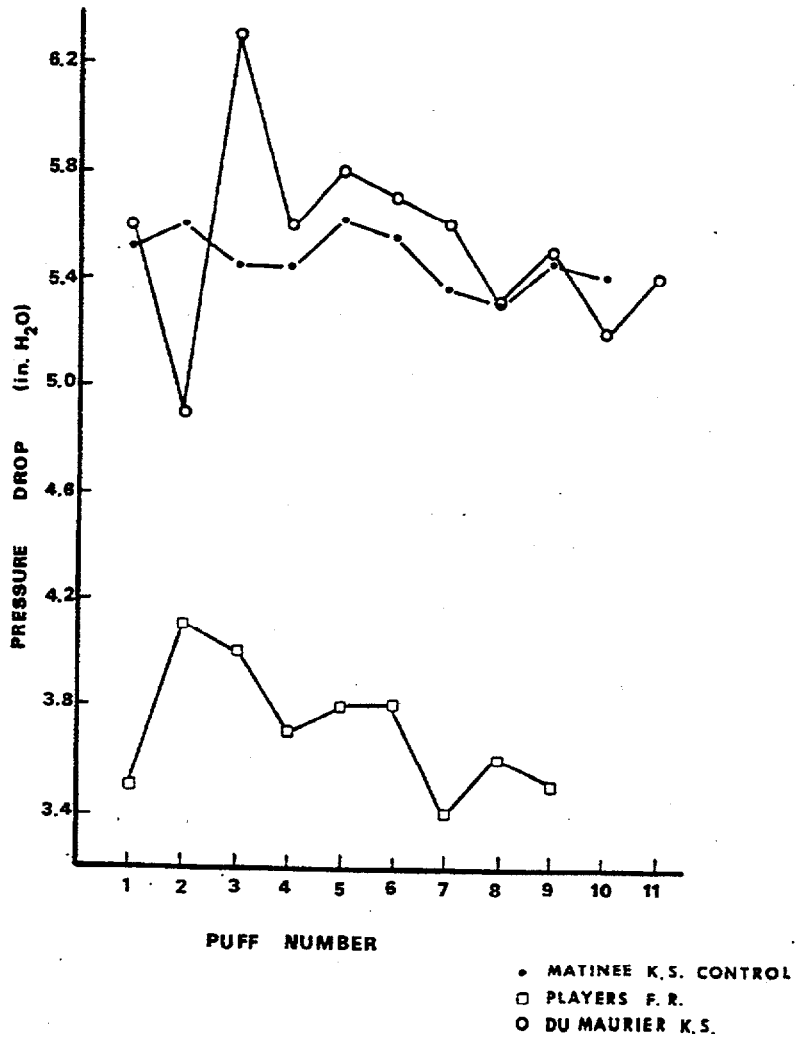
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Figure 2

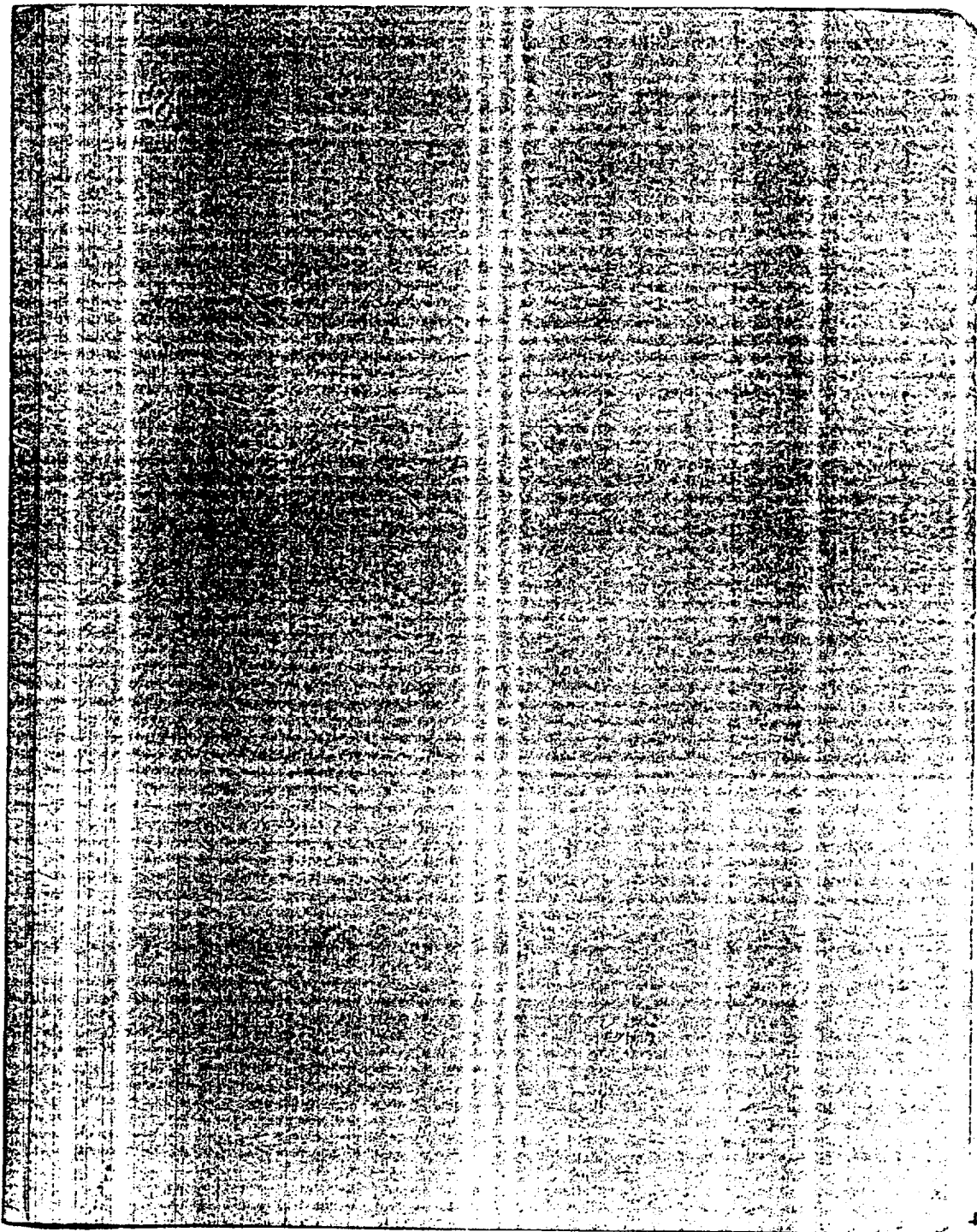


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Figure 3



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