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The Effects of Temperature and Humidity on the Permanency of Latent Fingerprints

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The determination of the age of a latent fingerprint is a matter of some concern, yet there is little, if any, in the way of systematic research in this area. In this study the effects of humidity and temperature on the clarity of a developed latent fingerprint stored for varying times has been studied. It is concluded that it is not possible to determine that a fingerprint is fresh or several weeks old by examining the fingerprint lift, or by observing how the print "develops" when the dusting powder is applied.

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Introduction

One of the most frequently occurring types of physical evidence is the latent fingerprint. Of all types of physical evidence, with the exceptions of evidence involved in drug and drunk-driving offences, the latent fingerprint is the most frequently found (Parker, 1970). In many cases the question arises as to whether the identified latent print was deposited at the crime scene during the commission of the crime or at some prior or subsequent occasion.

A review of the literature reveals little, if any, useful information regarding the determination of the age of prints. Most of the statements which do occur in the literature refer to the effects of temperature and humidity on the prints (Conner, 1974; Johnson, 1972; Moenssons, 1971) or else the contamination of the latent print by environmental contaminants. Some writers indicate that the atmospheric conditions when the print was made are important (Myre, 1974). Latent print experts vary in their response to questions involving the age of a latent print. A typical example is from a recent case in which the latent print expert was asked, "How long prior to the time it was lifted might the print have been placed on the object?". The answer was, in part, "the lifting technician would be better qualified to answer that question, but based on my experience as a lifting technician for approximately six years, given the clarity, the contrast and the very, very sharp detail in the latent print it would indicate that the latent print would have been at the scene from 3 to 7 or 8 days before it was lifted".

In considering what changes might take place in a latent print during the ageing process, there are two separate factors which must be taken into account. First, is the problem of environmental contamination. The settling of dust, the condensation of water or grease, or the traffic in the area of the latent print all may effect the longevity of the latent print. The second ageing process in a latent print will be those changes which occur in the material composing the latent print. Some of the changes which might take place within the latent print are oxidation, racemization, evaporation, absorption or adsorption, and perhaps others. The rates of several of these processes would be expected to be influenced by temperature and humidity as well as light, chemicals in the surrounding atmosphere, *etc.* In this particular study it was decided to examine the effects of varying temperature and humidity on the clarity of latent fingerprints developed using common dusting techniques.

Methods and Materials

Latent fingerprints to be used in this study were obtained from twelve

individuals as follows. The subjects were directed to thoroughly wash and dry their hands, then, using five prenumbered slides, leave latent fingerprints of the corresponding fingers on each hand on the five slides. Following this first collection, the subjects went about their normal activities for two and a half to three hours then were asked to repeat the procedure of leaving latent fingerprints, using a second group of slides and without washing their hands. Latent prints for a third set of slides were collected immediately following those of the second after having directed the participants to rub their fingertips across their foreheads or through their hair in order to increase the amount of oil and perspiration on the fingertips.

After obtaining prints from all of the subjects, a few prints from each subject were taken and immediately developed by dusting. The rest of the latent prints were placed in a series of 5 closed containers to be kept at various conditions of temperature and humidity. The conditions of storage which were used are shown in Table 1.

For two months following the collection of the prints, slides were periodically dusted and lifts made according to a predetermined schedule. This schedule called for processing at times of 24 hours, 72 hours, 1 week, 3, 5 and 7 weeks subsequent to collection, in addition to those prints processed the same day as collection. The schedule was arranged so as to develop equal numbers of prints from each person and under each condition of the fingertips at each time interval.

In developing the latents, the same dusting materials were used throughout the two month duration of the study: a single camel hair brush and Sirchie black fingerprint powder. Attempts were made to keep dusting procedures and techniques the same throughout the study.

In order to make some type of quantitative assessment as to the effects of the various storage conditions on the permanency of the latents, it was necessary to devise some scheme to "grade" the developed prints. This was done by scoring each developed print by comparison with a "quality" scale. This quality scale gave a highest quality print a score of 1, and a lowest quality print (a smudge) a score of 5. Prints developed initially were selected to prepare a comparison chart to score the subsequent prints (see Figure 1). In the choice of standards for comparison and grading of the lifts two properties were considered: (1) The amount of interpretable ridge detail present in the lift, and (2) the degree of adherence of the fingerprint powder to the microscope slide.

TABLE 1

AVERAGE SCORES AND STANDARD DEVIATION FOR LIFTS FROM LATENTS MADE AND STORED UNDER CONDITIONS INDICATED

	Age of Latent						
	0	*24 hrs.*	*72 hrs.*	*1 wk.*	*3 wks.*	*5 wks.*	*7 wks.*
All Prints	3·8	3·9	4·1	3·6	3·7	3·9	4·2
	1·1	1·1	0·8	1·5	1·4	1·2	1·0
Stored at 20°C, 32% RH		3·7	3·8	3·2	3·3	3·7	4·0
		1·7	1·2	1·8	1·7	1·6	1·0
Stored at 20°C, 73% RH		4·2	3·7	4·0	3·4	3·7	3·9
		1·0	1·0	1·1	1·6	1·2	1·1
Stored at 30°C, 69% RH		4·0	4·2	2·7	3·8	3·6	4·1
		1·0	1·0	1·6	1·1	1·4	0·9
Stored at 20°C, 98% RH		4·2	4·1	3·6	3·9	4·0	4·3
		0·8	1·2	1·7	1·2	1·1	0·9
Stored at 20°C, 93% RH		3·9	3·9	4·8	4·2	4·5	4·5
		0·9	0·9	0·4	1·3	0·7	0·9
Cleaned Hands	4·5	4·8	4·6	4·4	4·5	4·7	4·7
	0·7	0·4	0·5	1·4	0·9	0·7	0·6
Normal Hands	3·6	3·9	4·0	3·8	3·7	3·8	4·3
	0·9	0·8	1·0	1·4	1·4	1·1	0·9
"Greased" Hands	3·2	3·1	3·3	2·5	2·9	3·2	3·6
	1·1	1·2	1·0	1·4	1·3	1·3	1·0

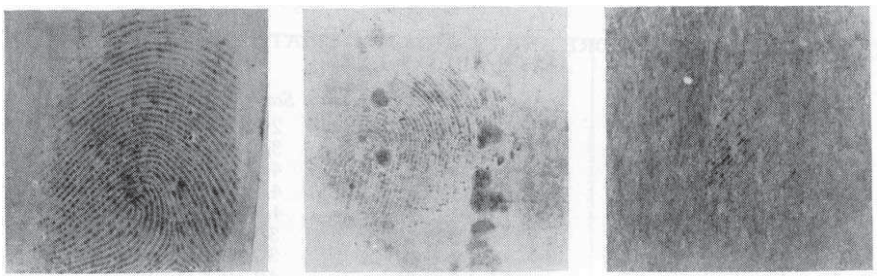

Figure 1. Fingerprint grading standards. Developed prints were graded by comparing them with the standards shown. (left) a grade 1 print; (centre) a grade 3 print; (right) a grade 5 print.

Separate grading scales were used to these two characteristics and lifts were individually scored as to their standing in each category.

Discussion

It is obvious that the "quality" of a latent print not only is a function of the ridge detail that has been reproduced but is also a function of the contrast between the reproduced ridge detail and the background. In grading the prints for clarity of ridge detail, it was attempted to take into account only the clarity of the ridge detail and not the amount of background present, although contrast certainly plays a part in the impression of clarity of the latent print. The following discussion will be restricted only to the scoring of the ridge detail clarity and no attempt has been made to take into account the amount of background or the contrast of the latent impression.

The latent prints were scored for ridge detail clarity independently by two individuals. It is interesting to look at the comparison between the scores obtained by the two individuals (see Table 2). Approximately 66% of the time the two individuals scored the prints the same, 22% of the time one individual scored the print better than the other and 12% of the time the other individual scored the print higher. In most cases the difference in scoring was only by one rank although in some instances the difference was greater. In comparing the average score obtained by both individuals, the overall average score for the first individual was 3·9 and for the second was 3·8 with standard deviation of 1·1 and 1·2 respectively. The difference between these two average scores is not significant ($P > 0{\cdot}1$) indicating that the two scorers have reasonable consistency in their grading.

Since the number of prints from each subject placed in the various environmental chambers and developed at specific times is approximately the same the comparison from subject to subject should show a difference if there is any subject variability. It can be seen from Table 2 that, although there is some difference between the various subjects, even the extreme subject, No. 1, falls only one standard deviation away from the mean for all subjects. Also, relatively consistent values found for the standard deviations indicate that any changes which might take place are roughly of the same magnitude for each subject.

The next variable which was studied was variation in the condition of the hand. Whether or not the hands had been freshly washed or purposely "greased" did make a significant difference. (See Table 1). The difference between clean hands and dirty hands, and clean hands and greased hands, both are highly significant ($P < 0{\cdot}01$) whereas the difference between dirty and greased hands is not significant ($P > 0{\cdot}05$). It is interesting to note that this difference remained fairly constant throughout the course of the experiment with there being no appreciable difference between the ageing effects on the clean hand fingerprint as opposed to the dirty or greased hand fingerprint.

TABLE 2

OVERALL AVERAGE SCORE AND STANDARD DEVIATION FOR EACH SUBJECT AND EACH SCORER

Subject	*Scorer # 1*	*Scorer # 2*
1	2·8 (1·3)	2·9 (1·4)
2	3·2 (1·5)	3·5 (1·4)
3	4·1 (1·1)	4·2 (0·9)
4	4·4 (1·0)	4·7 (0·5)
5	4·3 (0·8)	4·4 (1·0)
6	3·6 (1·3)	3·7 (1·1)
7	3·3 (1·0)	3·7 (0·9)
8	4·0 (1·2)	4·1 (0·8)
9	3·7 (1·4)	3·7 (1·4)
10	3·9 (0·9)	3·7 (1·2)
11	4·3 (1·1)	4·1 (1·2)
12	3·7 (1·4)	3·9 (1·3)

Table 1 shows the changes for prints stored under all conditions over the approximately 50 day time span of the experiment. Applying statistical tests for differences of the mean shows a significant difference ($P < 0{\cdot}05$) between the original average and the average overall after seven weeks. This would indicate that overall there is some deterioration with age of latent fingerprints, however the statistical argument is not highly persuasive. In looking at the numbers of prints which were useable as opposed to those which were of no value (that is arbitrarily defined as those which scored 1, 2 or 3 were useable and those prints which scored 4 or 5 were not useable) it can be seen (Figure 2) that even after seven weeks storage there was a total of approximately 15 out of 72 prints which were good and approximately 57 which were bad. This compares with approximately 12 prints which were good in the group developed immediately as opposed to 23 which were bad. Therefore, the percentage of good prints has decreased, but still there is a significant percentage of prints stored for seven weeks which are useable. The useable prints were reasonably evenly distributed throughout each of the various temperature and humidity conditions.

The various humidity environments can be arbitrarily classified as low or high, with high humidity being 93% and 98% relative humidity and low humidity being 32%, 73% and 69% relative humidity. These data are shown in Table 3. Comparing the overall average score after seven weeks for prints stored at high humidity with the score for prints developed immediately shows that the difference between the averages is highly significant ($P < 0{\cdot}01$). It should be noted that the differences indicate that the prints are in worse condition after having been stored at high humidity for seven weeks than they were originally. This is a somewhat surprising result since it seems to be the common belief that the primary effect of age is one of drying of the prints. Such effect should be significantly retarded at storage conditions approaching a saturated atmosphere.

For the prints stored at the lower humidity conditions, there is no statistically significant difference between the average score for these prints after seven weeks and the score for prints developed immediately.

The next effect to be looked at is the effect of storing the prints at relatively high temperature, approximately 30°C. In comparing the overall scores for these prints with prints developed immediately, there is no statistically significant difference ($P > 0{\cdot}1$). For the prints stored at low temperature conditions, approximately 20°, there is no significant difference ($P > 0{\cdot}1$).

Conclusion

It may, in general, be stated that the clarity of a developed print is primarily related to the original latent print quality and is not related to the temperature

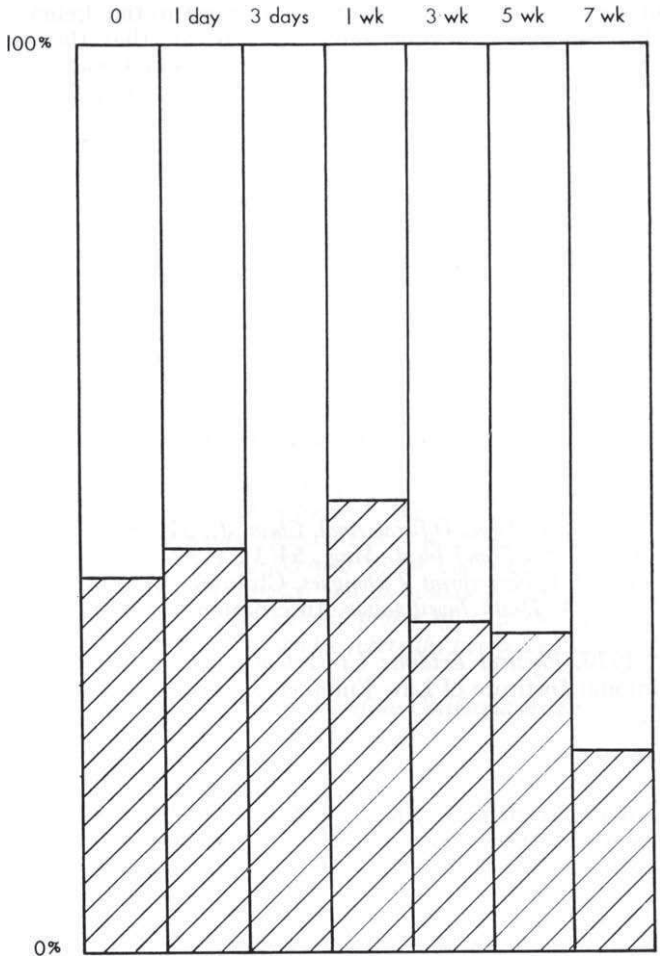

Figure 2. The percentage of prints classified as useable (grades 1 to 3) at the time intervals shown.

TABLE 3

AVERAGE SCORES FOR LIFTS MADE FROM PRINTS DUSTED AT TIMES INDICATED AND STORED UNDER THE INDICATED CONDITIONS

	Age of Latent Before Dusting					
	24 hrs.	*72 hrs.*	*1 wk.*	*3 wks.*	*5 wks.*	*7 wks.*
Stored at high RH	4·0	4·0	4·1	4·0	4·2	4·4
	0·8	1·0	1·5	1·2	0·9	0·9
Stored at low RH	3·9	3·9	3·2	3·5	3·7	4·1
	1·3	1·0	1·6	1·5	1·3	1·0
Stored at high temp.	3·9	4·0	3·7	4·0	4·0	4·1
	0·9	0·9	1·3	1·2	1·2	1·0
Stored at low temp.	3·9	3·9	3·6	3·5	3·8	4·1
	1·2	1·1	1·6	1·5	1·3	1·0

and humidity under which it has been stored, at least for the time period which this experiment has studied. Obviously, the effect of physical contamination or physical obliteration of the print is a significant factor. However it is certainly possible that a fingerprint impression may last for weeks at rather extreme storage conditions and still be easily detectable.

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