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An investigation into the enhancement of sea-spray exposed fingerprints on glass

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ABSTRACT

Fingerprints are considered one of the best forms of personal identification. While numerous enhancement techniques exist to develop fingerprints under various conditions, the enhancement of fingerprints exposed to sea spray aerosol (SSA) still remains problematic.

1056 fingerprints from four donors, using a depletion series and triplicate repeats, were deposited onto glass panels and exposed to SSA for 1 week and 1 month.

Control prints were deposited in the same manner and left under laboratory conditions.

All prints were enhanced using fingerprint enhancement techniques available to Forensic Police Officers and subsequently examined for identifiability by a Fingerprint Expert.

Significantly fewer identifiable prints ($p < 0.01$) were developed after exposure to SSA for 1 month (11%) compared to exposure for 1 week (69%) (compared to the control prints 99%) for all enhancement techniques.

After 1 week's exposure, all techniques enhanced over 50% of prints, except SPR white (12%), with iron (III) oxide and Wetwop™ white producing over 90% identifiable prints.

Only iron (III) oxide, Wetwop™ white and SPR black returned any identifiable prints following 1 month's SSA exposure. Iron (III) oxide being significantly better ($p < 0.01$, 67%) than the other techniques.

Iron (III) oxide suspension and Wetwop™ white were found to be superior at enhancing prints at both SSA exposure times.

1. Introduction

Numerous fingerprint enhancement techniques have been developed to enhance fingerprints on both porous and non-porous surfaces with great success [1]. Further developments have also been made to enhance prints after exposure to challenging environmental factors such as prints on wetted items [2], on the sticky side of tape [3], aged prints [4] and prints exposed to extreme temperatures [5].

Although the effects of multiple environmental factors on fingerprints have been explored, the effects of sea spray aerosol (SSA) have not yet been investigated.

Airflow, temperature, sunlight, humidity and water can all influence the durability of a print and as such can affect enhancement success [9]. High airflow and a high surface temperature can cause prints to rapidly dry out [9], while a high environmental temperature can cause the fats and oils to degrade [2].

Sea spray is generally deposited from the natural action of wind over the ocean [6]. A print that is exposed to SSA will consequently be exposed to potentially damaging airflow and salt particles.

A survey conducted with 20 Gold Coast Crime Scene Officers indicated that fingerprints could not be recovered from approximately 8–12% of all crime scenes due to SSA exposure (Finigan, A., Personal Communication, February 11, 2013).

Since the Gold Coast of Australia consists of 27 km of coastline and 260 km of navigable waterways [16] countless numbers of non-porous surfaces in water front dwellings are potentially being SSA exposed, preventing successful print enhancement.

The aim of this study was to find the most effective fingerprint enhancement technique for prints exposed to SSA at two time frames; 1 week and 1 month.

2. Materials and methods

Four donors, two male and two female, participated in this study.

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2.1. SSA experiments

Two large glass panels were placed on the balcony of a fifth floor ocean front apartment (approximately 100 m from the ocean) on Australia's Gold Coast. They were both cleaned with a microfibre cloth (Enjo™, Australia) dried with a second microfibre cloth, sprayed with 70% ethanol and dried again with the second cloth.

Panel 'A' was then left for 1 week for SSA to build up before print deposition. Panel 'B' was cleaned as described and prints were deposited immediately.

Each donor washed their hands 30 min prior to deposition. They used the right index finger and rubbed their hands together between repeat and depletion series to redistribute residues. They deposited prints in a series of four depletions with triplicate repeats in a systematic grid (see Fig. 1) [7].

The donation was carried out for Panels A and B on the same day to expose the prints to the same environmental conditions.

This whole process was then repeated (with both panels A and B) however the prints were exposed to SSA for 1 month.

The 1 month experiment was conducted after the 1 week and thus the environmental factors were slightly different.

Temperature, humidity, average wind speeds, wind gusts, wind direction and rainfall were taken from the [8], during the periods of time that the prints were SSA exposed.

Eleven fingerprint enhancement techniques were used, namely; aluminium flake powder (BVDA international, Holland), standard black and white, magnetic white and black and silver/grey powders (SIRCHIE™, Youngsville, NC, USA), iron (III) oxide suspension (prepared according to Home Office™ powder suspensions chemicals protocol (2012)) [4], Small Particle Reagent (SPR) black and white (Lynn Peavey Company TM, Lenexa, KS) and Wetwop™ black and white (Kjell Carlsson Innovation™ Sweden) [10].

The black, white and silver/grey standard powders were applied with an animal hair brush, black and white magnetic powders with a magnetic wand (SIRCHIE), aluminium flake with a fibre glass filament (zephyr) brush (SIRCHIE). The iron (III) oxide and black and white Wetwop™ suspensions were painted on with animal hair brushes and rinsed off with water. SPR was applied using the manufacturers spray bottle and rinsed off with water.

Each print was photographed and the photographs examined for identifiability (enough detail to be taken to court) by a Queensland Police Fingerprint Expert.

Multinomial logistic regression analyses were performed on the data using IBM SPSS Statistics 19, using a p value of <0.05 to determine statistical significance. This facilitated a comparison between multiple category variables.

2.2. Control experiments

Control experiments were carried out under laboratory conditions at a constant temperature of 24 °C. Fingerprints were deposited onto pre-cleaned glass panels (as previously described) which were then stored in a closed, dark cupboard for the allotted time.

3. Results

Following enhancement, all of the control prints were deemed identifiable, except for SPR white for donor 1 for the 1 week experiment, of which none were identifiable. This resulted in 98% returned prints for the 1 week and 100% for the 1 month timeframe, with an average of 99% recovery overall.

No significant difference was found between panels A and B (1 weeks' pre-SSA build up and no build up respectively) for either the 1 week or the 1 month SSA exposure experiments and so the results of both panels were considered together in the statistical analyses for each time frame.

Exposure to SSA for 1 week and 1 month showed that iron (III) oxide suspension and Wetwop™ white were both significantly better ($p < 0.05$) at recovering prints than all other enhancement techniques.

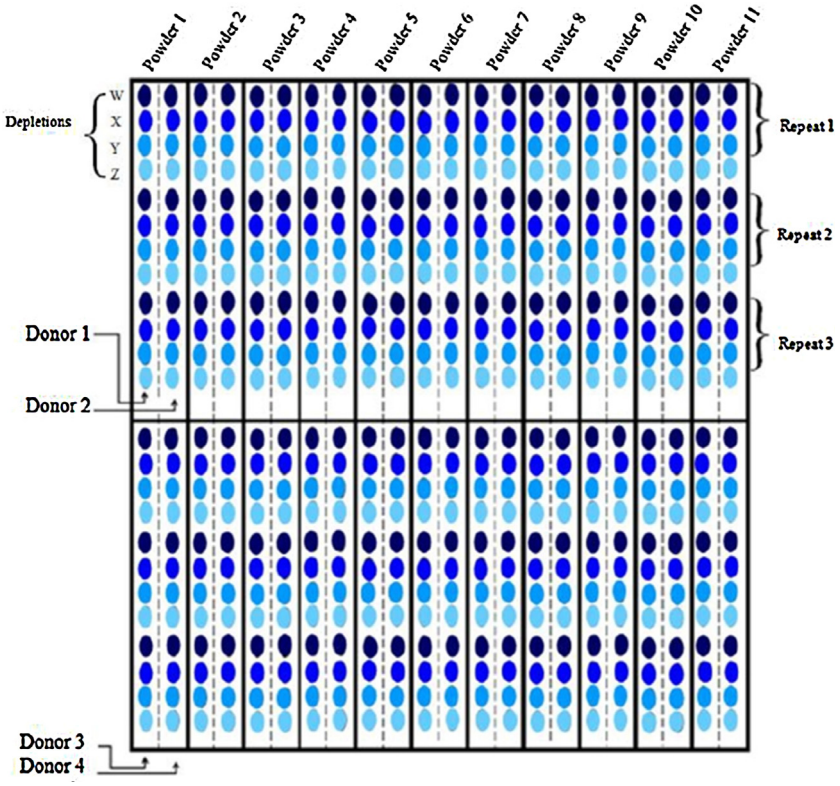

Fig. 1. Layout of the deposition of fingerprints on glass panels exposed to SSA.