



The Secondary Transfer of DNA: The Influence of Shedder Status on the Dominant Donor in a Mixed Profile

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Introduction

Various types of object found at crime scenes, such as those shown in Figure 1, have been found to yield successful DNA profiles from trace evidence on their surfaces. A useful review of trace DNA evidence is provided by Wickenheiser [1].

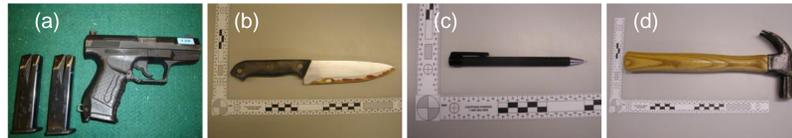


Fig 1. Example of types of object that have yielded successful DNA profiles. (a) Firearms and firearms related articles: (b) Knife handles: (c) Pens: (d) Hammer handles.

Problems with interpreting DNA profiles from such an object may arise if:

- the individual handling the object inadvertently transfers another person's DNA to it, a phenomenon known as secondary transfer, or
- if an object has been handled by more than one individual.

Mixed profiles might be expected from secondary transfer. However, Wickenheiser [1] states that 'While secondary transfer of trace DNA is possible, the transferred DNA will be overwhelmed by the vector individual's DNA, or be a minor component in a mixed profile'. Further Ladd *et al.*, [2] concluded from their results that secondary transfer need not lead to mixed DNA profiles. Lowe *et al.*, [3] observed secondary transfer from skin to skin to object and concluded that the degree to which this occurred was dependent on the shedder status of the individuals involved.

Objectives

In an attempt to explore the issues that secondary transfer of trace DNA may present to forensic science, this research was designed to:

1. Determine the occurrence of secondary transfer when an intermediary individual is the vehicle for transfer (i.e. skin to skin to object secondary transfer).
2. Establish whether the final person to contact an object is the donor of the dominant profile found on that object.

Method

This study involved six subjects, labelled A to F. Two types of experiment were carried out:

Experiment 1

Two subjects shook hands for 30 seconds, one of whom then immediately held an object (a DNA free glass beaker) for 30 seconds. The DNA retrieved from the object was then amplified and profiled. This experiment was repeated three times, each time with different subjects (see Table 1).

Experiment 2

One subject held an object (a DNA free glass beaker) for 30 seconds. The object was then immediately passed to another subject who also held it for 30 seconds. The DNA on the object was then amplified and profiled. This experiment was repeated three times, each time with different subjects (see Table 2).

Prior to each of the experiments, subjects were asked to refrain from washing their hands or coming into contact with any other person for at least 1 hour. The contact and swabbing techniques used can be seen in Figure 2.

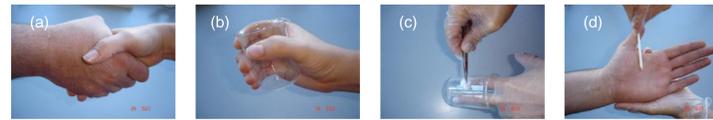


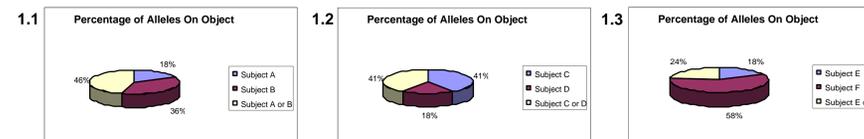
Fig 2. Experimental Design: (a) subjects shaking hands, (b) subject holding object for 30 seconds; (c) swabbing of the object, (d) swabbing of a subject's hand.

Results

Experiment 1

Table 1. Results of Experiment 1.

Repeat No.	Subjects Who Shook Hands	Subject Who Held Object	Subject With Dominant Profile on Object
1.1	A and B	B	B
1.2	C and D	D	C
1.3	E and F	F	F



Charts 1.1, 1.2 and 1.3. The percentage of alleles that are attributable to each subject in each of experiment repeats 1.1, 1.2 and 1.3, respectively.

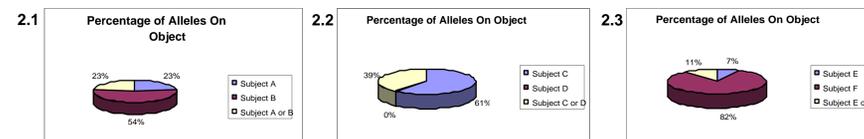
The results, shown in Table 1 and Charts 1.1, 1.2 and 1.3, indicate that secondary transfer was seen in every subject pairing, but to varying degrees.

Interestingly, in repeat 1.2, the object swab showed secondary transfer of DNA, with 41% of the observed alleles belonging to Subject C, and a further 41% observed to be shared alleles (can not be assigned to one subject alone).

Experiment 2

Table 2. Results of Experiment 2.

Repeat No.	Subjects Who Held Object First	Subject Who Held Object Second	Subject With Dominant Profile on Object
2.1	A	B	B
2.2	C	D	C
2.3	E	F	F



Charts 2.1, 2.2 and 2.3. The percentage of alleles that are attributable to each subject in each of experiment repeats 2.1, 2.2 and 2.3, respectively.

These results, shown in Table 2 and Charts 2.1, 2.2 and 2.3 indicate that the person to last handle an object is not always the dominant contributor to the DNA profile.

Interestingly, in repeat 2.2, the swab from the object handled by both subjects showed that the majority of the alleles (61%) belonged to Subject C. The remaining 39% of the observed alleles were shared alleles.

Discussion

Wickenheiser [1] states that 'While secondary transfer of trace DNA is possible, the transferred DNA will be overwhelmed by the vector individual's DNA, or be a minor component in a mixed profile. It is extremely unlikely for the vector individual to inadvertently transfer only the first person's DNA, without also leaving his or her own DNA in a larger amount'. The results gained throughout our preliminary study contrast with this opinion, indeed in repeat 1.2 the first person's DNA was dominant. **This would support the proposal that the degree to which secondary transfer exists is dependent upon the shedder status of the individuals involved, although this is not the only explanation.**

Further, the results of repeat 2.2 as reported in Table 2 and Chart 2.2 are in contrast with Wickenheiser's statement that 'The previous contributor will often be replaced by subsequent contact with a second individual. A trace DNA profile is indicative of the last individual to contact the substrate'.

Conclusions

1. Skin to skin to object secondary transfer of trace DNA was observed.
2. The final person to come into skin contact with an object is not always the donor of the dominant profile recovered.

Future Work

This poster addresses preliminary work carried out by the authors. Other variables that must be considered include:

- Increased number of subjects & determination of shedder type.
- Increased time intervals between initial and subsequent contacts (so prolonged time intervals between e.g. Subject A → Subject B and Subject B → Object).
- Increased number of potential transfer points (e.g. Subject A → Subject B → Subject C → Object and Subject A → Object 1 → Subject B → Object 2).
- Range of substrate materials.
- Controlled choice of subject to ensure they differ at more loci (to prevent allelic overlap) and vary in shedder status.

Acknowledgments

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