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DNA transfer during social interactions

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ABSTRACT

Multiple DNA transfer has increasingly been brought up in court as potential means for the presence of the defendants DNA at the crime scene or on a piece of evidence. This has prompted several investigations into DNA transfer under very controlled and semi-controlled conditions, however little is published about DNA transfer in "uncontrolled" or real life situations.

Here we examined the effects of multiple direct and indirect transfer of DNA within a small group of people and objects: three individuals participating in a social interaction of having a drink (jug of juice) together for 20 min. At the end of the tests all the surfaces of interest were sampled and analyzed.

In many instances the last person or the only person to come in contact with the object was the main or the only depositor of the DNA detected on it. The jug was a clear vector for secondary DNA transfer. Interestingly, in many instances the participants acted as vectors for foreign DNA transfer.

1. Introduction

Multiple DNA transfer has increasingly been brought up in court as potential means for the presence of the defendants DNA at the crime scene or on a piece of evidence. This has prompted several investigations into DNA transfer under very controlled and semi-controlled conditions [1–3], however little is published about DNA transfer in "uncontrolled" or real life situations [4]. Here we examine the effects of multiple direct and indirect transfer of DNA within a small group of people and objects.

2. Materials and methods

In the experiment, three individuals participated in a social interaction of having a drink of juice together for the duration of 20 min. The participants sat around the table and drunk from individual glasses while using a communal jug filled with juice. No restrictions were placed on talking or item handling and all the interactions by the participants during the tests were unscripted and recorded with two video cameras. Interactions were then reviewed and analyzed for person to person and person to object contacts including the location, duration and the sequence of these interactions. The test was repeated four times, each time with a different set of individuals.

New glasses were used for each test; however the jug was cleaned and re-used between the tests. All test surfaces and items were cleaned prior to each test and control samples taken. After 20 min, samples were taken from the segments of the table, chair arms, jug, jug handle, glasses and the left and right hands of each participant (note: the hand swabs were not taken in test 1). Table was divided into 6 segments, 2 segments per participant.

DNA was extracted, quantified, amplified and analyzed using DNA IQ™ System (Promega), Quantifiler™ Human DNA Quantification kit (Applied Biosystems), PowerPlex®21 STR multiplex kit (Promega), 3500xL Genetic Analyser (Applied Biosystems) and GeneMapper™ IDx Software (Applied Biosystems). DNA profiles were analyzed with continuous modelling statistical software STRmix™ to determine the inclusion/exclusion and the strength of the inclusion where applicable.

3. Results

3.1. Controls

No DNA was detected on the jug, glasses or table segments prior to each test. This was also so for the chair arms in the last three tests, however, mixed DNA profiles from a minimum of four people were detected on two of the three chairs in the first test. All participants were excluded as contributors to these mixtures.

3.2. General observations

None of the chair arms, table segments nearest to the sitter and glasses were touched by anyone other than the associated sitter; with the jug being the only item touched by multiple individuals.

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3.3. Table and chairs

Not surprisingly, in the first test where background levels of DNA were detectable after cleaning on two of the chairs, same mixtures of DNA were also detected on the same two chairs after completion of the test. All participants were excluded as contributors to these DNA mixtures.

In 33% of chair samples and 27% of table samples a participant who did not come into contact with the test surfaces was detected. Furthermore, in 42% of the chair samples and 58% of the table samples unknown profiles not attributed to any of the participant were also detected. Interestingly, 23% of these table mixtures contained recognizable unknown DNA profiles that did not match any of the participants however did match the unknown profiles detected both on the hands of the participants as well as glasses and chair arms.

3.4. Glasses

In 25% of the glass samples, a participant other than the holder was detected. Further, unknown profiles were detected in 33% of glass samples. One such unknown profile also matched the unknown profile recovered from the hand of the participant using the glass and table area and a glass that was not touched by the participant.

3.5. Jug handle and jug body

An unknown DNA profile was detected in one of the handle samples, which matched the profile recovered from a chair in control and test samples.

In remaining samples, only DNA of participants was detected. Interestingly, in the jug samples, the last person to come in contact with jug body was not the person who left the majority of the DNA. Based on the video evidence, it is possible, that because the last contact with the jug body happened late in the tests (16 and 18 min) the participant touching the jug body collected DNA of other participants on their hands, possibly from the jug handle, and then transferred it to the jug body.

3.6. Hands

In 17% of the hand samples, a participant other than the donor was detected as part of the mixture. Additionally, unknown DNA profiles were obtained in 64% of the hand samples. Two of the unknown profiles obtained from these mixtures matched two unknown profiles that were detected on the glass and table samples. Notably, while one of these samples matched the glass and the table area nearest to the hand owner, the other matched the area of the table that the owner of the hands was not in contact with possibly through the transfer via a jug.

4. Discussion

The results of these tests show that, in many instances the last person or the only person to come in contact with the object was the main or the only depositor of the DNA detected on it. However, it was also found that in some instances the participants acted as vectors for foreign DNA transfer, possibly present on their hands, via multi step transfer. While in the majority of situations the holder/sitter was the major contributor to the DNA detected and the transferred DNA profile was detected as a minor component, there were several samples where the transferred DNA was a major component. Additionally, further evidence of DNA transfer was observed through the detection of the identifiable DNA profiles from the unknown individuals on a number of experimental items and surfaces.

Logically, the most likely vector for DNA transfer was the jug and the jug handle; however these objects contained DNA mostly from the participants. It is possible that the unknown DNA was present in small or trace quantities and was drowned out or replaced more readily by the participants DNA on a "high traffic" surfaces such as jug than the less touched or "low traffic" surfaces such as the table.

This set of tests, although designed to mimic normal everyday interactions, was restricted by the environment that included only a limited number of items that were cleaned. Also, unlike in the majority of case work situations, the profiles of the participants were known thus allowing us to analyze and resolve some complex mixtures.

A comparison of our results with a similar study [5] that investigated transfer of UV powder under similar conditions showed that there is far less detectable transfer of DNA compared to UV powder. There are a number of factors that may affect the transfer of DNA comparative to the UV powder including: the moisture level of biological material being transferred, different interactions of DNA with the substrate material onto which it is transferred as well as extraction and sampling differences associated with the substrate type. Another important difference between these two experiments is that UV powder was introduced via a single individual while here each participant was a source of their own DNA as well as a transfer vector for other "unknown" DNA. The comparisons between the two studies indicate that UV powder cannot be directly substituted for DNA when investigating the DNA transfer phenomenon.

Conflict of interest

None.

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