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A Target Fiber Study Using Cinema and Car Seats as Recipient Items

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ABSTRACT: A target fiber study using two garments purchased from two major UK clothing retail chains was carried out using cinema and car seats as potential recipient items. A total of 17 acrylic fibers matching one of the target garments and six cotton fibers matching the remaining target garment were found on the recipient items. The limitation of using white light comparison microscopy alone is demonstrated. The findings of this study illustrate that the evidential value of matching fibers is heavily dependent on the number and type of tests used in a given comparison.

KEYWORDS: forensic science, criminalitistics, fiber transfer, fibers, target studies, cinema seats, car seats, acrylic, cotton

In an attempt to evaluate fiber transfer evidence, the assessment of the rarity (or commonality) of particular fiber type/color combinations in a given environment has been the subject of numerous studies (e.g., 1–6). Because the frequency of certain fiber types/color combinations in the environment may change over time (as a result of season, fashion trends, economic pressures, etc.), this study was carried out in an attempt to examine as large a representative sample as possible, over the shortest period of time possible. To this end, cinema seats as well as car seats were chosen as sources for sampling.

Materials and Methods

This study was carried out during the early part of the summer in 1994. Consequently, the majority of clothing stores were selling their "summer ranges" at this time.

A lightweight red acrylic jumper and a pair of green cotton leggings were purchased from two respective stores, each part of a national UK chain. Control fibers were taken from various areas of each of the two items of clothing, and the microscopic features were determined only at this stage.

Fiber tape lifts (100- by 150-mm Scotch™ Tape 822 pads) were taken from a representative number (67 out of 200) of seats from one of three auditoriums of a modern cinema. At the time of this study, this cinema had been open for just over 12 months and over 140,000 people had sat in the auditorium that was sampled. No similarities were found between the seat upholstery and the target fibers. The seats of this cinema were not routinely cleaned/vacuumed.

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Fiber tape lifts were taken from the front driver and passenger seats from a total of 66 cars. These cars were obtained from a local car dealer and represented "trade-ins" that had not been valeted. Cars were also obtained from members of staff at the laboratory. These vehicles represented a wide variation in age, model, and numbers of owners. No similarities were found between the car seats and the target fibers.

Target fibers were mounted in DePeX (BDH Laboratory Supplies, Poole, England) for comparison with the sample fiber tape lifts. The sample lifts were initially searched using low power microscopy (10 × Nikon SMZ 2B), with apparent fiber matches being removed and mounted individually in DePeX. These apparent matches were then compared against the target fibers using: comparison white light and fluorescence microscopy (Leitz Wetzlar) and visible range microspectrophotometry (Nanospec 100 AFT, by Nanometrics, connected to a Leitz Diaplan microscope). Where the recovered fiber type and size permitted, Fourier transform infrared spectroscope (FTIR) (Perkin Elmer 1720X, connected to a SpectraTech IR Plan microscope) and thin layer chromatography (TLC) analysis (Machery Nagel Alugram Sil G plates) were performed. The best TLC eluent for the red acrylic target fibers was found to be *n*-butanol:ethanol:.88NH_3:pyridine (4:1:3:2) after prerunning in methanol (7).

Results

Microscopically, both target fibers were found to be unremarkable. The red acrylic target was found to be delustered with a round cross section. FTIR showed the acrylic type to be acrylonitrile with a methyl acrylate copolymer. TLC revealed that a red monocomponent dye had been used.

Matches with the fibers comprising the red acrylic jumper were found with 3 fibers from the car seat tapings and 14 fibers from the cinema seat tapings. The maximum number of matching fibers on a seat was 1.

Matches with the fibers comprising the green cotton leggings were found with six fibers from the car seat tapings and none from

TABLE 1—*Number of fibers matching red acrylic target after each analysis stage.*

Seats	Number of Tapings	LP micro	Comparison Microscopy White	Blue	UV	MSP	FTIR + TLC	Not Tested*
Car	264	712	33	13	3	3	1	2
Cinema	67	112	16	15	14	14	4	10
Total	331	824	49	28	17	17	5	12

*Denotes fibers insufficient in size for FTIR and/or TLC analysis.

the cinema seat tapings. The maximum number of fibers found in any one car was four. The remaining fibers were each found in separate vehicles.

In no vehicle were fibers found which matched both target fibers.

The following tables give a breakdown in the number of fibers recovered from each respective set of tape lifts, and subsequent elimination after each comparison step. Note that in the case of the red acrylic fibers, not all of the fibers remaining after microspectrophotometric analysis were tested for FTIR and/or TLC. This was simply a result of size, as they were too small for FTIR sample preparation and/or successful dye extraction. The green cotton fibers (target and recovereds) were individually too pale for TLC analysis. Obviously, FTIR was not considered.

TABLE 2—*Number of fibers matching green cotton target after each analysis stage.*

Seat	Number of Tapings	LP micro	Comparison Microscopy			MSP
			White	Blue	UV	
Car	264	798	91	16	13	6
Cinema	67	116	13	0	0	···
Total	331	914	104	16	13	6

Discussion

An industrial inquiry revealed that the red acrylic target garment (jumper) had been introduced by one of the stores a year previously. In the stores in the UK, 558 of these garments had been sold with 997 of these items remaining in the stores throughout the UK at the time of this study. The green cotton target garment (leggings) had been introduced at the beginning of March 1994, 673 of which had been sold nationally at the time of this study. No figures of the numbers of this item remaining unsold were available. It is important to note that it was not possible to determine whether or not the same fiber type/color used in the construction of the target garments had been used in the previous or present production of other garments.

Although 14 red acrylic fibers from the cinema seat tapings were found to match the red acrylic target, only four of these fibers had been compared using FTIR and TLC. Because FTIR will subclassify acrylic fibers according to the copolymer used and TLC may identify differences in dye batch (8,9), it is possible, of the 10 remaining fibers, some may have been excluded if the full battery of comparison tests could have been used. Similarly, of the three matching red acrylic fibers recovered from the car seat tapings, only one of these was compared using FTIR and TLC.

Although it is likely that a significant proportion of the extraneous fiber population on each seat may exhibit a quick "turnover" (as a result of secondary transfers), it is possible that a proportion of the extraneous fibers present at a given time will represent a cumulative addition to the fiber population of the seat over a period of time, because some fibers may be pushed further into the upholstery pile and therefore resist a "casual" secondary transfer. Thus, a proportion of fibers present on the seats may represent contacts from numerous donor garments over a long period of time.

The results show that the number of apparent matches with the green cotton target under white light microscopy was dramatically reduced by using fluorescence microscopy. The number of these fiber matches was further reduced using microspectrophotometry (to minimize the chance of "false exclusion," several measurements were made along the length of the fiber where variation in color because of inconsistent dye uptake was observed). These results demonstrate the limited evidential value of performing comparisons on colored cotton fibers using white light microscopy alone and support the findings of Grieve, et al. (6).

Tapings from only three vehicles were found to have green cotton matches with the second target garment (four in one car, one in two others). In this case, none of the fibers were suitable for TLC analysis.

Had UV microspectrophotometry been available to us, then this technique may have added a further level of discrimination.

Conclusion

The results of this study show that the chances of finding a particular fiber color/type at random, in the population, is unlikely; however, this likelihood is dependent on how comprehensive the battery of comparative tests performed on the suspect fibers is. Where only minimal comparison can be carried out, the evidential value of any matches is reduced—even when ostensibly large numbers are found. The evidential value of white light microscopic comparison alone, on colored cotton fibers, would appear to be somewhat limited.

The environment in which the recipient item from which fibers are recovered may have considerable significance in the interpretation of evidential value, because the chances of finding random "matches" on recipient items that have been subjected to relentless contacts would ostensibly seem greater. The value of a thorough industrial inquiry in these cases would appear self evident.

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