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Morphological Characteristics of Bloodstains - Forensic Consequences

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Abstract Bloodstains are almost always present at the scene of a violent act and often can bring invaluable data regarding the cause of death, weapon, perpetrator, the kinetics of the traumatic event, etc. However, often important information which can be brought by the bloodstains is missed due to incorrect sampling and analysis of this material evidence. The purpose of this presentation is to summarize the main morphological characteristics of the bloodstains and to present the positive outcomes resulted from a correct identification.

Keywords: Forensic science; Physical evidence; Morphological characteristics; Bloodstain analysis; Spatter.

Introduction

Blood is a bodily fluid present in all animals, which has as a main function the delivery of nutrients and oxygen to all tissues and the transport of catabolites to specific organs of excretion (respiratory system for carbon dioxide, renal system for protein degradation products, etc.) [1].

In humans (as in almost all vertebrates) the blood is a reddish fluid, due to the presence of hemoglobin, a complex structure containing iron and proteins. Blood is circulated in the body throughout vessels (arterial and venous) and the active force is represented mainly by contractions of the heart.

Blood is a form of physical evidence, often analyzed in forensic sciences as it can bring useful information in the following areas:

- Origin of bloodstains (arterial, venous, pulmonary, digestive, etc.)
- Type of impact (gunshot, fall, aggression)
- Direction of impact (e.g. backspatter, forward spatter) [2]
- Mechanism of spatter pattern production [2]
- Characteristics of the weapon [2]
- Position of the victim and aggressor [2]
- Postmortem interval [3]
- Identification of the victim/aggressor, etc.

In order to respond to most of the objectives presented above, we must analyze two main characteristics of the bloodstains: (1) the morphological characteristics of the blood stain and (2) identification data, obtained through specific serological, immunological, and genetic tests, which can aid us, with a variable degree of certainty, in telling to which person the analyzed blood belongs to.

The purpose of this article is to summarize the main morphological characteristics of the bloodstains and their consequences in forensic practice.

Color

The blood color is variable depending on its source. Arterial blood is present in the lungs, left chambers of the heart and arteries (except for pulmonary arteries) and has bright red color [4].

Venous blood is present in the right chambers of the heart, veins (except for pulmonary veins), and pulmonary arteries, and has a dark-red color.

Postmortem blood is also dark-red, as the color is determined mainly by the oxygenation of the hemoglobin. After death the oxyhemoglobin transfers the oxygen to the surrounding cells, accepts carbon dioxide and resembles venous blood, irrespective of the da facto source or location [5].

After death the blood remains bright red in cases in which the tissues cannot accept the oxygen. For example in carbon monoxide or cyanide poisoning, or in refrigeration the cellular respiratory chain is blocked and therefore the cells cannot utilize the oxygen brought to them by the blood.

This in turn leads to the appearance of typical, bright red lividities in these cases, which significantly aids the legal medical physician in diagnosing the cause of death.

In methemoglobin poisoning the blood is blue-brownish and this can also be useful in detecting a possible intoxication with nitrites, nitrates, or other methemoglobin causing substances.

The blood which has had a passage through the upper respiratory system has a frothy appearance, due to the bubbling effect of the air present at this level.

The blood from the digestive apparatus has a typical tar appearance, due to the effect of the hydrochloric acid on the hemoglobin.

Aggregation state

Most blood stains are solid, as

(1) they typically contain only small quantities and (2) the water component tend to evaporate quickly. Medium or large sized blood stains can be either solid or liquid, depending mainly upon (1) the time passed from the moment of its production until its analysis, (2) absorbent capacities of the surface (time until complete evaporation is inversely correlated with the absorbent capacity of the surface), (3) temperature (time until complete evaporation is correlated with ambient temperature [1, 6].

Patterns of bloodstains

According to James and Kish, bloodstains can be classified in:

- passive patterns, produced by transfer, drop, flow, or large volumes
- active patterns, produced by impact mechanism, secondary mechanism or projection mechanism, and
- altered patterns, caused by clotting, dilution, diffusion, insects, sequences and voids.

Passive patterns

Free-falling patterns – appear when the blood droplets are falling under the gravitational force and are not broken into smaller droplets during their descent. The shape of these free falling droplets depends upon:

- The angle of the surface upon which they fall. If the surface is horizontal the bloodstain in round; if there is an angle between the surface and the horizontal line, the bloodstain becomes elongated, and the elongation is directly correlated with the magnitude of this angle. (see Figure 1)
- The volume of blood – if the volume of blood is large enough, the contact with the surface can lead to the appearance of secondary droplets (like the rays around the sun)
- The falling distance – if the falling distance is long enough the contact with the surface can lead to the appearance of secondary droplets (like the rays around the sun).

Drip patterns. Appear when multiple free-falling droplets fall on a surface on after the other, in the same spot. They are typically larger than a free falling pattern, irregular, with satellite spatters

Drip trails. Appear when the blood droplets fall during o horizontal move of the source; therefore in their production are involved two forces – a horizontal one, caused by the moving of the source and a vertical one (gravity). Subsequently the blood stains are elongated, and the elongation is directly proportionate with the speed of the source.[8] If the speed is slow the spots forming the bloodstain are almost circular; if the speed is higher the spots are elongated and the smoother end suggests the direction of walking.

Flow patterns appear when a volume of blood is slowly displaced from its initial position, by flowing on the surface until it reaches the final position. (see Figure 2).

They have significant medical-legal consequences as their pattern may suggest that the body was moved/the person has moved from the initial position before death [9].

Active patterns

Active patterns can be classified in spatters (resulting when the blood spreading is caused by a force applied to the source of blood) and splashes (splash patterns, resulting when a large amount of blood comes in contact with an even surface at minor or low velocity [10]) .

Spatters can be classified according to the mechanism of production and to the velocity. According to the velocity, spatters can be:

- Low velocity spatters (less than 1.5 m/sec) – they are large (more than four millimeters, irregular, sometimes with centrally pointed or elongated secondary stains. A typical example is a bleeding from a ruptured varicose vein.

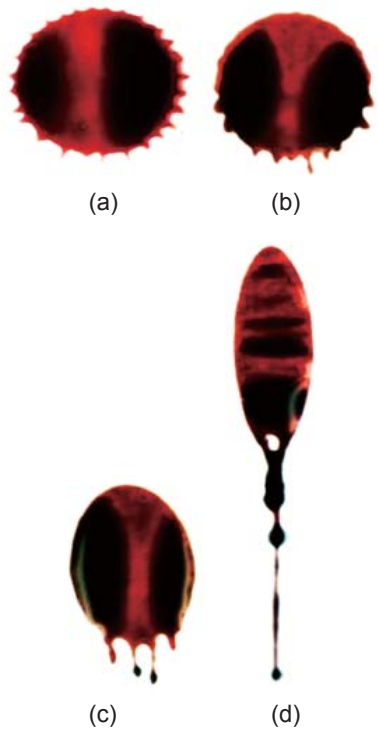

Fig. 1 Free falling patterns after non-perpendicular impact from 0.8 meters (a – at an angle of 80 degress, b – at an angle of 60 degrees, c – at an angle of 40 degrees, d – at an angle of 20 degrees. After Adam, with permission [7].

Fig. 2 Flow pattern – at the mobilization of the body, if the blood is not clotted/dried, it moves from the initial position to a new position of equilibrium, leaving a trail between the initial and the final position.

Fig. 3 Impact spatter. The bloodstains identifiable on the left arm have resulted from the impact of the head with a hard surface (secondary to a fall).

- Medium velocity spatters (1.5 – 7.5 m/sec) – they are smaller (1-4 mm), with an irregular shape and sometimes larger volumes. A typical example is somebody being beaten with a solid object.
- High velocity spatters (described at velocities over 35 m/sec) are small (less than 1 mm in diameter). Usually associated with gunshot injuries [10].

According to the mechanism of production, spatters can be spatters associated with a secondary mechanism, impact spatters, and spatters associated with a projection mechanism.

Spatters associated with a secondary mechanism. Spatters appear when in the final pattern of the bloodstain is involved a secondary mechanism, and is dependent upon:

- the source of the bleeding (arterial, venous, digestive, etc)
- the flight pattern of the spatter before reaching the target surface
- the angle of impact
- Texture of the target surface.

Impact spatter results when an object directly strikes a source of exposed blood; this is the most common type of spatter analyzed in forensic medicine as its analysis can bring a lot of useful data. It can be further classified in:

- impact spatter associated with blunt or sharp force trauma (see Figure 3). The quantity of blood, and subsequently the spatter analysis is highly dependent upon the force of the traumatic event, but also upon the hit area (larger spatter in areas with thin skin or with arteries lying immediately underneath the skin (like the cervical area)
- impact spatter associated with gunshot wounds, with two subtypes – back spatter and forward spatter. Forward spatter appears when the bullet exits the body, and is caused by the blood entrained by the either the bullet or small solid tissues mobilized by the bullet when passing through the body. Backspatter appears when the bullet enters the body, and is caused by the rapid expansion of a gas in a limited space, leading to a high pressure at the skin-air interface, and subsequently to ruptures with small droplets of blood emerging in a anterograde direction. Back spatter can be used to differentiate a suicide from a homicide, or to detect the aggressor.

Spatter associated with a projection mechanism are defined as a "projected bloodstain… created as the results of a force other than impact [2]", and can be further sub-classified in:

- Arterial mechanisms – the projection force is the arterial pressure leading to a typical beans on a string appearance (during systole the pressure is higher and subsequently the blood stain is higher whilst during diastole the pressure is lower, leading to a smaller trail). The pattern depends upon the location of the artery (greater spots from superficial arteries and smaller one from deeper ones), volume of blood, orientation of the surface (due to the higher volume of an arterial bleeding, if the surface is not horizontal from the initial spot/spots will appear secondary flow patterns), nature of the surface, blocking effects of the muscles (if the arterial rupture is within or under a muscle layer), bloking effects of the clothes (dependent upon the thickness and material), position of the victim, movements of the victim (both passive and active), occuring after the arterial rupture, *etc*.
- Venous mechanisms – the projection force is much lower than the one present in the arterial mechanism, but can produce a significant, even lethal blood-loss.
- Expiratory mechanisms appear when the projection force is represented by the air, which propels a mixted combination, of blood and air. It appears in many circumstances, both violent and non-violent like the rupture of a Rassmussen aneurism, blood exhalation, spitting of blood, *etc*.[11]
- Cast-off mechanisms appear then the blood is taken on the surface of the object with which the trauma has occurred, and then leaves the object during its movement, due to centrifugal forces.

Splashed bloodstains. Usually appear when the droplets have more than 1 ml in volum, and are characterized by a rounded

Table 1. Algorithm for distinguishing entomological artifacts from human bloodstains [15]

Documentation of entomological evidence at the scene	present at the scene as long as they have nutrients or when trapped any flies must be analyzed, documented and identified, including dead flies identification of insects at the scene makes mandatory the search for entomological artifacts
Documentation of the range of stains	insect activity is higher near light sources, and light colored areas. These must be checked even if at a distance from the corpse.
Comparison with known fly artifact patterns	- may be useful in documenting the type of insect present at one time at the scene
Identification of suspected human bloodstain patterns, by removing patterns specific to insect activity	The following must be removed: • stains with a tail/body ratio >1 • stains with tadpole or sperm type structure • stains with a sperm cell type structure not ending in a small dot • stains without a distinguishable tail and body • wavy or irregular stains • stains whose direction does not correspond with the normal convergence point

central area with secondary rays and splashes, which tend to exhibit reverse directionality.

Altered patterns

Blood aging. During the aging process of a bloodstain the hemoglobin suffers oxidative processes, causing a shift in color from red to brow, green, dark brown and black. All morphological tests can only give a very rough estimate regarding the age of the stain. Better results are obtained by using simultaneously multiple advanced laboratory techniques like UV spectrometry of the plasma or atomic force microscopy of the red cells.[12]

Blood drying. Is dependent upon the initial volume, the surface, temperature and humidity. Blood drying starts at the edge of the stain (the thickness is minimal) and progresses toward the center. For details see the study conducted by Ramsthaler *et al* [13].

Blood clotting. Clotting normally appears after 7-15 minutes of time after the blood is exposed, but the time is highly variable, depending upon various preexistent pathologies (blood clotting disorders), medication (for example aspirin increased the time), or other local factors (the surface, concomitant presence of corticospital fluid, etc. Treatment with anticoagulants does not seem alter significantly the extracorporeal blood clotting time [13]. According to James[2] in forensics the main uses of clotted bloodstains are: (1) the presence of a significantly dried and clotted blood suggest the passing of a significant time from the traumatic event, (2) clotted bloodstains on the victim's clothes or surrounding areas suggest, in case of a heteroaggression, the presence of a significant interval between the blows (needed for enough blood to emerge and coagulate), (3) clotted bloodstains associated with a pedestrian traffic accidents suggest and multiple impacts with multiple vehicles and a free interval in between and (4) couching or exhaling clotted blood suggests that between the aggression and death a significant interval of time has passed (the blows did not cause the death immediately)

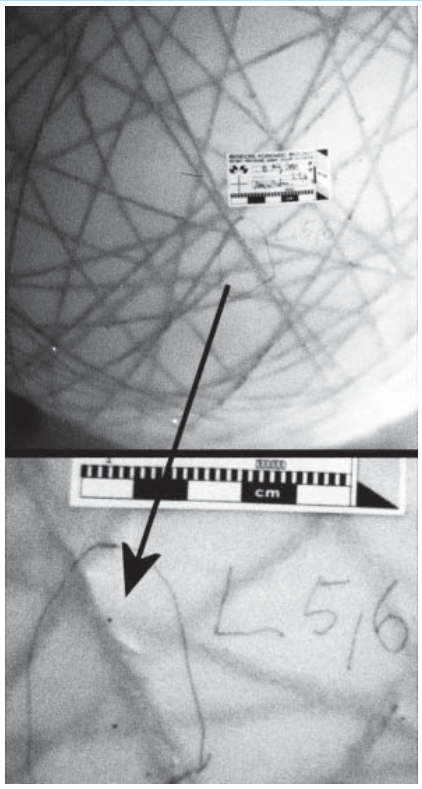

Fig. 4 Blood spatter-like droppings on a lamp hanging about 1.80 m over ground, produced by insects. Very small stains were found all over the lamp, on all sides, including top and bottom. Bottom: close-up of those stains. After Beneke and Barksdale, with permission [15].

Capillary action. Appears when the blood reaches a very narrow space, in which the surface tension and the adhesive forces are higher than the gravitational force, allowing it to flow in an antigravitational manner. They are usually linear, and present at the junction between two very narrow surfaces.

Void pattern. Appears when between the blood source and the surface is interposed a secondary object on which some spatters are projected. Therefore on the first surface can be identified an area in which spatters are absent [10].

Diluted bloodstains. They appear when at the scene there is a mixture between blood and other fluids (either external like water or internal like urine, or corticospinal fluid). The dilution attenuates the color and other properties of the blood but the genetic and serological data can still be identified is the dilution is not excessive.

Removed bloodstains. Even if no certain bloodstain is identifiable, by using photochemical agents (especially luminol), traces can be identified [14].

Entomological alterations. Can be identified using the criteria established by Beneke and Barksdale (see Table 1) [15], see also Figure 4.

Conclusions

Bloodstain analysis is off on uttermost importance for the forensic team which is present at the crime scene as it brings invaluable information about the circumstances and the kinetic of the aggressive act.

The analysis must be conducted with extreme care and detail, using both crime scene and laboratory related techniques, as the traces are often very difficult to identify but a correct identification and analysis can be crucial for solving the case.

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On the Sinicization of Criminal Profiling

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Abstract Criminal profiling was introduced into China in the 1990s. It is a kind of criminal technological means focusing on the description of the psychological characteristics of criminal suspects based on case-related information obtained. At present, China is basically in the stage of comprehensive introduction for the purpose of learning, and has simultaneously carried out some preliminary exploratory research autonomously. The development of criminal profiling in our country will be a relatively long-term process, we should carry out in-depth the sinicization of criminal profiling by establishing China's criminal archive information system, structuring a domestically-originated theoretical system and training professional talents, based on China's social and cultural background.

Keywords: Forensic science; Criminal profiling; Sinicization; Criminal psychology.

1 A summary of criminal profiling

Criminal profiling has many designations in the west (mainly in America), resulting in many names accordingly when they are translated into Chinese, including among others, *criminal profiling*, *offender profiling*, *criminal personality assessment*, and *crime scene profiling*. The expression of ***criminal profiling*** is the most commonly used term in China, which is up to now basically a consensus, and other designations are rarely used. Since this conforms to the conception of mental image [1] in psychology (i.e. *dynamic image*), simultaneously, it also "stresses the role of psychological analysis in profiling… and criminal profiling stresses psychology from the aspect of method, rather than from the aspect of content"[2].

The term of criminal profiling is defined in several ways. Douglas, senior agent of the FBI of the U.S. and one of the representative personages of criminal profiling, thinks that it is an analysis of the primary personality and behavioral characteristics of an individual on the basis of criminal analysis [3]. This definition coincides with the criminal profiling method asserted by Douglas, i.e. the crime scene analysis approach, by which he stresses that investigators should infer the personality and behavioral features of the offender through crime scene analysis. David Canter from England defines criminal profiling as the acquisition of clues on the personality and lifestyle of the offender based on elaborative investigation and examination of the crime and the crime scene in terms of behavior, and accurate predication of the family, profession and personality of the offender [4]. This definition complies with Canter's theory of investigative psychology, which focuses on predicting the personality and lifestyle of the unknown offender on the basis of the crime committed and the crime scene. American scholar Brent E. Turvey holds that, criminal profiling is the inference on special properties of the offender made in accordance with the material evidences and behaviors, and is based on the interpretation of all behaviors in connection with the crime in order to describe the features of the offender [5]. Turvey's definition embodies his thought of behavioral evidence. He considers that criminal profiling is a technology and process rather than a conclusion, and a presumption made by persons in possession of related knowledge background with professional training [5]. Taiwan scholar YANG Shilong thinks that it is a criminal identification technology which applies information and tactics of social and behavioral sciences to do criminal psychological trace examination and anatomy in respect of certain category of violent crimes [6]. LI Mei-jin, professor of Chinese People's Public Security University considers that criminal profiling is the description in writing of the personal image and psychological characteristics of the criminal suspect during the investigation stage through the analysis in terms of behavior, motivation, psychological process and characteristics of the unknown criminal suspect based on the circumstances in possession.[1] In a word, criminal profiling is a criminal technological means with particular

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stress on describing the psychological characteristics of the criminal suspect in accordance with the case-related information obtained.

Presently, there are three approaches of criminal profiling with greater influence: i.e. FBI's crime scene analysis approach, Canter's psychological investigation approach, and Turvey's behavioral analysis approach. In brief, there are two approaches of criminal profiling, i.e. the inductive criminal profiling and the deductive criminal profiling. The typical inductive criminal profiling may be expressed as the depiction of the behaviors of the offenders, the crime scenes and the characteristics of the victims of the current crime, by use of the already-known behavioral characteristics, mental/emotional characteristics and other personal characteristics as obtained from other crimes, scenes and victims in previous cases [7]. Nevertheless, the deductive criminal profiling takes crime reconstruction as the basis of criminal profiling. Turvey defines the deductive criminal profiling as the accurate reconstruction of the behavioral traces of the offender on the crime scene by studying pictures of the crime scene, coroner's report, pictures of the corpse and forensic science evidences in relation to the conflict between the criminal and the victim, and the presumption of the personality, natural, mental/emotional and motivational characteristics of the criminal based on those specific and individualized behavioral traces. [5]

2 Status-quo of sinicization of criminal profiling

Criminal profiling has a unique role to play in combining cases and reducing the scope of investigation, and is proven in practice to be an effective supplementary means to investigation. FBI's criminal profiling expert Douglas alleges that, around 92% of their analysis of cases per annum is correct during the period from 1978 to 1994. Therefore, Chinese researchers have also carried out certain study on criminal profiling, on the principles of "absorbing the essence" and "discarding the dregs", thus advancing the progress of sinicization of criminal profiling.

2.1 Sinicization progress of criminal profiling

2.1.1 Comprehensive learning: introduction of criminal profiling

The term "Criminal Profiling Technology" was first introduced into China at the end of the 20th century. Domestic researchers comprehensively introduced the achievements of foreign criminal profiling study in terms of theoretical system and practical application into China through translating related foreign works and literature, and carried out criminal profiling study with a focus on "learning". The main translation works are: "Sexual Homicide: Patterns and Motives" (Robert K Ressler, Ann Wolber, John E Douglas, 1988) translated by LI Puliang (1998), "Mindhunter: Inside the FBI elite serial crime unit" (John E Douglas, Mark Olshaker, 1995) translated by YAN Weiping, et al. (1999), "The psychology of criminal conduct: theory, research and practice" (R Blackburn, 1993) translated by WU Zongxian, et al. (2000), "Criminal shadows: inside the mind of the serial killer" (David Canter, 1994) translated by WU Zongxian, et al. (2002), "Das Profil der Mörder: Die spektakuläre Erfolgsmethode des britischen Kriminalpsychologen" (Paul Britton, 1998) translated by LI Si (2004), "Criminal Profiling: An Introduction To Behavioral Evidence Analysis" (Brent E Turvey) translated by LI Mei-jin (2005), "Geographic profiling" (D Kim Rossmo, 1999) translated by LI Mei-jin (2007), "Offender Profiling and Crime" (Peter B Ainsworth, 2001) translated by ZHAO Guifen (2007), "In the Mind of Murderers" (Paul Roland, 2007) translated by WENG Li, et al. (2008).

The publication of those translation works provided sufficient sources for domestic understanding of criminal profiling and comprehensive learning by domestic researchers of criminal profiling, and also attracted more attention to criminal profiling. By learning knowledge relating to foreign criminal profiling, domestic researchers carefully analyzed and compared the concepts, approaches and operating instructions of criminal profiling, and finally laid a firm foundation for the sinicization of criminal profiling.

2.1.2 Dialectical study: preliminary exploration of sinicization of criminal profiling

For the past few years, after going through the upsurge of translating tremendous foreign literature in criminal profiling and learning foreign criminal profiling knowledge, domestic researchers started to rethink and further explore the theories and approaches of criminal profiling comprehensively introduced from overseas. Many researchers started to make comparisons among all foreign criminal profiling approaches, in lieu of the comprehensive absorption of foreign criminal profiling, and started the critical learning processes of "rejecting the dross and keeping the fine part", "discarding the false and retaining the true" and "self-regardness" instead. From that time on, Chinese researchers started the preliminary exploration of sinicization of criminal profiling.

Related research literatures include: A Modest Proposal on the Scientificity and Applicability of Criminal Psychology (2005) by LI Mei-jin, Research on the Psychology and Behavioral Rule of Escape in Killing and Injury Crimes (2005) by LIU Jie, et al., Computer Evidence Taking Analysis Approach Based on Criminal Profiling (2006) by WEI Shijing et al., and Application of Criminal Profiling in Psychological Test (2006) by CHEN Chao. Some experts and scholars also conducted specific researches in criminal profiling, including among others, research by Li Mei-jin, et al, in the National Social Science Fund project named The Role of Criminal Psychological Analysis and Profiling in the Prevention and Control of Crimes (2004-2007), and the research by XIONG Lirong and WANG Guangjie in the project of the Public Security Bureau of Hunan Province named the Analysis and Application of Behaviors of Offenders After Crime, which are ground-breaking researches in China.

2.2 Shortcomings of sinicization of criminal profiling

2.2.1 Deficiency of sinicization in basic research

YANG Guoshu pointed out frankly and forthright that, in our scientific research field, it is a common situation which constantly occurs that "the objects of our discussion are China and Chinese, but the theories and approaches employed are nearly western or western-style. We intentionally and unintentionally hold down our Chinese way of perception and philosophical orientation. We only dance to others' tune, and take pride in catching up with foreign academic trends. And eventually, we become inessential."8 So is the research in criminal profiling in China at the present time. Presently, books of criminal profiling in China are mainly popular readings introducing cases, such as Suspect Profiling and Shadows of Crimes, lacking domestically-originated research works and summary monographs, and purely theoretical works are mainly translations. Therefore, criminal profiling research in China is basically in the learning stage, still moving ahead slowly holding others "walking stick".

Despite that some domestic researchers have commenced exploring domestically-originated theories of criminal profiling, it only stays in the preliminary exploration stage, without going deep into the deepening and systematic basic research from the cultural background, historical development, humanistic amorous feelings and habits of thinking of China. The imitation of foreign theories divorced from Chinese background will make criminal profiling be short of Chinese imprint and symbol, resulting in not a few obstacles to the application of criminal profiling in China, which will definitely affect the exertion of its effectiveness.

2.2.2 No indicator system has been established

In the practice of criminal investigation in China, some investigators have consciously applied criminal profiling, and some experts and scholars have made profound and fruitful exploration and study in criminal profiling, focusing on collecting some important criminal profiling-related indicators through individual criminal psychology interviews with sentenced offenders in typical cases. For example, LI Mei-jin have carried out in-depth work in such nationally-influential cases as abnormal homicide by HUANG Yong, homicide by MA Jiajue, series of abnormal homicide by YANG Shuming of Yangquan of Shanxi province, and series of homicide by YANG Xinhai. One of the important basis of establishing the indicators of criminal profiling is to do interviews with perpetrators, but it is very difficult for domestic researchers to acquire such opportunities. Furthermore, in addition to our insufficient attention and organizational efforts in criminal profiling, the accumulation of individual case materials of criminal profiling in China is far away from enough, such that support for the establishment of an indicator system of criminal profiling in China is insufficient.

2.2.3 Cognitive limitation of scope of application

As to the functional cognition of criminal profiling, domestic researchers mainly pay attention to its investigative function, such as the analysis of the psychological and behavioral characteristics of the criminal suspects, reducing the scope of investigation, so as to accelerate the process of confirming the criminal suspects. Since this function produces instant results, satisfying the urgent needs of clearing up cases, it receives tremendous attention and concern. Nevertheless, researchers ignore the preventive function of criminal profiling, in that through criminal profiling of convicted offenders we can fairly clearly outline the formation trace of the psychological characteristics of the offenders and analyze such reasons as the growth background of them, thus offering reference for the prevention of crimes. Most domestic researchers ignore this function, and only few of them including LI Mei-jin conduct researches in this respect.

2.2.4 Serious lagging behind of talent fostering

Criminal psychology is attracting ever-increasing attention from both the academic circle and practical sector of judiciary, bringing in a large number of talents and experts in criminal psychology. Criminal profiling is an important research field of applicability, but few persons devote to research in this respect, which can hardly meet the needs of theoretical research and practical work. This is partly due to the strict requirements of criminal profiling for practitioners, but more importantly, due to insufficient attention to the fostering of talents.

Many front line public security personnel in China have no idea of criminal profiling, let alone receiving professional training. They have long-term contact experience with criminal suspects, and to certain extent, they understand the psychology of the criminal suspects, possessing their own set of "theories". However, due to a lack of professional trainings, their "theories" are but the product of accumulation of experience, without inheritance. This is a huge loss.

3 Countermeasures for sinicization of criminal profiling

3.1 Perspective: based on the Chinese social and cultural background

It is a difficult process for imported things to take root in China, which will not reach its aim in one move and will encounter many obstacles. To base itself on Chinese society and culture is the only way to surmount these obstacles and integrate criminal profiling into China and be used by us. Sinicization is to put criminal profiling in the social and cultural background of China, examine it with Chinese insight and remodel it with Chinese ways. Otherwise, criminal profiling will be water without a source, unable to take root and germinate in China, thus hard to play its proper role.

Particularly, in order to base itself on Chinese social and cultural background, we should study the Chinese people and Chinese criminal suspects from the

aspects of the cultural value systems and social structure systems of China. That it to say, we should combine China's traditional culture and western criminal profiling in order to establish our own criminal profiling theories and methods, and better application in practice.

3.2 Foundation: establishing China's criminal archive information system

The most important thing is to establish China's criminal archive information system, for the purpose of practical effectiveness of criminal profiling, more precisely, the sinicized criminal profiling. In more than thirty years from the establishment of the department of behavioral science in the 1970s up to now, the U.S. applied modern computer technology to the field of criminal profiling, and completed the accumulation of nationally-uniform criminal archives, laying a firm foundation for the research and application of America's criminal profiling technology. Whereas, the work and investment of China in this respect is almost none, where research in criminal profiling receives no strong support, and the disciplinary development faces bottleneck. Therefore, it is particularly important for us to establish the mechanism of psychological interview with convicted offenders during the process of sinicization of criminal profiling. We should establish mechanisms in order to guarantee professionals to do interviews with and record in detail and accurately relevant archival information of offenders, which will eventually form China's criminal archive information system through accumulation over a long period of time. In this way, the sinicization of criminal profiling will have a firm foundation.

Consequently, in the process of sinicizing criminal profiling, it is particularly significant to establish a national criminal archive information system under the leadership and organization of relevant government authorities.

3.3 Pivotal: structuring a domestically-originated theoretical system

3.3.1 Devotion to basic theory exploration

Criminal profiling takes its source at the western culture. To fit into the "water and soil" of China, the pivotal is to structure a domestically-originated theoretical system based on the cultural background of China. We must explore the domestically-originated theoretical system of criminal profiling on the principle of "adapting foreign things for Chinese use". First of all, we should devote to the research and discussion of basic theories to avoid the research and application of criminal profiling going in the wrong direction; only with scientific and systematic basic theories, can it receive recognition of the academic circle and practical departments. Secondly, we should devote to creating a complete and united methodology. In the process of localization research, on the one hand, we should pay attention to the new development of criminal profiling methods in foreign countries, on the other hand, we should also on the basis of China's situations probe criminal profiling methods in compliance with our national psychological characteristics and our practical rule of criminal investigation.

3.3.2 Focusing on establishing an indicator system

In the process of sinicizing criminal profiling, we should focus on establishing an indicator system of criminal profiling on the basis of exploration in basic theories. The indicator system is the compass and navigator guiding the practical application of criminal profiling. Without indicators, the applicability of criminal profiling will be reduced greatly, and hard to be effectively applied in clearing up cases and preventing crimes in China. Therefore, we should attach importance to the research in the sinicized indicator system of criminal profiling; carry out project development and provide guarantee in funds, manpower and material resources; and conduct trainings enabling criminal profiling to become the conscious action of the criminal investigators, and explore step by step an indicator system of criminal profiling fitting in with China's actual situations on the road combining learning and application.

3.4 Focal point: fostering professionals

Criminal profiling is an interdisciplinary technique highly demanding on various qualities of the professionals. An expert of criminal profiling should possess not only multi-disciplinary knowledge structure but also practical experience. As a result, fostering professionals is the focal point of realizing the sinicization of criminal profiling. We should focus on structuring the multi-disciplinary competency structure of professionals of criminal profiling enabling them to possess the professional competency of criminal psychology, criminal investigation and practical competency, and professional competency of psychological consulting. There should be a clear planning of fostering periods, and this should be carried out in the human resource training mechanism of public security authorities.

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The Use of a 3-D Laser Scanner to Document Ephemeral Evidence at Crime Scenes and Postmortem Examinations

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Abstract Proper documentation of physical evidence at both crimes scenes and postmortem examination is crucial for downstream analysis, interpretation, and presentation in court. Ephemeral or transient evidence poses particular challenges to investigators, as its very nature renders it difficult or impossible to seize and maintain in its original physical state. The use of a hand-held three-dimensional (3-D) laser scanner is proposed to capture and document such evidence, both in the field and at autopsy. Advantages of the scanner over traditional means of documentation such as photography or casting include the ability to obtain measurements in all dimensions, the ability to reconstruct missing elements, and the ease with which generated images can be interpreted by the jury at trial. Potential scenarios warranting the use of the scanner are identified, and the limitations of its use are discussed.

Keywords: Forensic science; Physical evidence; Documentation; Crime scene; Autopsy; Forensic anthropology; Forensic archeology; Forensic photography; Three-dimensional imaging.

Ephemeral or transient evidence is physical evidence that is temporary in nature and can be easily changed, altered, or lost over time [1]. It cannot be seized and maintained in its original or in situ state. Documenting such evidence presents special challenges to investigators. Traditional methods of documentation include photography, sketches and notes, electrostatic lifting, or casting [2] as well as field forms and video footage [3]. An alternative, supplemental method of documenting transient evidence may be the three-dimensional (3-D) laser scanner. The use of such scanners in forensic contexts has already been discussed in the use of bitemark analysis [4], cranial volume and area measurement [5], morphometric analysis of human facial shape variation [6], general craniometry [7], and documentation of injury at autopsy [8].

Capable of generating high-resolution 3-D digital images, laser scanners are available in both hand-held and stationary units. In the past 10 years, advanced scanners have been developed for surveying, engineering, archeology, and medical purposes. Laser scanners range widely in portability, depending on the intended use of the scanner. Some laser scanners (including those designed for documenting biological material or smaller objects) can be quite large in size. For example, 3dMD's Cranial System requires a dedicated room to accommodate the frame and 5-camera system (http://www.3dmd.com/3dmdcranial.html, accessed July 5, 2010). Some mid-sized scanners such as Eyetronic's FaceSnatcher (approximately US$125,000) are not portable enough to be easily taken into the field.

There are a variety of high-resolution hand-held scanners on the market. Hand-held models usually consist of a single or double headed laser scanner, a transmitter that serves as datum to orient the object and provide scale, and a software package to capture and manipulate the images (Fig. 1). An optional stylus unit allows for specific point information capture and the software includes a ''mark with mouse'' feature that facilitates measurement, image comparisons, and highlights specific features for use in court presentation. The images can then be exported to a variety of 3-D image manipulation software packages such as 3DS Max, Maya, AutoCad (Autodesk), Rhino, or Blender (http://www.blender.org, accessed July 2, 2010). The hand-held units fit in a briefcase for easy transport and require only a power source and a laptop with the appropriate software.

Creaform 3D (Levis, Quebec, Canada) offers a wide selection of hand-held scanners in the HandyScan 3D family, ranging from the entry level UNIScan to the VIUScan, which captures 3-D data in full color. The Leica T-Scan TS50 (Knowhill, Milton Keynes, U.K.) offers a scanner that is able to capture a single object up to 30 m in size. With the increase in laser scanning accuracy, current scanners have the ability to go from part-to-CAD ready, which allows for reverse engineering and advances analyses. Pricing is dependent on the level of accuracy and resolution, whether the device captures data in color, and whether the scans are limited to small parts or larger volume objects.

Unlike traditional digital images, in which resolution is measured in dpi, 3-D laser scan images are saved as microns, which are a measurement of space, rather than pixels. Therefore, direct translation of image resolution to current industry standards is not appropriate. However, image quality and resolution of a laser scan far exceeds that of traditional digital photography. Scanning time per object is minimal and dependent on the number of separate passes or scans of the object with

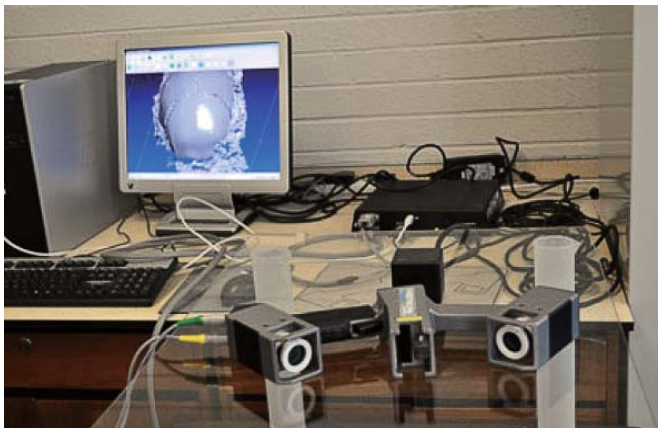

Fig. 1 The Polhemus FastSCAN Scorpion 3-D laser scanner. The double headed hand-held scanner is in the foreground, with the transmitter directly behind. The image on the screen is of a buried skull scanned in situ.

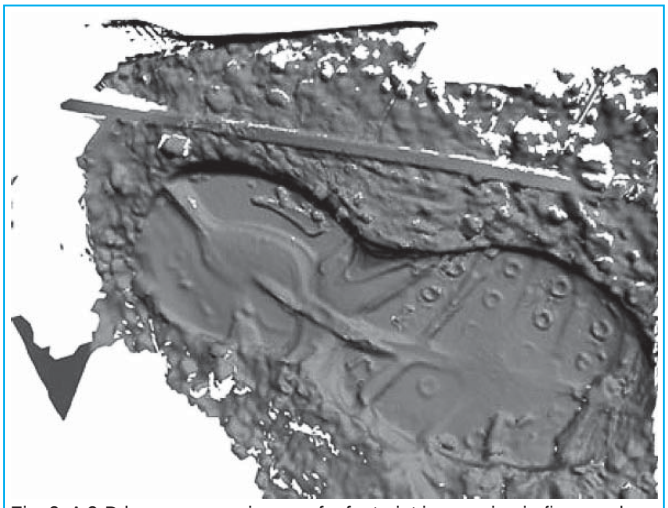

Fig. 2 A 3-D laser scanner image of a footprint impression in fine sand.

the hand-held wand.

The images contained in this article were generated using a Polhemus FastSCAN Scorpion two laser hand-held unit (Colchester, VT). The unit was purchased in 2009 and the total price, including necessary software, was approximately £12,000 (US$18,000). Those with tight budgetary constraints or working in remote areas may even be able to fashion their own laser scanner from materials available at standard hardware stores or home centers (see, e.g., http://homebiss.blogspot.com/2009/02/diy-3d-laser-scanner.html, accessed July 2, 2010). Those utilizing noncommercial or homemade scanners should check that there are no legal impediments to introducing evidence generated by such units in their relevant jurisdictions.

Potential Scenarios in Which to Use 3-D Laser Scanning

Although not comprehensive or exhaustive, the following list provides some indication of the possible field and laboratory scenarios that might benefit from the use of 3-D laser scanning as a supplement to standard documentation.

Clandestine graves. Laser scanning can be used to capture features of the grave walls, including shovel marks for future comparisons against suspect tools, as well as footprint or tool impressions on the grave floor. Because the hand-held laser scanners are capable of recording objects of any size (limited only by file storage capacity), it is possible in theory to scan the entire grave, with remains in situ, as a supplemental source of documentation. Only the transmitter (a small unit) would need to be placed within the grave, to serve as datum and orient all subsequent laser scan passes. With proper use of the equipment, the resolution of the image remains constant for the entire object.

Footprints, tool marks, and other impressed artifacts. Prior to any attempts to cast the feature using conventional methods, a laser scan of the impression can be generated and used in subsequent comparisons against objects suspected of creating the impression (Figs 2 and 3). The 3-D images generated of both the impression and suspect object are then available for downstream analysis and comparison, as well as for presentation in court, providing an easily understood visual demonstration tool for lawyers and juries.

Impressions in materials resistant to standard casting methods. Such impressions include tool, teeth or fingerprint marks in soft, perishable or frozen food items (Fig. 4) as well as footprints or other impression in snow, powder, or other media unsuitable for casting. A recent case investigated by one author (DK) illustrates the potential offered by laser scanning. A homicide victim was buried in a remote location in a grave in which the perpetrator had added a layer of powdered lime, mistakenly believing it had the same destructive properties as caustic lye. The victim was deposited face down in the grave, and the full facial features were captured in the lime in a naturally occurring ''death-mask.'' Photographs of the impression failed to capture the image, and attempts to stabilize the lime powder as a cast were unsuccessful. Subsequent attempts to introduce a casting material into the impression destroyed the lime base and the information was lost. Had a laser scanner been available, an accurate 3-D image of the face could have been rendered without damaging the artifact.

Fire scenes. Burned human remains are exceptionally friable, and their collection, transport, and analysis require special handling (see, e.g., Fairgrieve [9]). Of particular concern is evidence of trauma in burned and degraded remains, which can be damaged or lost during exhumation or recovery. In situ laser scanning can capture images of friable remains that will degrade upon collection and handling, providing 3-D models of remains preferable to 2-D images available from conventional photographs.

Mass graves in human rights investigations. Laser scanners can be used to capture tire, bucket teeth, and other impressions associated with heavy equipment used to form the grave, as well as shovel marks and other impressions visible in the grave walls. 3-D images can also be rendered of features that may be disturbed or dissociated during the recovery process, including blindfolds and ligatures, ephemeral personal effects such as degraded photographs, identification cards, or decomposing clothing, or biological materials such as food stuffs, plant remains, or other perishable items. Skulls with gunshot wounds or other traumatic defects can be scanned in situ, allowing for easy reconstruction of the fragments of the skull in the laboratory.

At postmortem. In addition to standard photographic protocols, capturing 3-D images using a laser scanner should be considered in cases involving bitemarks to skin or other tissues [4], skin impressions such as ligature marks or tool imprints, kerf analysis of sharp force injuries [8], and skeletal cranial remains for use in facial reconstructions or osteological analysis [5,7]. Scanning the texture of an organ at autopsy can document pathological conditions such as cirrhosis of the liver, which causes

lesions that are difficult to document well in 2-D photographs. A final novel use of the laser scanner involves cases in which visual identification of the remains by a family member is required. The laser scan can be used in lieu of viewing either a photograph or the actual remains to ease the anxiety of the next-of-kin or in cases in which mild decomposition or other postmortem changes may render the remains disturbing to the family members, as such changes can be modified or removed on the 3-D image prior to viewing by the family.

Advantages of the Technology

Advantages of laser scanners over other 3-D imaging technologies (such as computed tomography [CT] or magnetic resonance imaging [MRI]) include relative cost of the initial equipment and subsequent maintenance, speed of image generation, portability, equal or greater spatial resolution of models generated, and that the low-energy light used by laser scanners is nonhazardous to the operator and biological specimens under examination [5,10]. One final advantage of laser scanning over CT or MRI is that laser scanning is user friendly and easily mastered with minimal training, typically provided by the scanner's commercial supply house as well as on-line user tutorials.

The benefits of laser scanning over conventional photography include the potential to generate accurate, reproducible measurements from the 3-D image [5]; information discernible in three but not two dimensions; the ability to manipulate 3-D images using alternative software programs (including the potential for animations or other demonstrations for court purposes); and the ability to reconstruct missing elements from partial evidence, such as filling in absent or damaged cranial bones for the purposes of a computer generated facial reconstruction. Ambient lighting also has no impact on the performance of the scanner, unlike traditional photography. The image is generated by a series of laser beams, which operate independent of scene lighting. Unlike photographs used for video superimposition or other identification or comparative techniques, which must be shot in the same orientation as the suspect image, the 3-D images generated by laser scanner can be manipulated into any position. Finally, the images generated by 3-D laser scanner can be saved in a variety of formats, making them easily shared with

Fig. 3 A 3-D laser scanner image of the suspect shoe. Manipulation of the images in Figs 2 and 3 with an imaging software permits direct comparison and provides a demonstration tool for court purposes.

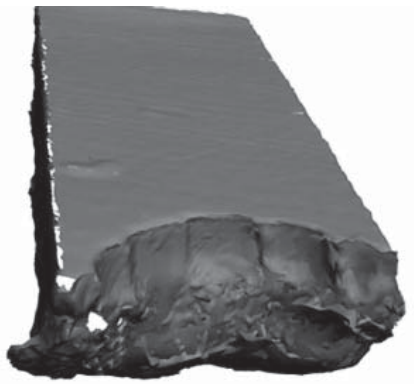

Fig. 4 An example of a laser scan of an impression embedded in media unsuitable for traditional casting. The image is of a bitemark registered in a chocolate coated, soft caramel bar with oatmeal flake base. This image can then be compared to laser scans of suspect dental casts.

colleagues and consultants via email, should second opinions or assistance be needed or for demonstration purposes in court.

Limitations of the Technology

While the advantages gained by supplementing photography and other traditional methods of documentation with 3-D images are considerable, the use of the laser scanner may be limited by a number of factors. First, the unit requires a power source. Although generators, car adaptors, and other remote power sources offer potential, some scenes are sufficiently remote, dispersed, or otherwise inaccessible as to render this a valid constraint. Second, the cost of the unit may be outside of the budgets of smaller law enforcement units or medico-legal death investigators. Third, incorrect use of the equipment can produce artifacts on the images that can be misinterpreted or misidentified. Proper training and maintenance of the equipment typically overcomes this problem. Fourth, certain types of evidence may not be captured by the laser scanner. For example, an attempt by the authors to image very faint sharp force kerf defects on human rib bones was unsuccessful because of the size and limited visibility of the objects. Some metallic objects, such as a mirror or highly reflective surface, can cause interference with the scan. Highly reflective surfaces may pose problems but can be powder-coated. Some lower end hand-held scanners do not capture complex geometries such as the human skull or mandible well because of inferior resolution quality. There are some handheld units such as the HandyScan 3D that require small targets be placed on the object being scanned to capture surface detail. Often these targets are small reflective stickers that are affixed to the surface. These stickers can be destructive and, in most forensic contexts, would be prohibited as it modifies the object under examination. Finally, those wishing to use 3-D images as evidence in court should review all statutes pertaining to the introduction of digital images within the relevant jurisdiction, particularly those relating to the subsequent manipulation of such images (i.e., animation) for demonstration purposes. To the authors' knowledge, 3-D laser scan images have not yet been introduced in a court of law.

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Research on Application of Eye Tracking Technology on Criminal Psychological Test - A Case of Simulate of Murder

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Abstract Two groups (A: murderer; B: innocent person) were arranged in the psychological test of simulated murder case, and the index of fixation duration (FD), fixation count (FC) and visit duration (VD), etc. was recorded by eye tracker during the experiment. It was found that the index of FD, FC, VD on stolen item (pictures of ring), offence site (pictures of murder house), murder tool (pictures of hammer) and the victim (pictures of victim) of group A was higher than that of group B, but the significant difference was only shown from murder tool and victim ($P<0.05$); The FD on murder involved pictures of group A was longer than that of unrelated pictures (but not so obvious), and the FD on murder involved pictures of group B was un-obviously longer (or less) than that of unrelated pictures.

Keywords: Forensic science; Eye movement, Psychological test, Experiment; Criminal psychology.

1 Introduction

1.1 Introduction on psychological testing technology

Psychological testing technology (polygraph) was introduced to our country in the early of 1980s, and it was officially enrolled into the order of criminal science and technology as an independent major in 2004. It is a technology that testing the related psychological information in individual case, and psychological test is that the equipment which is capable of detecting the individual physiological index condition is used to search related psychological information of individual (subject) on specific events or special purpose and deduce its behavior.

The traditional multi-channel physiological and psychological tester (polygraph) is the most common one for criminal polygraph at present, and the traditional multi-channel physiology recorder has been in dominant position in psychological testing technology until the middle 1980s (*Rosenfeld, Shue & Singer, 2007*). This method is used to judge the subject whether lying or not with the help of the change of plant nerve activity (breathing rate, blood pressure, skin resistance, etc.) (*Elizabeth,2006*). Its principle is to measure the accompanied physiological parameters of the emotional reaction, and not the cognitive process itself, which makes the validity of this technology low, especially it is hard to avoid the false positive questions. So many researchers put forward the challenges on the accuracy of this method after the 1980s. Some researchers are developing the new technology and psychological test, and that using the event related potential (ERP), functional magnetic resonance imaging (f MRI), and other brain imaging technology to do psychological test is the main method (*Zheng Hong-li, Ding Tong-chun, 2007*).

1.2 Eye tracking technology

Eyes are the windows of the soul, and some people investigated eyeball movement to research the human psychological activities in the 19th century. Psychologists think that eyeball movement is the direct reaction of visual process and cognitive activities of a variety of humans. The information processing of human brain depends heavily on vision, and about 80%-90% of the external information is obtained through the eyes. Eye tracking technology can record the process and level of cognitive processing. The research of *O'Regan, McConkie and Rayner, etc.* showed that eye movement speed, eye beating distance, fixation time and scan route etc. were effective index for analyzing the brain cognitive process, the comprehensive analysis of the index could reveal the change of complex cognitive activities. At the same time, eye movement characteristics are a physiological index for emotion, so the people's cognitive process can be analyzed through the eye tracking technology.

Functional magnetic resonance

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imaging (fMRI) has a high requirement on equipment, and the price of equipment is extremely expensive, therefore, there are a few equipments in domestic. So many researchers have applied the event related potential (ERP) technology to polygraph research in recent years, and they have achieved good results. The event related potential polygraph technology gives subjects some irritant (visual, auditory) to detect the generated evoked potential, and directly investigate cognitive process of lying, so there is higher reliability and validity. But the complexity of evoked potentials has extremely high requirement on the polygraph technology operators, so the operators need to acquire a lot of psychology knowledge such as cognitive neuroscience, experimental psychology, cognitive psychology and so on, at the same time, they should also have the knowledge of criminal investigation, and strictly control the experimental condition in the test. The strict requirement for test condition of ERP makes it difficult to be popularized in the public security bureau practice.

Compared with the two technologies above, eye tracking technology has distinct characteristics. On one hand, it is the ease of use, this equipment has a simple operation, and the data analysis is also relatively visual in image; On the other hand, it is the ecology, this equipment often takes non-contact ways, so it will not affect the processing of normal cognitive information, and electrode cap needed in ERP technology is not needed here. The picture stimulus is the priority to eye tracker, sight change is continuously recorded through infrared ray reflected from human cornea and pupil, and eye movement data of subjects can be recorded and analyzed after seeing the stimulated pictures, so there is no need to directly connect subjects, and operability and concealment are good. At present, the sight tracking technology is gradually mature, and it has already been extensively applied to the plane design, product testing and other fields. There is a good theoretical and physical basis with the application to the psychological test in criminal cases.

1.3 Eye tracking index

Eye tracker can collect many indexes such as FD, FC, VD, eye movement trajectory, pupil diameter, the first viewpoint and so on. It was found that in the experimental study, eye movement trajectory was difficult to be quantified, and the calculation of pupil diameter was also complicated, therefore, combining with previous relevant studies on eye movement, the only first three indexes were temporarily conducted statistical analysis considering the efficiency of research and application of research conclusion.

1.3.1 FD refers to the fixation time of an unit area, which is combined with a specific research area (interest area). The data from the Immediacy Assumption and Eye-mind Assumption of American psychologists Just and Carpenter till present have shown that the fixation to something is the cognitive process of it. When cognitive process is difficult, the fixation time will be extended accordingly. FD is a relatively effective test index in criminal fluttering, because it can show the familiarity of subject to certain information such as information on spot scene, murder tool and face, etc.

1.3.2 FC refers to the fixation times of an unit area, which is combined with a specific research area (interest area). The parameter shows the familiar and interesting degree of the subject to a certain region, especially in a criminal fluttering, something in the spot scene can be regarded as a stimulation material, delimiting the murder related special area which murderer is familiar with, and testing the fixation times of murderer to this area. This parameter can clearly reflect the informed degree or familiarity of subjects.

1.3.3 VD is similar to FD, and VD will not be longer than FD. If the VD reaches above a standard (such as 0.75 seconds) when the eyes of a subject sweep an area, then VD is equal to FD, if not, then VD is regarded as zero and FD is recorded. This study was based on a simulated murder, and role-playing method was used for subjects to get real feelings. Group A and B were asked to look at murder involved pictures and unrelated pictures in this experiment, and VD, fixation point, FD, etc. of the subjects were recorded with eye tracker to explore eye movement index which could be used for criminal case psychological test. The results of this experiment showed that the index on FD, FC and VD to murder involved pictures(ring, hammer, scene and victim) of group A was larger than that of group B as well as the unrelated pictures, while the index on murder involved pictures was not obviously larger than that of unrelated pictures for group B.

2 Methods

2.1 Subjects

Subjects are the cops from criminal police corps of public security bureau in Chongqing city, including 26 males and 2 females. The subjects were healthy, without mental disorders, and corrected visual acuity was above 1.0, no color blindness, color weakness, and not illiteracy; mental health was in good condition. The data of a total of 24 people were collected after eliminating invalid data caused by unfinished experiment or the head movement in experiment, etc., and the average age of subjects was 22.3 years old. The subjects are right handedness and get some gifts after experiment.

2.1.1 Experimental group A (Murderer Group)

A total of 14 people (including a female) acted as murderers respectively, and implemented simulated murderous activity.

2.1.2 Control group B (Innocent Group)

A total of 14 people (including a female) acted as innocent people respectively, and generally understood the information in this case. The gender, age, education background of people in control group should be similar with those of experimental group subjects, and it could become the matched group for experimental group.

2.2 Experimental materials

2.2.1 Script of simulated murder

Murderer committed a burglary and found a ring after rummage, and he was about to leave when the victim was returning. The victim wanted to catch him, and the murderer hit the head of victim with a hammer inside the house in order to run away, but the victim died. Murderer ran away quickly in the end.

2.2.2 Materials for psychological testing program

The pictures are the stimulus and involve 4 kinds of photos in the script: stolen item (pictures of ring), offence site (picture of murder house), murder tool (picture of hammer) and the victim (picture of victim), these four kinds of information photos are made into

experimental materials for four groups , and used to these four groups. Each stimulus picture is consist of multiple combined photos in each experimental material, of which there is one murder involved picture, and the others are not, which are the foils of it (selecting the picture which has similarity and difference with the murder involved picture). Combine, gray and brighten the pictures with Photoshop software. The testing picture in the group of stolen items (ring photo) includes one murder involved picture and five unrelated pictures, and these six pictures are put into one photo with 3 pictures above and 3 below, then change the position of murder involved picture, therefore, there are six testing pictures; the design of picture is the same as that in the group of murder tool (picture of hammer) and the victim (picture of victim). The testing picture in the group of offence site (picture of murder house) includes one murder involved picture and three unrelated pictures, and these four pictures are put into one photo with 2 pictures above and 2 below, then change the position of murder involved picture, therefore, there are four testing pictures.

2.3 Experimental procedure

2.3.1 Simulation of murder scene

The subjects were asked to read and memorize the simulated murder script and complete the process of murder by the experiment “director”, the more subjects were involved, the better the result would be, and they could repeat until their performance involved all the key plots of the script. The “director” would take the subjects to psychological testing laboratory after the show. Before entering the lab, “director” told subjects that the lord in this lab was equivalent to the police, and she was investigating the case. She would do the polygraph to all the suspects, and find out who was the real murderer. Only you and I knew your real identity, and I would not tell her. You had to conceal your identity, and didn't be found by her. Only you were the real murderer and knew the crime details of this case in all suspects, so you could not be measured out when she did psychological tests to you. The “director” left after taking the subjects into the lab.

2.3.2 Psychological testing program

Present the psychological test instruction to the subjects: "A case of burglary homicide happened just now, we had already explored the scene, and got some details of the case, the murderer stole a ring and killed the victim with a hammer, but we did not know who was the real murderer. Everyone in the group could be the suspect, so we need to do the psychological test for you respectively. Some pictures will appear on the screen in the process of the psychological test, please look at the pictures and see whether you have seen the things in the pictures or not, and a white "+" will appear at the center of blank screen before and after the appearance of each picture, and please look at the white "+" during the appearance of blank screen. In order to test whether you have carefully watched these pictures or not, we will ask you some simple questions related to those pictures after psychological test, and you can answer them if you have watched them carefully. If you can't answer, we will think you want to hide something. In a word, your task is to co-operate with us, and that is the only way to prove your innocence”. The subjects can rest for some time in each testing group. The subjects are asked to sit in the laboratory, keep still when testing, and their eyes need to look at the center of screen, the distance between eyes and screen is about 60 cm, and their eyes can not blink frequently. Formal experiment includes four experimental groups, and each group tests one class of murder involved information respectively. The testing process is that a white "+" will appear at the center of blank screen, and it will last for 1s, then the stimulus picture appears and lasts for 5s, the subjects can recognize the stimulus but do not need to make response; a white "+" will appear at the center of blank screen again after stimulus disappears, and it will last for 1s, then the stimulus picture appears; cycle this process until the end of a set of tests (Figure 1).

2.4 Record and analysis of eye tracking data

T120 eye tracker (tobii studio 3.0.2) produced by company tobii in Sweden was used. The imperceptibility of this eye tracker display is good, because it is not easy to be perceived, and it only needs the subjects to look at that display in 60 cm distance, then the data of fixation point, FD and VD can be collected well. The data was derived from tobii studio and statistical analysis was conducted with spssl6.0.

3. Result

FD (unit: S); FC (unit: Number); VD (unit: S). The picture with No.1 is the murder involved picture and the others are unrelated pictures.

3.1 Murder tool (picture of hammer)

The FD average on hammer pictures of group A was obviously longer than that of group B ($P=0.002<0.01$), and the FD of group A on hammer pictures was longer than that of unrelated pictures ($P=0.137$) ,but not so obvious, and according to the principle of statistics, it could be said that the false probability of “longer” in conclusion is only 13.7%. There was obvious difference on FD between hammer pictures and other pictures for group B ($P=0.002$), but the former one was shorter than that of later one. In fact, that the FD on pictures of murder hammer was not longer than that of unrelated pictures was corresponding characteristics for group B. The results of FC and VD were almost similar with that of FD, and specific data interpretation was as above.

3.2 Offence site (picture of murder house)

The FD average on offense site pictures of group A was longer than that of group B ($P=0.562$), but not so obvious, it could be said that the false probability of “longer” in conclusion is only 7.3%; Moreover, the FD on offence site pictures of group A was longer than that of unrelated pictures ($P=0.643$), the difference was not obvious, and according to the principle of statistics, it could be said that the false probability of “longer” in conclusion is 64.3%. There was not an obvious difference on FD on offense site pictures and other unrelated pictures for group B ($P=0.104$). In fact, that the FD on pictures of murder house was not longer than that of unrelated pictures was corresponding characteristics for group B. The results of FC and VD were almost similar with that of FD, and specific data interpretation was as above.

3.3 Victim (picture of victim)

The FD average on victim pictures of group A was obviously longer than that

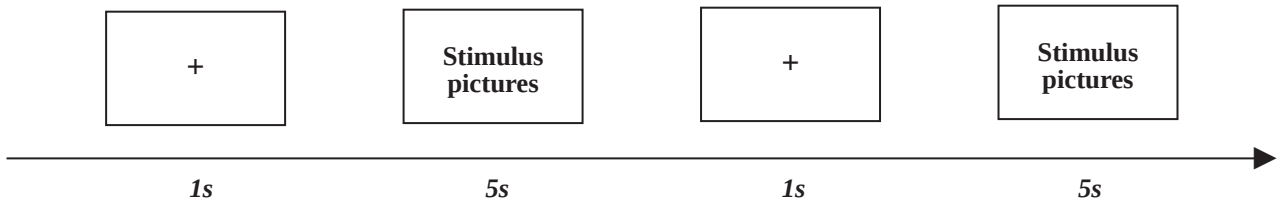

Fig. 1 Process of presenting stimulus pictures.

Table 1. Average and difference test of FD, FC and VD with the sight of murder tool picture

Classification		FD		FC		VD	
		A	B	A	B	A	B
Average	1	4.7408	2.4733	19.33	12.17	5.1558	2.6508
	2	4.5558	4.0650	18.08	18.67	4.9125	4.6117
	3	3.7917	3.6025	16.92	18.25	4.1500	4.0400
	4	3.0842	3.1483	13.42	14.08	3.3150	3.3808
	5	3.5175	2.9033	14.50	14.75	3.7767	3.2450
	6	3.0358	2.8958	13.17	15.25	3.2267	3.3058
Difference test	Intra-group	0.137	0.002	0.105	0.002	0.163	0.006
	Among group	0.002		0.004		0.001	

Table 2. Average and difference test of FD, FC and VD with the sight of offence site picture

Classification		FD		FC		VD	
		A	B	A	B	A	B
Average	1	4.3933	3.1767	18.75	15.58	4.9533	3.6525
	2	3.4342	3.1575	14.50	14.75	3.8683	3.8450
	3	3.7733	4.4750	15.58	20.25	4.2392	5.2958
	4	3.8658	2.5325	16.42	12.50	4.3180	3.0740
Difference test	Intra-group	0.643	0.104	0.273	0.030	0.669	0.101
	Among group	0.073		0.004		0.001	

Table 3. Average and difference test of FD, FC and VD with the sight of victim picture

Classification		FD		FC		VD	
		A	B	A	B	A	B
Average	1	6.0264	3.3392	21.18	15.58	6.4555	3.6583
	2	3.4773	3.6208	15.36	15.50	3.8491	4.0417
	3	3.1118	3.1442	15.45	15.75	3.3936	3.4525
	4	3.0245	2.8892	13.27	13.92	3.2645	3.3017
	5	2.7509	3.1642	13.55	14.25	2.9527	3.6367
	6	4.1145	3.0858	16.45	14.08	4.4782	3.3258
Difference test	Intra-group	0.051	0.505	0.113	0.714	0.064	0.472
	Among group	0.002		0.013		0.002	

Table 4. Average and difference test of FD, FC and VD with the sight of stolen item picture

Classification		FD		FC		VD	
		A	B	A	B	A	B
Average	1	4.4467	4.0675	21.67	20.58	4.9308	4.6400
	2	3.1720	3.4320	14.83	17.08	3.4070	3.7730
	3	3.1758	2.8483	15.17	13.67	3.4817	3.0925
	4	3.5425	3.2808	17.92	15.92	3.8258	3.6067
	5	4.0450	3.3292	18.92	16.83	4.4400	3.6858
	6	3.1992	3.1642	16.50	16.08	3.4767	3.4825
Difference test	Intra-group	0.495	0.372	0.374	0.160	0.281	0.292
	Among group	0.562		0.619		0.685	

of group B (P=0.002<0.01); Moreover, the FD on victim pictures of group A was longer than that of unrelated pictures (P=0.051), the difference was almost obvious, and according to the principle of statistics, it can be said that the false probability of "longer" in conclusion is only 5.1%. There was not an obvious difference on FD on victim pictures and other unrelated pictures for group B (P=0.505). In fact, that the FD on pictures of murder house was not longer than that of unrelated pictures was corresponding characteristics for group B. The results of FC and VD were almost similar with that of FD, and specific data interpretation was as above.

3.4 Stolen item (picture of ring)

The FD average on stolen ring pictures of group A was longer than that of group B (P=0.562), but not so obvious, it could be said that the false probability of "longer" in conclusion is 56.2%; Moreover, the FD on stolen ring pictures of group A was longer than that of unrelated pictures (P=0.495), the difference was not obvious, and according to the principle of statistics, it could be said that the false probability of "longer" in conclusion is 49.5%. There was not an obvious difference on FD on offense site pictures and other unrelated pictures for group B (P=0.372), but the former one was longer than the later one. In fact, that the FD on pictures of murder house was not longer than that of unrelated pictures was corresponding characteristics for group B. The results of FC and VD were almost similar with that of FD, and specific data interpretation was as above.

4. Discussion

The control on experimental condition should be strengthened. There must be some similarities between murder involved picture and unrelated picture besides the difference. It can't be significantly different from irrelevant picture, the ring picture of experiment is not good enough in this point, because it caused the attention to stolen ring photo of group A and B to be in the first level, and in the experiment, some people in group B had tried to guess "that picture" should be stolen ring picture, and said "the picture" was obviously different from other photos, and it was proved through the review of the experiment. It should be ensured that group B can hear but absolutely not see the related information of murder; To try to guide the subject to a deeper role, and not only pay attention to group A, but also to group B.

Design some methods which can identify the anti-test behavior of subject, for example asking the subject to make the corresponding reaction key in the experiment, and collecting the reaction time and accuracy of subject as analysis indicators.

5. Conclusion

The index of FD, FC, VD on stolen item (picture of ring), offence site (picture of murder house), murder tool (picture of hammer) and the victim (picture of victim) of group A was higher than that of group B, but the significant difference was only shown from murder tool and victim (P<0.05). The FD on murder involved pictures of group A was longer than that of unrelated pictures (but not so obvious), and the FD on murder involved pictures of group B was un-obviously longer (or less) than that of unrelated pictures.

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Isolation and Quantification of DNA from Blood Samples on Absorbent and Non-absorbent Surfaces

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Abstract Over the past twenty years, DNA analysis has revolutionized forensic science, and has become a dominant in law enforcement. Today, DNA evidence is a key to the conviction or exoneration of suspects of various types of crime, from theft to rape and murder.DNA is used in forensic laboratories for establishing origin if biological fluids found at the crime scene. A forensic analyst routinely encounters a variety of challenging biological samples, many of which contain DNA which has been exposed to environmental insults.As blood and blood stains are found at the crime scene, it important to isolate DNA from blood and blood stains. Isolation of DNA from anti-coagulated blood and blood stains were carried out using Bunce method and from clotted blood. Ideally blood sample obtained from suspect or victims should be placed immediately storage but in practice there will always be a deal between collection and sample processing. It is important to determine whether this deal introduces changes into the result obtained from the sample. Therefore, a first aim of this study was to assess the impact, on extracted DNA quality and quantity, from absorbent and non-absorbent surfaces.

In the present study it was observed that the collection of blood sample from absorbent and non-absorbent surfaces to isolate the DNA by using Swized method and scratched method. By using PCR method we can detect the quality and quantity of DNA obtained from the absorbent and non-absorbent surfaces. Collection and preservation of various biological materials from crime science thus plays an important role in the isolation of DNA from forensic samples for establishing the link between the crime suspects.

Keywords: Forensic science; Blood; Blood stains; DNA extraction.

Introduction

Forensic science is a science in the service of crime detection, law and justice. Its practice includes scientist of various discipline e.g. Chemists, physicists, biologist, serologists, firearm experts, toxicologists, document experts and others. Despite a wide overlap with the field of forensic medicine, forensic science as an integral component of the criminal justice system. In most of the crime scene blood and blood stains are found. So it is important to isolate DNA from the blood or blood stains on absorbents and non-absorbent surfaces. DNA is material that governs inheritance of eye color, hair color, stature, bone density and many other human and animal traits. DNA is a long, but narrow string-like object. A one foot long string or strand of DNA is normally packed into a space roughly equal to a cube 1/millionth of an inch on a side. This is possible only because DNA is a very thin string. Our body's cells each contain a complete sample of our DNA. One cell is roughly equal in size to the cube described in the previous paragraph. There are muscle cells, brain cells, liver cells, blood cells, sperm cells and others. Basically, every part of the body is made up of these tiny cells and each contains a sample or complement of DNA identical to that of every other cell within a given person. There are a few exceptions. For example, our red blood cells lack DNA. Blood itself can be typed because of the DNA contained in our white blood cells. Not only does the human body rely on DNA but so do most living things including plants, animals and bacteria. A strand of DNA is made up of tiny building-blocks. There are only four, different basic building-blocks. Scientists usually refer to these using four letters, A, T, G, and C. These four letters are short nicknames for more complicated building-block chemical names, but actually the letters (A, T, G and C) are used much more commonly than the chemical names so the latter will not be mentioned here. Another term for DNA's building blocks is the term, "bases." A, T, G and C are bases. This bases forms both coding and non-coding DNAs which may vary from one individual to another. These DNA variations can be used to identify people or at least distinguish one person from another. The following paper shows the method to isolate DNA from various sources, which will help to find out the criminal.

Materials and Methods

1. Blood DNA Isolation from Non-absorbent surface like Glass, Iron, Table top

100 µl of blood was taken on a glass slide with pipette and dried it for half an hour. Then with a spatula blood was collected into centrifuge tube and added 600 µl of lysis buffer. Centrifuged at 4000 rpm for 5min. The supernatant was discarded. Then added 2 volume of solution B and shaked for 1min. Incubated the sample at 370C for 30 min. Added 650 µl of ice cold chloroform and mixed it well. Centrifuged the solution at 4000 rpm for 10 min. Transfered supernatant into eppendrof tube and added equal amount of ice cold isopropanol. Then tube was incubated at 40C overnight and centrifuged the eppendrof tubes at 12000 rpm for 5min. Discard the supernatant and washed the pellet with 70% ethanol by centrifuging it at 12000 rpm for 5 min. discarded the supernatant and air dried the pellet. Dissolved the DNA pellet in 50-100µl of TE buffer.

2. Blood DNA Isolation from Absorbent Dried Filter Paper, Soil, Cotton

100µl of blood was put on filter paper and allowed to dry for an hour. After drying, the stained filter paper was cut into small piece and taken into centrifuge tube. 300µl of solution was added to it. Mixture was vortex vigorously for 2 min and incubated at room temperature for 5min. Sample was then centrifuged at 10000rpm for 5min. Supernatant was removed. 180µl of 2.5% SDS and 20µl 2X-prot K buffer was added and incubated at 560C for 1 hr. Chloroform and Isoamyl alcohol was added and centrifuged at 10000rpm for 4min. Aqueous phase was transferred to fresh tube and added 50µl of 3M sodium acetate with 40µl of isopropyl alcohol. Again tubes were centrifuged at 10000rpm for 4min. Pellet was washed with 70% ethanol. After air drying the tube 50-100µl of TE buffer was added and pellet was dissolved in it.

Quantitative Analysis of DNA By DPA Method

10lµ of DNA sample was taken in a test tube using a micropipette. To make up the volume to 2ml, 1990l distilled water was added. Blank was maintained with distilled water in the place of DNA. After making up the volume to 2ml, 3ml DPA reagent was added and kept in a water bath at boiling temp (1000C) for 15 min. Switch on the colorimeter and allow warming up. Set the wavelength to 595nm. Wash the cuvette with dist H2O. Dry it with tissue paper. Insert the cell containing 2000µl of TE into chamber as blank. Set the reading to zero. Set the wavelength to 595nm. Remove the cuvette from its compartment and discard the TE. Add the above prepared sample to the cuvette. Insert the cuvette into the sample compartment and cover it. Take the O.D value directly from the screen. Likewise take down the O.D values of the entire sample.

Results and Discussion

Samples were collected and processed to obtain DNA from blood and blood stains. To run the DNA sample 0.8% agarose gel was prepared. It was poured in a gel tray. After solidifying the combs were removed. The gel tray was then put into tank containing TAE buffer. 10µl of DNA sample was mixed well with 5 µl of loading dye on paraffin paper. Then the samples were loaded carefully on the gel by using micro pipette without disturbing the gel. After completion of loading samples run it at 100V for minimum one and half hour. After completion of agarose gel electrophoresis then the gel was placed in to UV transilluminator. It shows the bands of DNA samples. By watching UV transilluminator we can find the DNA bands. It will show orange color bands.

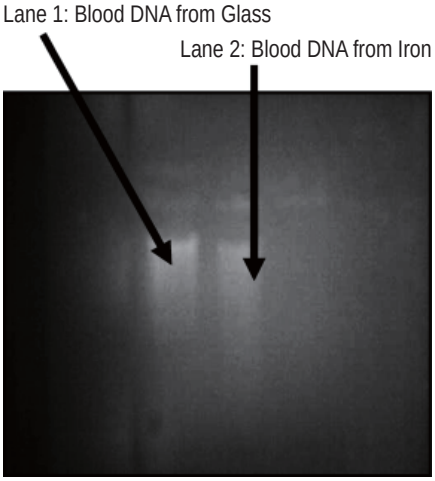

Fig. 1

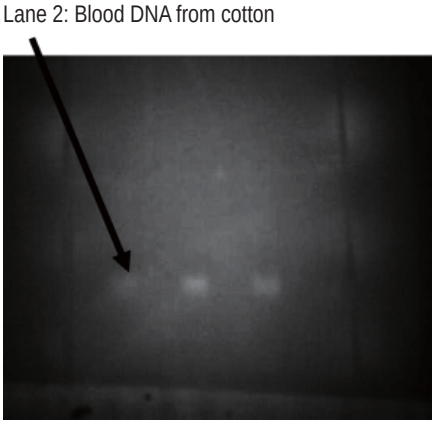

Fig. 2

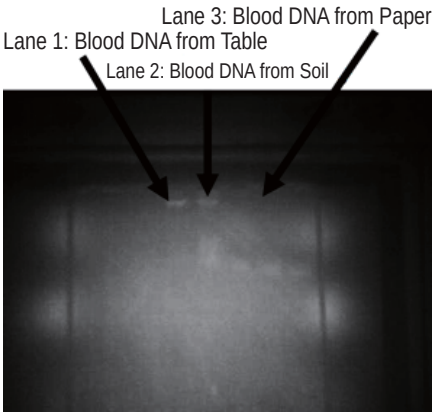

Fig. 3

Table 1.

Vial No.	Sample volume of DNA	DPA	Dist. H_2O		O.D value
1	10µl	3ml	1ml	Incubate the sample for 15 min	0.15
2	10µl	3ml	1ml		0.26
3	10µl	3ml	1ml		0.18
4	10µl	3ml	1ml		0.06
5	10µl	3ml	1ml		0.16
6	10µl	3ml	1ml		0.20

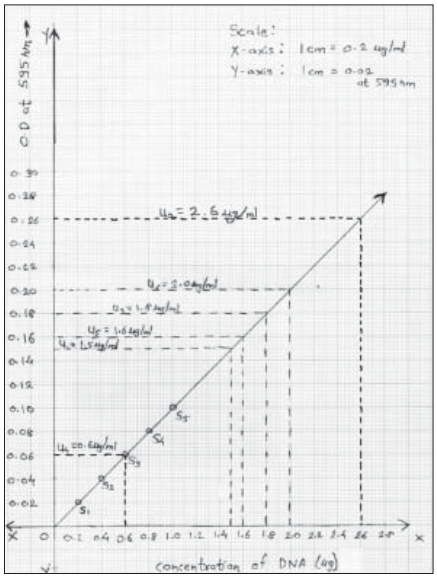

Fig. 4

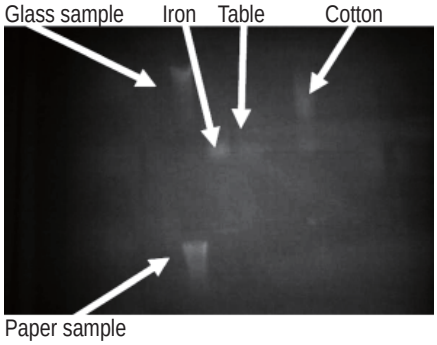

Fig. 5

Observation Table for Quantitative Analysis of DNA by DPA Method (Table 1)

Calculation of DNA concentration (by graph)

1. For Glass surface sample

Amount of DNA present in 10µl of sample is 1.5 µg. Hence concentration of DNA as obtained from Glass surface is 0.15 µg/ µl

2. For Iron surface Sample

Amount of DNA present in 10µl of sample is 2.6 µg. Hence concentration of DNA as obtained from Iron surface is 0.26 µg/ µl

3. For Table surface sample

Amount of DNA present in 10µl of sample is 1.8 µg. Hence concentration of DNA as obtained from Table surface is 0.18 µg/ µl

4. For Soil sample

Amount of DNA present in 10µl of sample is 0.6 µg. Hence concentration of DNA as obtained from Soil is 0.06 µg/ µl

5. For Cotton sample

Amount of DNA present in 10µl of sample is 1.6 µg. Hence concentration of DNA as obtained from Cotton is 0.16 µg/ µl

6. For filter paper sample

Amount of DNA present in 10µl of sample is 2µg. Hence concentration of DNA as obtained from Filter paper is 0.2 µg/ µl

Restriction Fragment Length Polymorphism was performed. Various bands patterns and smear was observed as in following fig.

Conclusion

In most of the crime scene blood or blood stains are found as evidence in more quantity. So isolation of DNA from blood on absorbent and non-absorbent surface was studied.

From the above experiment performed we can conclude that the concentration of DNA on non-absorbent surface is more as compared to absorbent surface. So the blood and blood stains on non-absorbent surfaces like floor, weapons, table, glass, non-absorbent wall etc. should be collected to get good quality and quantity of DNA, which further can reveal many queries regarding the crime scene.

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The Dynamic Visualization Application of 3ds Max in Organ Deceleration Injury

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Abstract *Objective* The dynamic visualization process of chest organs in the event of deceleration injury is to be constructed based on the PC in order to directly observe and und\erstand the injury process and mechanism of chest viscera in traffic deceleration injury.

Methods Firstly, combined with chest organ anatomy as well as the structure of spatial location and the abutting relationship, it constructed the main models of the chest organs and bones in the software of 3D Studio Max (version 2010) through the modeling method of edit mesh, mesh smoothing, UVW map and FFD, etc., to complete the 3D reconstruction and display of chest main organs. Secondly, based on the chest and abdomen high strength landing experimental conclusions, it completed the chest viscera injury process design through 3ds Max animation design principle and FFD software deformation technology.

Results Using 33ds Max technology, (1) it has well reconstructed the main organ morphology and structure of the chest; (2) it can do arbitrary scaling, rotating and mobile display in the three-dimensional space; (3) the dynamic visualization is very close to the experimental process of thoracic deceleration injury; (4) it can do display and observation from different perspectives on injury process.

Conclusions The 3D models reconstructed according to the real organ anatomy characteristics, are of strong sense of reality. Through the 3ds Max model visualization dynamic process, it can conveniently observe and understand the thoracic organ damage process and mechanism in the deceleration injury. It solves the visual problem and visual adjustment problems, to achieve a good simulation of three-dimensional effect.

Keywords: Forensic science; Traffic medicine; 3D studio max; Deceleration injury; Dynamics; Visualization; Organ; Model.

1 Introduction

As a major threat to human security, Road Traffic Trauma (RTT) causes about 1.2 million deaths each year in road traffic injury around the world according to statistics. [1] The thoracoabdominal viscera deceleration injury is common and is an important type in RRT injury. In recent years, the organ of deceleration injury has been widely reported in clinical reports [2] and experimental studies [3], but it is rare studied of the process reproduction for organ deceleration injury by the dynamic visualization technology.

3D Studio Max 2010 (Autodesk, USA) is a solution for 3D modeling, animation and rendering especially to the visual design, game, movie and TV.As the world's most widely used 3D animation software currently, it is to meet the new requirements of advanced design and visualization.

In this paper, this software is used for the main functional structure modeling on the chest and abdomen, and then, for the dynamic visualization of the chest viscera deceleration injury by its animation design function, to reproduce the effect of three-dimensional simulation process.

It has set up a visual multimedia platform for a more intuitive display and understanding of the deceleration injury process and mechanism on the internal organs.

2 Materials and Methods

2.1 The reconstruction of three-dimensional model

The precision of model and scene is key and foundation to the three-dimensional visualization simulation. Different from the reconstruction method which is processed in the 3D medical image software based on continuous sectional two-dimensional images [4], it reconstructed major thoracic and abdominal organs (skeletal, cardiac, lung, diaphragm, liver, stomach and kidney, etc.) with the help of 3ds max 2010 add graphite modeling tools, combining the organ anatomy characteristics and mutual relationship.

The model belongs to the low dimensional model, and its precision is

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lower to the digital model, but it can also meet the requirements of the visualization effect of three-dimensional simulation.

First of all, the scene was set in advance; to build the project folder and collect items required documents and materials. The system unit was set to mm, and the display unit was set to M.

Secondly, it created the basic body in view of corresponding viscera. At the same time, it loaded image files of organs in the viewport as model reference patterns.The basic body was converted to editable mesh, and then it adjusted and modified the five levels of vertices, edges, faces, polygons and elements of the editable mesh. Table 1 shows the structure modeling methods of each organ.

Finally, the model was optimized by adding mesh smoothing, FFD and other modifications. The performance of the texture model details was increased by adding textures, models of diffuse color, transparency, high light and other material parameters for the three-dimensional model.

2.2 The reproduction of injury process

The jnjury process dynamic visualization is the focus of this paper. The organ deceleration injury mechanisms and process has been found by us research group through early basic experiments [5]. In real life, the human thorax injury includes the acceleration injury and deceleration injury. The main factors of organ injury are not caused by the extrusion between organs and the thoracic-abdominal wall, but due to the compression collision of organs and the thoracic-abdominal wall by inertia continued movement, for the sudden deceleration of chest and abdomen in resistance to the deceleration movement.

In order to truly simulate the dynamic injury process in the organ deceleration injury, the basic visual scene was set up. On the basis of the human perspective modeling in the early stage, it used floodlight to set lighting. At the same time, a free camera was created in view. 3ds Max has two modes for creating key frames as Auto Key and Set Key. It can simply drag the time slider and parameter adjustment to run the Auto Key mode. This article created the dynamic simulation process of organ deceleration injury mainly through the Auto Key mode.

First of all, click [Auto Key] to activate the function in the 3Dmax view window. At the same time, open [Time Configuration] and set the frame rate as PLA with time length of 600 frames.

Secondly, this study focuses on the performance of chest viscera deceleration injury process, namely the main reproducing cardiopulmonary during deceleration injuries. Therefore, it is just an assisted reproduction process for the diaphragm, the abdominal cavity and the organ. It represents a perspective view of the moving human body model which suddenly encounters an obstacle from 0 to 200 frames, to simulate the formation of deceleration injury. In this process, the various organs of the human body in the perspective model are treated as a grouped object for keyframe settings. It represents a continued forward movement for the chest cardiopulmonary due to inertia in the case of a sudden body stop from 201 to 380 frames, which wounded directly colliding with the front side of the chest wall until its own inertia compression deformation reaching the maximum amplitude. In this process, there is no squeeze injury process for the back side of the chest wall to the heart and lungs, and this is the focus of the reproduction process in this article. From 381 to 550 frames, it represents the recovery process of the cardiopulmonary after the maximum compressed. In this process, there is a self deformation recovery process for the biological material properties of the cardiopulmonary. There is no dynamic settings from 551 to 600 frames.

Since it has very complex grid throughout the dynamic changing process for various organs, the Rigid Body Simulation method can not produce the real deformation of organs. Therefore, it can edit parameters of keyframes for each organ by the use of the FFD software modifications, to control the FFD crystal to achieve the overall deformation of the organ. Again, drag the time slider to various key points to adjust the camera view, and the view shows Smooth + High Light, in order to complete the dynamic setting of the camera view. Finally, set the rendering properties when the entire dynamic process in the camera view is ideally simulated, and output to AVI video files for the entire dynamic process. The entire rendering process may take a long time to complete.

3 Results

3.1 Three-dimensional model results

It reconstructed the morphology and structure of the major organs of the chest by 3ds Max, and the details of some of various organs were also well performed with a strong sense of reality. It reconstructed the spatial location of the vital organs of the chest and abdomen and adjacent relationship by arbitrarily scaling, rotating and moving in three-dimensional space. The reconstruction structure can be used alone or in combination to show injury process not only from a different perspective for display and observation, but also be able to adjust to the different perspectives.

Figure 1 to Figure 8 are perspective models of the body generated by 3ds Max as the diaphragm model, the lung model, the heart model, the liver model, the stomach model, the bone model and the kidney model.

3.2 The dynamic simulation results

In this paper, it reconstructed the dynamic process of the deceleration injury through automatic keyframing settings. The simulation results well reproduced the dynamic process of organ deceleration injury. The dynamic visualization is very closed with the chest deceleration injury experiments. It especially visually

Table 1. The structure modeling methods for organs.

	Heart	Lung	Diaphragm	Liver	Stomach	Kidneys	Abdominal aorta
Basic Objects	plane	rectangular	plane	line	sylinder	sphere	line
Modifier	Mesh Editing UVW Map	Mesh	FFD Meshsmooth	Loft FFD	FFD Noise	FFD Meshsmooth	Loft Mesh Editing

reproduced organs in the process of deceleration injury due to the direct collision of organs and chest wall because of the inertia, rather than the squeezing of the chest wall of the organs.

Figure 9 to Figure 15 are some key frames in the simulation process.

4 Discussion

Chest trauma is the second cause of death in traffic injuries. In real life, the human chest injury includes the acceleration injury and the deceleration injury. From the pre basic experimental study, we found that, the traditional injury assessment based on the chest compression has great limitations. In order to simulate the dynamic process for chest organs in deceleration injuries more realistically, we carried out human injuries dynamic visualization technology, which has been demonstrated of great significance for the basic research of human injury.

The reconstruction of the three-dimensional model of the human organs is the premise and basis of the 3D simulation of human injury. The morphology of human organs is very specific, and it is difficult for the three-dimensional reconstruction.

The group of Zhang Shaoxiang[4] (Third Military Medical University, China) has complete the three-dimensional reconstruction and visualization of the structure of various organs on the PC, concentrating various organs tomographic images based on the first digitized visible human data of China, by data partitioning,

Fig. 1 The perspective model of human body.

Fig.2 The model of diaphragm muscle.

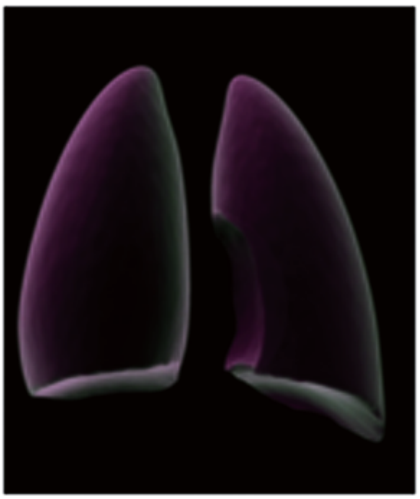

Fig.3 The model of lung.

Fig.4 The model of heart.

Fig.5 The model of liver.

Fig.6 The model of stomach.

Fig.7 The model of bones.

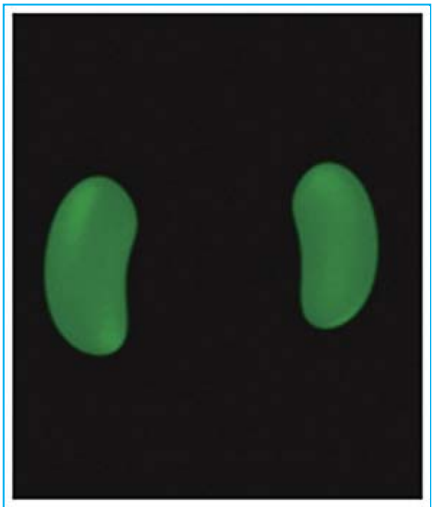

Fig.8 The model of kineys.

alignment reconstruction and three-dimensional display, to ensure a high accuracy of their models.

In this study, it is mainly through modeling capabilities of 3D Studio Max 2010 (Autodesk, USA) to complete the human organs three-dimensional reconstruction. And then, it combined materials and lighting features with software to complete the details of the performance of each structure. Although the accuracy of the model does not reach the accuracy of the digitized remodeling, it is also able to truly achieve the three-dimensional structure of the organ.

3ds max is for three-dimensional modeling, rendering and dynamic simulation and production softeware developed by Autodesk and based on the PC system. Its applications can be found reported [6, 7] in medical simulation.

With the rapid development of computer technology, medical image processing technology and information technology, and through the concerted efforts of clinicians and engineers and technicians, the accuracy of the three-dimensional modeling of human organs will be getting higher and higher, and simulation results will also be increasingly more authentic.

At the same time, 3D organs of simulation and visualization, built based on digitized visible human dataset, can be saved as max format file, if they can be combined with 3ds max software, both will be the basis of human injury research and have a broad application prospect.


Fig. 9 The 100 frame.

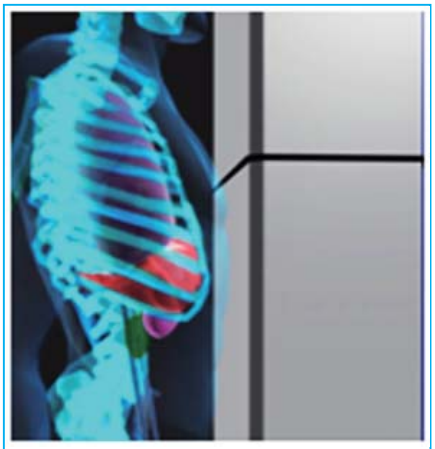
Fig. 10 The 200 frame.

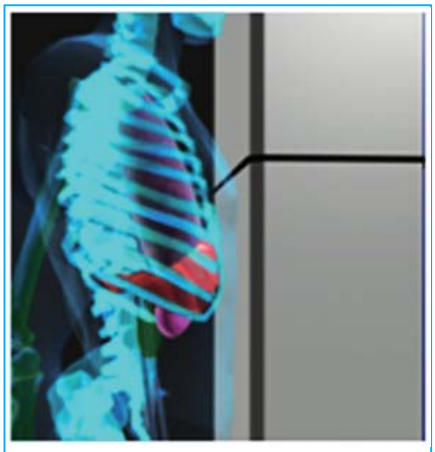
Fig. 11 The 300 frame.

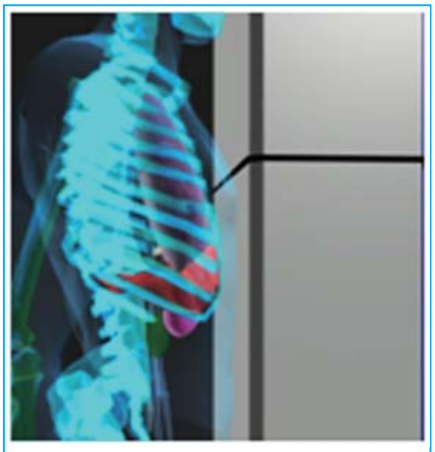
Fig. 12 The 380 frame.

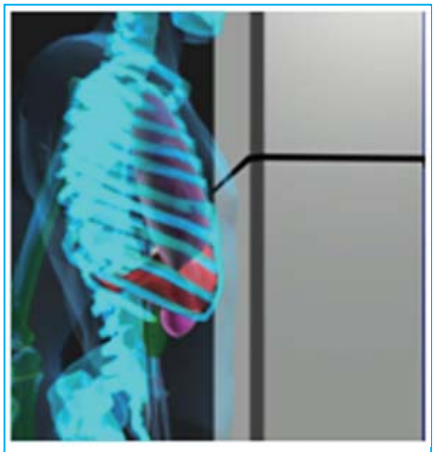
Fig. 13 The 450 frame.

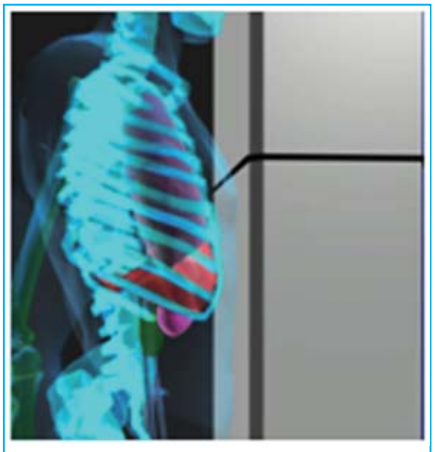
Fig. 14 The 500 frame.

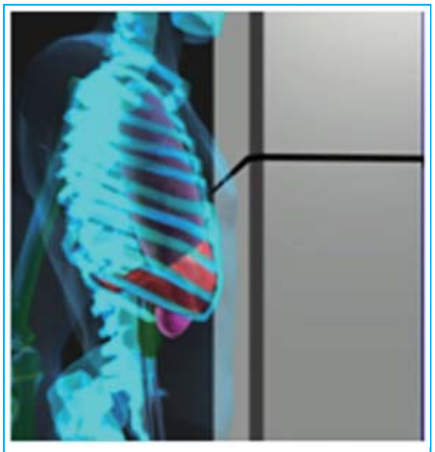
Fig. 15 The 550 frame.

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Analysis and epidemiologic characteristics of 106 patients with cervical vertebral fracture caused by traffic injury

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Objectives Through investigating the epidemiology characteristics and injury mechanisms of cervical frature caused by traffic accidents, to guide clinicians better diagnosis and treatment with cervical injury.

Methods Car accident injury patients were selected from the 287 hospital with cervical fractures between January 2009 and November 2010. Through extracted their cases and imaging data retrospectively, all the patients' age, gender, possible injury mechanisms, injury segment, fracture type, neurological condition and treatment after admission were analyzed and discussed. To summarize the susceptible group of cervical fracture, sensitive segment, common type of frature, as well as the rule of age, gender, injury mechanism for the type of cervical fracture, segmental, neurological influencing. In this study, upper cervical spine fracture contains the anterior arch of atlas types, posterior arch, lateral mass and jefferson fracture, axis odontoid fracture, hangman fractures. However, the fratures of lower cervical spine fracture rely on AO type classification, neurological evaluation depends on Frankel grading standards.

Results Totally 106 traffic patients with cervical spine fractures were admitted during two years, with mean age of 38 years (15-17 years), male to female ratio of 3.24:1. The age peak of injured persons were in the 20-30 and 40-50 years; including 23 motorized/ electric car drivers or passengers (21.7%), 15 pedestrians or riding bike patients (14.1%), and 68 automobile driver or passenger (64.2%). A total of 71 patients (67%) were with spinal cord injury. Different mechanisms of injury, age factors on spinal cord injury showed no significant relationship and 34 patients (32%) were multi-segment cervical fractures. Cervical spine fracture caused by traffic accidents usually occurred in the C5 (24.8%) and C2 (17.0%), among these upper cervical spine fracture patients the odontoid fracture is B-type (68/116 cases). Including 62 patients treated conservatively and 44 patients with surgica treatment, the neurological function recovery of petients treated by surgery is superior to that by conservative treatment, besides, the extent of neurological function with the time between injury and surgery is inversely proportional.

Conclusions The cervical spine fractures caused by traffic accdents results in a high risk of spinal cord injury, and these patients are mostly young crowd, which caused such a high rate of diability. Traffic injuries in newly diagnosed patients with medical treatment received special attention is required if cervical spine injury, these patients of the fracture in the cervical spine with spinal cord injury having clear surgical ppinter, should be actively and timely arrangements for surgery to increase recovery of nerve function possible. In the area of prevention, increasing motor vehicle and pedestrian road management and protection were without delay. ■

Analysis on the basic characteristics of mountainous expressway fatal traffic accidents and coutermeasure

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The fatal traffic accidents on Mountainous Expressway was analyzed, so did the characteristics and causes regarding to the accident modality, traffic environment, accident time, type of vehicle technology and vehicle types, based on which the prevention and reduction measures are suggested.

1. Accident characteristics

1) Accident modality It is similar to that of the rearend impact in the plain highway, besides there are a large portion of the single vehicle accidents and the pedestrian accident, which resulted in a higher casualty rate. The restriction of mountain geographical conditions, with more up-and-down ramps, corners and tunnels, and then the car in front is too fast or too slow and distance control is not good, it would lead to rearend accident easily; the poor safety consciousness of pedestrian made them across the highway, which often led the crash happen; poor vehicle condition, not familiar with the road, and speeding are the chief causes for the single vehicle accidents.

2) Traffic Environment The indexes in sunny weather conditions, such as the number of accidents, the number of deaths and injuries are much higher than the indexes in other weather conditions. Main reasons: weather is good; drivers are more likely to let down their guard, illegal drive more easily, leading to accidents. Under different lighting conditions, the accident statistics circumstances show that, the number of accidents and deaths during the day and other indices are higher than the index of the night.

3) The time of the accident occurred The most accidents happened in 7:00 to 9:00, and 18:00 to 21:00. Reason: at the stage of time change between day and night, the driver's psychological state is excite or fatigue, line of sight is vague, along with more pedestrian haunted. During 11:00 - 14:00 the number of accidents is the least because of the less vehicle flow.

4) The technical performance of vehicles and the types of vehicles From the accident vehicles' technical performance, 71.56% of the accident vehicles meets GB72582004 requirements, 28.44% can not reach the relevant national standards. Trucks account for 53.61% of total accidents vehicles in serious traffic accident, cars account for 30.41%, passenger cars accounted for 11.86%. The poor vehicle condition and the bad habits of the truck drivers made trucks the largest proportion.

2. The Countermeasure

1) Human factors: education and publicity, elimination highway butt accidents; strict drivers' examination system, acceleration in the training of highway traffic management expertises.

2) To further enhance the technical performance of the vehicle testing.

3) On the basis of ensuring the highway alignment design and the quality of construction of the building to enhance

the conservation and maintenance of highways, improve, and strengthen road safety measures.

4) Strengthening statistical analysis of highways traffic accidents, to grasp the rules and characteristics of traffic accidents, is conducive to early prevention and targeted treatment.

Key words: mountainous expressway, traffic accident, prevention measures.

Compensating age related physical and cognitive impariments of older drivers by technological measures and training

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In manycountries in Europe, America and Asia, the proportion of older persons in the population is rapidly increasing. Safe traffic participation is very important for the independent functioning and quality of life of older persons and they are increasingly dependent on private cars. In principle, driving a car is very userfriendly for older persons because it allows transport from door to door in a relatively protected cocoon. However, with increasing age the body becomes more vulnerable and the prevalence of imparied sensory, motor and cognitive functions caused by agingrelated neurological and ocular diseases, does increase, reducing fitness to drive.

To a certain degree, technological measures in the traffic system can compensate these impairments. Adaptations of the infrastructure as proposed in "sustainable safe", a European policy for making the traffic infrastructure forgiving with regard to human error and frailty, are generally favorable for older drivers because they increase predictability of the road environment, separate opposing traffic streams and reduce speed differences. Care has to be taken, however, that infrastructual characteristics intended to reduce speed in general, do not make the driving task so difficult for impaired older drivers that they drive too slow or otherwise hinder the flow of traffic. Advanced invehicle driver assistance systems (ADAS) may suffer less from this problem because they can be adjusted to the individual needs and preferences.

Some frequently occuring older driver impairments (MCI, AD, PD) will be discussed in the light of developments in Intelligent Transport Systems (ITS) and ADAS, and it will be considered what existing and future to be further developed systems appear to be important for sustainable sage mobility in impaired older drivers. It is proposed that ITS and ADAS interventions should be designed and applied in such a way that potential mobility and safety effects are not regulated away by social and behavioral adaptation. This issue is currently the subject of research going on in the EU funded Marie Curie Initial Training Network "Adaption", also with a special emphasis on older drivers. One expectation is that speed regulation and warning systems which young drivers consider as a nuisance, are viewed as helpful and pleasant by older drivers and that the positive safety and mobility effects will not be regulated away by undesired behavioral changes.

Even with optimally (older) userfriendly infrastructure and incar technology, the driver remains an essential element in the loop and opportunities must be provided to allow older drivers to compare their functioning with what is required ("calibration") and to improve their functioning by driver education and training in the use of new technology. Advanced driving simulators can play an important role there as will be illustrated by ongoing research in the "Adaptation" network and on visual strategy training in drivers with visual impairments. Finally, consequences of the new technological development for the assessment of fitness to drive will be briefly discussed.

Different effect of codeine/paracetmol on driving performance in a monotomous surrounding as a function of age

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Introduction Epidemiological studies revealed that drug consumption is suspected to increase the risk of driving accidents. Among drugs, the association of codeine/paracetamol who is considered one of the most efficient to ease pain as compared to other analgesics of level II in the WHO classification, could decrease vigilance and thus impair driving performance. However, few experimental study evaluated codeine effects on driving, and they only tested these effects on young healthy drivers whereas elderly people represent a large part of drivers and are used to consume this type of drugs. The objective of the present communication is to compare the behavioural effect of therapeutic dose of codeine/paracetamol on simulated driving in subjects of different age.

Methods The effects were evaluated in two groups of 16 subjects, young (2030 years) and aged (55 to 65 years). One hour of monotonous driving performance was evaluated after 1 dose of codeine/paracetamol (20mg/400mg) intake and compared to a placebo in a double blind and balanced design. Pills were taken at 8AM, monotonous driving task was performed with a monoscreen driving simulator one hour after at the theoretical plasma peak concentration of the drug. Participants had to keep a constant speed of 110km/h and a stable trajectory in the center of the right place. Standard deviation of both the lateral position and the speed, the number of road exits were analysed. Plasmatic concentration of codeine, morphine and paracetamol were determined at the beginning and at the end of the experiment.

Results They showed that the minimal therapeutic dose of codeine/paracetamol used here differently affect driving performance in function of age. Young subjects performances did not vary after drug intake whereas aged subjects performance were impaired. In particular aged subjects standard deviation of lateral position on the lane (SDLP), which is considered as the most sensitive parameter to investigate durgs effects, increased after the minimal therapeutic dose of codeine/paracetamol. Moreover, aged subjects seemed to eliminate the drug more slowly than young subjects. These results are in agreement with our past study on the effects of zolpidem revealing that this hypnotic which did not appear at risk for driving in healthy young subjects could be at risk for aged subjects. These results underline the necessity to evaluate the effects of drugs in several aged range.

Exploring the age discrepancy in death rates from motorcycle injury in the United States of America: the decomposition method

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Introduction Motorcyclist deaths accounted for 13% of all traffic deaths in 2009 in the United States of America. Previous research has suggested age discrepancy among motorcycle drivers. We examined the various factors that contribute to this age discrepancy.

Methods The decomposition methodology separates the individual components contributing to overall rates. It has been used to explore differences in injury death rates across population groups, time periods, and geographic regions. The populationbased motorcycle driver fatality rate (A: # motorcycle driver fatalities / # personyyears) can be expressed as the product of the driving exposure (B: # miles driven / # personyears), crash risk (C: # crashes / # miles driven) and crash fatality rate (D: # motorcycle driver fatalities / # crashes). Using ages 4049 as the referent group. We expressed the comparison of fatal crash involvement rates between the referent group and those aged 2029 years as a ratio:

$A_{2029} / A_{4049} = B_{2029} / B_{4049} \times C_{2029} / C_{4049} \times D_{2029} / D_{4049}$

The relative contribution (RC) of each component (B, C, or D) to the difference in motorcycle driver fatality rate is:

$RC_i = |In(RC_i)| / \{|In(RC_b)| + |In(RC_c)| + |In(RC_d)|\} \times 100\%$, *where i = b, c or d; In: natural logarithm*

Data sources included the 20082009 Fatality Analysis Reporting System (FARS), General Estimates System (GES), National Household Travel Survey (NHTS), and resident population estimates. FARS is a cencus of fatal crashes in the United States. GES is a nationally representative sample of policereported crashes. Respondents in the NHTS were instructed to keep a written diary of all the trips made during a randomly assigned 24hour travel day: information included trip prupose, transportation means, and trip length. The estimates of miles driven were obtained on the day trip diary.

Results Relative to ages 4049 years, the ratio of populationbased fatality rate was 0.39, 1.14, 0.93, 0.95, and 0.40 for ages of 1619, 2029, 3039, 5059, and 60 and over. Compared with persons aged 4049 years, the ratio of average annual miles driven was 0.13, 0.32, 0.41, 0.80, and 0.27 for ages 1619, 2029, 3039, 5059, and 60 and over; the ratio of crash risk was 4.81, 3.72, 2.40, 1.22 and 1.08 for ages 1619, 2029, 3039, 5059, and 60 and over; the ratio of crash fatality rate was 0.64, 0.96, 0.96, 0.97, 1.37 for ages 1619, 2029, 3039, 5059, and 60 and over. The relative contribution of driving exposure and crash risk was equally important for ages 2029, 3039, and 5059, while the relative contribution of crash fatality rate was 19% for age 60 and over.

Conclusions Motorcyle drivers aged 4049 years had the highest average annual miles driven and the lowest crash risk. For 2029 and 3039 year olds, reduced driving offset their high crash risk, making their fatality rate comparable to that for ages 4059. Prevention practice should focus on safety training and crash avoidance for motorcycle drivers aged 1619, 2029, and 3039 years to reduce their elevated crash risk. ■

Exploring the relationship between the driving behavior questionnair and hiway driving behavior

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The Driver Behavior Questionnair (DBQ) is a well documented instument for obtaining selfreport information on aberrant driving behaviors. The DBQ is comprised of three subscales: (a) errors – the failure of planned actions, which could result in unsafe driving; (b) violations – deliberate contravention of behaviors which are considered necessary for safe operation, and: (c) lapses – absentminded behaviors which are assumed unlikely to impact driving safety. A substantive body of research has demonstrated a relationship between DBQ scores and both retrospective and prospective accident involvement. In addition, DBQ subscale scores have been shown to have relationships with drivers' attitudes, personality characteristics, psychological wellbeing, demographics, etc. However, to the best of our knowledge, there is little or no published information on the relationship between DBQ scores and driving performance variables under actual driving conditions that may bear some relationship to accident risk.

The present study focuses on the relationship between DBQ subscales and highway driving behaviors. A sample of 108 drivers in selfreported good health and having a safe recent driving history (no accidents in the previous year) was balanced by gender and across three age groups (2029, 4049, 6069). Prior to driving, participants completed a 24item U.S. version of the DBQ. After approximately 30 minutes of driving an instrumented Volvo XC90, driving behaviors were assessed over an 18 minute period. During this time, participants were engaged in both periods of single task driving and driving while engaged in a structured working memory task requiring a division of attention. A dischotomous breakdoown of subscales of the DBQ (above or below the median) were independently examinded as predictors of driving behavior (average velocity, standard deviation of velovity, standard deviation of steering wheel position, hard braking, rapid throttle acceleration, and sudden unidirectional acceleration (the vector sum of longitudinal and lateral acceleration)).

Significant relationships were found to exist between subscales of the DBQ and actual driving behaviors. Drivers with high violations scores drove faster, had poorer lateral control (higher standard deviation of wheel position) and more sudden unidirectional accelerations. Among these factors, higher driving speed is known to influence the probability of accidents. The relationship between lateral control and sudden acceleration to accidents is less established but appears reasonable. High lapses scores were related to less consistent gas pedal control (larger standard deviation of velovity and more frequent periods of rapid throttle acceleration). It is interesting to speculate as to whether there is an attentinal factor that links the lapses score and these consistency of control measures. There were no main effects observed between errors scores and any of the driving behavior measures. Significant interactions in errors×gender on rapid

throttle acceleration and violations×age on hard braking appeared. Male drivers with high errors scores speed up more abruptly than those with low scores while female drivers did not. High violations drivers in their 60s more frequently engaged in periods of hard braking than those with low violations scores. The relationships observed here are likely conservative since drivers having had accidents in the past year were excluded. ■

How to consider the protection of the abdominal area of children: the CASPER's project contribution

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The European research project CASPER is dedicated to the improvement of the safety of restrianed children in cars through improving the quaility of use of the restraint systems and the development of new tools allowing the birth of a new generation of restriant systems. This paper shows the point of advancement of the work conducted in European research projects to improve the knowledge of injuries in the abdominal area sustained by restrained children in cars.

Field studies are conducted to have a good picture of the situation of traveling conditions of children in cars. In depth accident studies show that for children using the seatbelt of the car, with or without a booster system, severe or fatal abdominal injuries can be observed when they are involved in a severe frontal or side impact. An overview of the main abdominal injury mechnisms is proposd through a careful analysis of the detailed CASPER accident database. A comparison with the abdominal injuries and corresponding mechnisms sustained by adults under similar type of loadings has been performed and is reported in the paper. These real world results were used to make steps in the area of the protection of the abdomen of children.

In dynamic tests, it is important that to approve child restraint systems or to evaluate their level of performance the child dummies used are able to reproduce abdominal injury mechanisms, to measure physical parameters linked to a corresponding injury criteria. In the current regulation tests, this risk is only covered by the use of pieces of clay that are deformed if the seatbelt intrudes the erea.

For many years, research projects have been looking for solutions based on a more scientific basis. During previous European research projects, CREST and CHILD, a new set of dummies representing children of different ages were developed: called the Q family dummies. They are more biofidelic than the ones of the previous generation still used in the European regulation. At the beginning of the CASPER project, three prototype systems of abdominal sensors existed, all at the stage of being usable for research purposes. One main output of the project is to select the one that is best adapted to be widely used in crash test laboratories running intensive test campaigns, to modify it in order to make it easy to use in the Q dummies and that it can be industrialized. In addition to work on the sensor it has been necessary to improve the global kinematics of the child dummies to allow a better submarining behaviour. In the CASPER project, different proposals were made and tested. This paper describes the technical choices and the works carried out both on the dummies and on the selected sensor to improve the protection of the adomen. The approaches taken to ensure that the abdominal protection is also considered on the child dummy models and child human models developed in the CASPER project are also explained. ■

Multinomial logit model of bicycle injury risk in Hong Kong

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Background More and more countries have been promoting bicycle transport mode, as one of the key strategies in sustainable transport development. In many European and American countries (e.g. Netherlands, Denmark and Canada), bicycle has been a popular commuter transport mode. In contrast, bicycle is mainly used for recreational purpose in Hong Kong. Well planed bicycle transport infrastructure was absence, except smallscale and isolated bicycle path network in suburban area. Unfavorably, proportion of bicycle crash to total road crash has been increasing, from 5.3% in 1997 to 12.7% in 2004. Therefore, factors contributing to bicycle injury risk are worth exploring.

Study Design An integrated database, Road Casualty Information System (RoCIS), was jointly developed by the Police, Transport Department and hospital, linking up the trauma records of casualties admitted to the accident and emergency department of hospital and the crash records maintained by the Police and Tranport Department the advantage of RoCIS, information on bicyclist demographics, injury severity, injured body part, collision type, road design and vehicle attributes, of 682 bicycle casualties during the period 20042006 have been collected.

Results In this study, multinomial logit regression is applied to identify the significant factors contributing to the risk of severe and lifethreatening injury of bicycle casualties. Results indicate that middle age and elderly bicycle casualties are more likely to have severe injury. Besides, bicycle casualties with severe head injury and with motor vehicles involved are remarkably more likely to have lifethreatening injuries. Unfortunately, the helmet wearing rate is extrmely low and at 2% only. Therefore, safety education, campaign and enforcement could be targeted to the middle age and elderly bicyclists. In particular, use of protective device and compliance to traffic rules should be promoted. Also, access of bicycle on the motorway should be scrutinized.

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Neuropsychiatric consequences in obstructive sleep apnea syndrome & traffic safety

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Introduction Obstructive Sleep Apnea Syndrome (OSAS) lead to physical problems like hypertension and arrhythmias ad mostly to neuropsychiatric consequences like Brain atrophy, Depression Anxiety and Insomnia. Apart from a multitude of physical complaints, OSAS patients suffer from excessive daytime spleepiness, reduced sustained attention, limited memory processes and cognitive functions, Among other aspects, such a decline in performance influences the persons affected in their ability to drive a car. Considering the poor knowledge of reliable facts of etiology in neuropsychiatric diseases could show unusually cleancut conditions of interference with the mechanism of mental and sensorymotor plasticity.

Methods In our study we used neuropsychological and neuropsychiatric methods: in different patient groups in a sleep laboratory. Over the past five years we have been testing more than 2000 patients, During admission to the clinic, all patients were selected according to their clinical diagnosis (ICD10) and all patients were examined neurologically, neuropsychologically and psychiatrically. All test presons must not suffer from any severe psychiatric disorders. The study was carried out involving all groups of randomly selected patients with OSAS on a number of neuropsychiatric parameters.

Results Testing of neurolopsychiatric diseases and difficulties and quality of life revealed a highly significant difference between healthy persons and OSAS patients ($p < 0.05$). Examination of specific domains of neuropsychiatric diseases and quality of life, untrated OSAS petients had inferiority scores than those who had undergone therapy. After more than 6 weeks nCPAP therapy, the neuropsychiatric diseases of the OSAS patients, and quality of life improved to a significant degree ($p < 0.05$). Analysis of the degree of severity showed for OSAS that on the whole, there is a significant difference concerning neuropsychiatric diseases and quality of life.

Discussion The study revealed that patients with OSAS whos neuropsychiatric problems and deficits concerning their vigilance achievements, their memory processes and their quality of life. The improvement if vigilance achievements and memory processes show a lower driving fitness (traffic safety) in untreated patients and increasing traffic safety in treated patients. In summary, based on our results, it is to be said that although a continuous nCPAP therapy improves the OSAS symptoms; neuropsychiatric consequences and the quality of life require longerterm degeneration. ■

Sudden onset of disease while driving a fourwheeled vehicle: a retrospective analysis for commercial driver in Japan

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Recent progress in automotive technologies and continuous upgrades in global safety standards have considerably improved automotive collision safety. Sudden onset of the signs and symptoms of the diseases while driving fourwheeled vehicles is a crucial cause of traffic accidents. Because such accidents are not due to a human error, and can endanger the lives of other road users, detailed analysis and preventive measures are required to enhance road traffic safety. We retrospectively analyzed 211 commercial drivers (taxis, 70; trucks, 53; buses, 88) in whom the sudden onset of any signs and symtoms of the diseases had obliged them to stop driving, from data collected by the Ministry of Land, Infrastructure, Transport and Tourism, Japan from 2004 through 2006.

Cerebrovascular disease was a major cause of trafficrelated incidents (28.4%), followed by cardiac diseases (23.2%), syncope (8.5%), and digestive diseases (8.1%). Of the 76 fatalities, cardiac disease was the most frequent (50.0%), followed by cerebrovascular (32.5%) and aortic (7.9%) diseases. Of the 187 drivers in whom sudden onset of signs or symptoms of a disease occured while in control of a moving vehicle, 66 (35.3%) avoided collisions by attempting avoidance maneuvers (breaking or steering). However, subsequent traffic accidents occurred due to drivers losing control (64.7%), also resulting in injury to passengers and other road users. In 76 of 88 incidents involving bus drivers, an avarage of 13.9±14.1 passengers traveled by bus and of those, an average of 5.2±5.6 passengers in 10 buses became injured. Seventeen of 70 taxi drivers caused subsequent accidents that resulted in injury to passengers or road users of 1.7±1.5 (mean±SD) per accident. Ten of 53 truck drivers also caused accidents with a mean injured person among road users of 5.6±6.7. The persons had enough holidays (7 to 9 days) within one month of the onset. Those who had caused accidents had been on 7-9 days of holiday within one month of onset.

Concern for the health of commercial drivers is important because driving a vehicle often constitutes significant emotional stress. Furthermore, when driver lose control of a moving vehicle due to sudden signs or symptoms of diseases, other road users and passengers can become injured due to subsequent accidents. Therefore, to minimize the likelihood of such incidents, we investigated the actual condition of professional drivers in Japan. The data are based on comprehensive and highly reliable reports obtained according to Japanese law. To predict the risk of sudden disease onset while driving from annual routine medical checkups is difficult. Prventive safety measures that address the physical condition of employees, particularly of commercial drivers should be implemented at the goverment level. Furthermore, findings indicate that active preventive safety measures should also be promoted to prevent secondary accidents. ■

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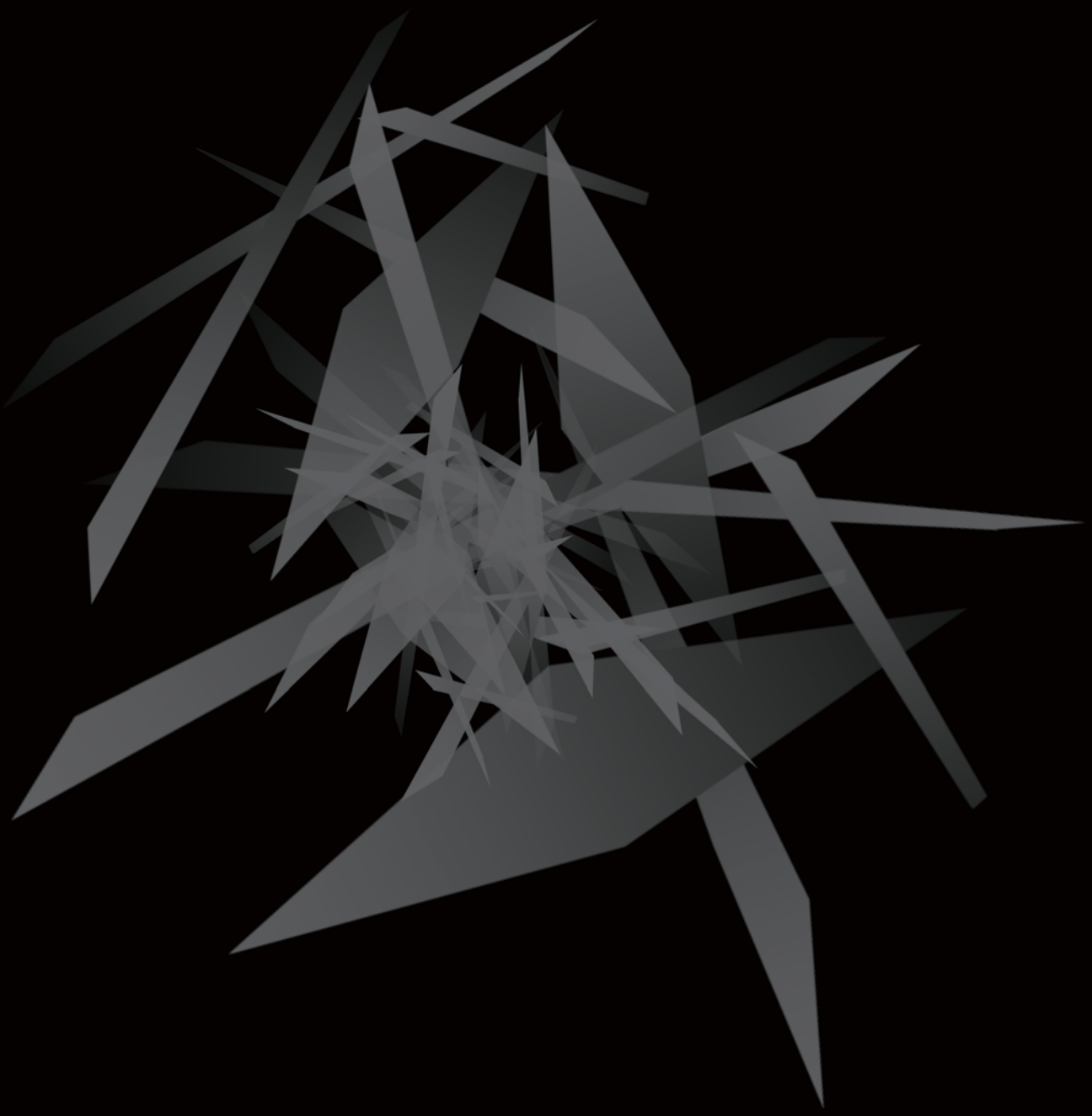

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