Quantifying the Dermatoglyphic Growth Patterns in Children Through Adolescence

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Background

With the exception of unnatural friction ridge structure changes such as deep wounds or epidermis-altering diseases, an individual's dermatoglyphic fingerprint patterns remain unchanged from birth.

While friction ridge patterns expand with maturation, inadequate research has been given to Level II detail with respect to ridge endings and bifurcations.

Discussions on childhood fingerprints most often assume a linear relationship of ridge width and age/growth.

This effort addressed questions regarding adolescent dermatoglyphic growth distortions:

- ✓ Whether a adolescent's fingerprint changes uniformly as the finger grows
- ✓ Distortions in friction ridge patterns during growth (e.g. disproportionate horizontal vs. vertical growth)
- ✓ Commonality among all spatial differences due to age

Ultra-Scan was awarded a five year grant to research friction ridge patterns during a rapid period of growth (such as that found in children through adolescence) to determine whether a commonality of growth exists and to attempt to develop a statistically valid mathematical model for predicting change.

The project's goal was to provide the NIJ and scientific community a means for predicting the shape changes of fingerprints during this period of growth (a Minutiae Growth Map or MGM) in order to significantly enhance the probability of matching an individual's adolescent/adult fingerprints to fingerprints acquired when the individual was a child.

Study Goals and Methods

The project's goal necessitated the capture of children's fingerprints at specific intervals.

Prior to any interaction with collection subjects, a thorough Independent Review Board (IRB) application and review process was required to be completed, as was a full design research protocol.

Recruitment, Consent, Procedure, Confidentiality and Human Participant Protections protocols were developed and approved.

The data was thoroughly examined, categorized and analyzed.

The research team divided the work plan into three sections.

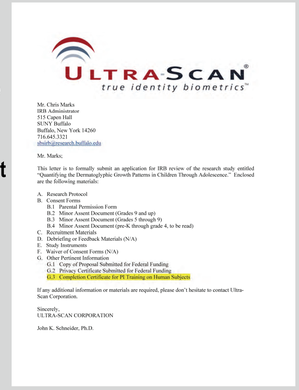
- ✓ Administrative
- ✓ Data Collection
- ✓ Data Analysis

A Cub Scout participating in study enrollment

Recruitment

Estimated as a two week task, IRB submittal and approval took nearly nine months due in large measure to the lack of biometric research protocol precedence within the IRB community.

Verbal consent was obtained and recorded from each child in the study (on a range of consent forms to accommodate Pre-K to Grade 12 reading skills), along with a written consent form signed by a parent or guardian.



ULTRA-SCAN
true identity biometrics™

Mr. Chris Marks
IRB Administrator
SUNY Buffalo
SUNY Buffalo
Buffalo, New York 14260
716.643.3321
cbmrks@research.buffalo.edu

Mr. Marks;

This letter is to formally submit an application for IRB review of the research study entitled "Quantifying the Dermatoglyphic Growth Patterns in Children Through Adolescence." Enclosed are the following materials:

A. Research Protocol
B. Consent Forms
B.1 Parental Permission Form
B.2 Minor Assent Document (Grades 9 and up)
B.3 Minor Assent Document (Grades 5 through 9)
B.4 Minor Assent Document (pre-K through grade 4, to be read)
C. Recruitment Materials
D. Debriefing or Feedback Materials (N/A)
E. Study Instruments
F. Waiver of Consent Forms (N/A)
G. Other Pertinent Information
G.1 Copy of Proposal Submitted for Federal Funding
G.2 Primary Certificate Submitted for Federal Funding
G.3 Completion Certificate for PI Training on Human Subjects

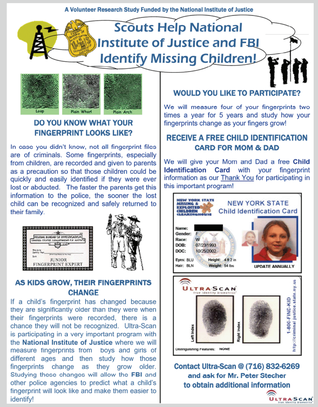
If any additional information or materials are required, please don't hesitate to contact Ultra-Scan Corporation.

Sincerely,
ULTRA-SCAN CORPORATION

John K. Schneider, Ph.D.

Local school districts were initially targeted but significant resistance was encountered. The research team then shifted its focus to an alternate local, potentially cooperative population; the Boy Scout groups of Western NY.

The project goal of collecting 308 child fingerprint data sets was concluded after approximately 10 months of recruitment and enrollment. Subsequent re-collection of subject fingerprints yielded 186 and 123 fingerprint data sets for growth analysis.



A Volunteer Research Study Funded by the National Institute of Justice

Scouts Help National Institute of Justice and FBI Identify Missing Children!

Loop | Twin Whorl | Plain Arch

DO YOU KNOW WHAT YOUR FINGERPRINT LOOKS LIKE?

In case you didn't know, not all fingerprint files are of criminals. Some fingerprints, especially from children, are recorded and given to parents as a precaution so that those children could be quickly and easily identified if they were ever lost or abducted. The faster the parents get this information to the police, the sooner the lost child can be recognized and safely returned to their family.

AS KIDS GROW, THEIR FINGERPRINTS CHANGE

If a child's fingerprint has changed because they are significantly older than they were when their fingerprints were recorded, there is a chance they will not be recognized. Ultra-Scan is participating in a very important program with the National Institute of Justice where we will measure fingerprints from boys and girls of different ages and then study how those fingerprints change as they grow older. Studying those changes will allow this FBI and other police agencies to predict what a child's fingerprint will look like and make them easier to identify!

WOULD YOU LIKE TO PARTICIPATE?

We will measure four of your fingerprints two times a year for 5 years and study how your fingerprints change as your fingers grow!

RECEIVE A FREE CHILD IDENTIFICATION CARD FOR MOM & DAD

We will give your Mom and Dad a free Child Identification Card with your fingerprint information as our Thank You for participating in this important program!

NEW YORK STATE Child Identification Card

UPDATE ANNUALLY

Contact Ultra-Scan @ (716) 832-6269 and ask for Mr. Peter Stecher to obtain additional information

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Flyer created to generate interest in study participation among scouts and scout leaders

Ultra-Scan Corporation
Child Identification Card

FirstName: Scott
LastName: Guyton
Gender: Male
DOB: 5/11/1996

Eyes: Blue
Height (ins): 62
Weight (lbs): 95

Scott Guyton

Left Index | Right Index

Date Issued: 06/28/2009

1-800-FIND-KID
http://crimeinjustice.state.ny.us

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With further input from the IRB, the research team elected to offer scouts & parents a complimentary child ID fingerprint card.

Subject recruitment proved to be unexpectedly difficult, with limited availability of subjects (children) and modest cooperation of guardians (Scout leaders) and parents (consent) throughout the recruitment process.

The research team observed that there is clearly a negative parental bias with regard to the collection and retention of children's fingerprints in a database (as was necessary for this study). While many organizations are successful in promoting child ID cards that include fingerprints and demographic data, none of these entities maintain a database of the child's information

Data Collection

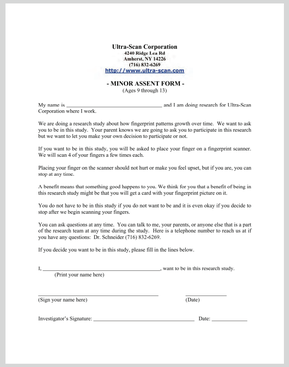
Fingerprints were scanned on location in the field by trained team members using a UPEK TouchChip single finger capacitance scanner, a digital camera, and a laptop PC, all designed into a portable jump kit.

The initial goal was to collect six fingerprint images (fingers 1-3 and 6-8) from each study participant, twice annually, during a four year period, as well as to document the age, sex, ethnicity, height and weight of each subject as part of the growth analysis.

After analyzing a small number of early 6-month interval collections, it was determined that the collection timeframe should be extended to a single annual collection to better allow for discernable fingerprint ridge growth/variation.

It was also observed that it was often awkward for small children to properly place their thumbs on the scanner platen, resulting in poor quality images that were unusable. The collection protocol was subsequently modified to require only fingers 1, 2, 6 & 7.

Required subject consent paperwork required >10 minutes for each enrollment, making it difficult to process large numbers of subjects at events that were time limited. Subsequent re-collections were much easier and less time consuming.



Ultra-Scan Corporation
4240 Ridge Lea Rd
Amherst, NY 14226
(716) 832-6269
http://www.ultra-scan.com

- MINOR ASSENT FORM -
(Ages 9 through 13)

My name is _____, and I am doing research for Ultra-Scan Corporation where I work.

We are doing a research study about how fingerprint patterns growth over time. We want to ask you to be in this study. Your parent knows we are going to ask you to participate in this research but we want to let you make your own decision to participate or not.

If you want to be in this study, you will be asked to place your finger on a fingerprint scanner. We will scan 4 of your fingers a few times each.

Placing your finger on the scanner should not hurt or make you feel upset, but if you are, you can stop at any time.

A benefit means that something good happens to you. We think for you that a benefit of being in this research study might be that you will get a card with your fingerprint picture on it.

You do not have to be in this study if you do not want to be and it is even okay if you decide to stop after we begin scanning your fingers.

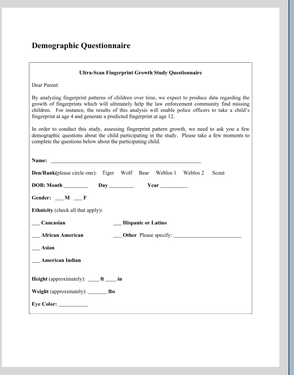
You can ask questions at any time. You can talk to me, your parents, or anyone else that is a part of the research team at any time during the study. There is a telephone number to reach us at if you have any questions: Dr. Schneider (716) 832-6269

If you decide you want to be in this study, please fill in the lines below.

I, _____, want to be in this research study.
(Print your name here)

_____ _____
(Sign your name here) (Date)

Investigator's Signature: _____ Date: _____



Demographic Questionnaire

Ultra-Scan Fingerprint Growth Study Questionnaire

Dear Parent:

By analyzing fingerprint patterns of children over time, we expect to produce data regarding the growth of fingerprints which will ultimately help the law enforcement community find missing children. For instance, the results of this analysis will enable police officers to take a child's fingerprint at age 4 and generate a predicted fingerprint at age 12.

In order to conduct this study, assessing fingerprint pattern growth, we need to ask you a few demographic questions about the child participating in the study. Please take a few moments to complete the questions below about the participating child.

Name: _____

Dew/Rank(please circle one): Tiger Wolf Bear Weblos I Weblos 2 Scout

DOB: Month _____ Day _____ Year _____

Gender: ___ M ___ F

Ethnicity (check all that apply):

___ Caucasian ___ Hispanic or Latino
___ African American ___ Other Please specify: _____
___ Asian
___ American Indian

Height (approximately): ____ ft ____ in

Weight (approximately): _____ lbs

Eye Color: _____

A second challenge involved preserving the communication links with enrolled subjects as they progressed through the ranks of the scout organization.

Data Security

The security of the child's demographic and biometric data was typically the first subject addressed by parents when presentations were made to solicit participation.

All data was collected, entered, and stored for analysis in accordance with established IRB rules pertaining to maintaining the security of privacy-protected data associated with the study of human subjects.

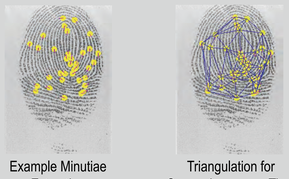
Identifiable data was also destroyed at the end of the project in accordance with IRB guidelines.

Data Analysis

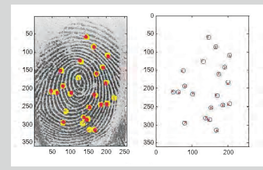
Every attempt was made to collect high quality images. Images that included occluded areas were rejected because such areas can mask minutiae.

High Quality | Poor Quality

Although the original plan was to use an automated minutiae identification process, it did not have the precision necessary for this type of exacting analysis, and a manual Minutiae Extraction Matching Tool was developed to simplify selection of the best minutiae location.



Example Minutiae Extraction | Triangulation for Comparisons over Time



Plotting growth over 1 year

Conclusions

The collected data was thoroughly examined, categorized and analyzed with the resulting conclusion that *growth patterns of fingerprints over three years as measured in this study do not appear to follow a general pattern.*

Observed growth patterns were so individualistic that it was determined to be impossible to develop a single map or family of maps that accurately models minutiae pattern growth with the data that was collected.

Although the results indicate that a minutiae growth map does not seem feasible, the researchers employed another technique to meet the project goal of matching a child's minutiae at one age to a set of their minutiae at an older age.

The researchers modified and refined a recently developed, scalable minutiae matching algorithm to compensate for plastic distortion. This stand-alone matcher was able to successfully match all fingerprint pairs for each child from all of the collection periods. Although this algorithm is not necessarily the MGM as originally envisioned at the project's onset, the research team nevertheless was able to meet the project goal by developing a successful method for matching fingerprints of individuals after a numbe of years of growth.