

A NEUROCOGNITIVE PROTOCOL SYSTEM TO SUPPORT HEALTH AND CARE OF ABUSED CHILDREN

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Abstract: Abused children is highly endangered of developing critical cognitive dysfunctions. Clinical observation has encountered many related cases of abuse and poor learning performance. Authorities unaware of these conditions may take longer to act, detrimentally to the child welfare. This work provides a wide coverage of medical protocols for every area concerned with endangered children procedures. These protocols were researched with the collaboration of specialist in each area to achieve the most detailed and conspicuous information of children status. These protocols are proposed as a Web system available to all concerning professionals and authorities to input and access the relevant information. This data can be processed and analyzed to provide decision support and handling indications derived from statistical and heuristic treatment of the whole information.

1 INTRODUCTION

The violence in the childhood is highly co-related with serious behavioral, cognitive or emotional damages that are immediately noticed on school learning, on language expression and on the relationship life. The abuse and negligence commit the social cognition development, that means to say that the semantic and pragmatic dimensions of the language become very impaired, what leads to the delay in the vocabulary acquisition and development and in grammatical structures of the oral and writing language.

These results found in the neuropsychological tests, show qualitative alterations, mainly in tasks that involve the activity of the frontal lobe. On first analysis, poor performance was observed in sheltered children, in levels, co-varying the type, intensity, duration of the abuse and/or negligence, age group in which elapsed the abuse situation and presence of aggravating environmental factors (shelter type or street experience) or the opposite, opportunities of compensatory interpersonal entails.

Qualitative differences were identified on the cognitive development, especially in the attention, formal learning, memory, language, abstract reasoning and executive functions, without deep lowering of the global cognitive competence (IQ).

In the same way, the behavioral alterations in sheltered children, identified as risk factor for the development of psychiatric impairment, appeared to be related to the abuse conditions, abandonment or negligence. This symptoms varied a lot depending on the anxiety, shyness, phobias, panic syndrome, impulsiveness, low-self-esteem, little or no tolerance to the frustration, disturbed sleep, night enuresis and presence of psychogenic motor stereotypies.

Behavior disorders - post-traumatic stress syndrome, deficit of attention disorder, psychotic symptoms, obsessive-compulsive disorder and conduct disturbances, little interpersonal ability, acceptance anxiety, imitative behavior, and even dissociatives disorders: hiperactivity, hipervigilance, threats illusory perception, paranoiac interpretation of interpersonal relationships, emotional immobility, incapacity of reacting when challenged or in

pressure, inferiority and uselessness feeling, suicidal and/or homicidal ideation, hallucinations, irritation, despair and self-mutilation.

And finally dysthymia: chronic depressive state, melancholy, obsessive-compulsive behavior, bad-humor, low motivation, low self-esteem, emotional apathy, pessimism, anxiety, chronic fatigues, self-isolation, alimentary and drug addiction disorder.

We still have academic difficulties in the learning of school contents in the Portuguese language and mathematics areas.

Our investigations show that sheltered, abuse or negligence victims, children have low performance at school, revealing that the consequences of violence can persist years after their retreat from the streets or from the origin family. According to the collected information, it happens because the child's past traumatic experiences seem to be added to the sheltering situation in which they are. Besides to total absence of specific educational programs for these children, they make their formal learning impossible, becoming an apart group inside the school. The life conditions in the shelters become an aggravating factor on symptoms of cognitive delay and school abandon, appearing as the cause of high stress and propitiating the continuity of the privation conditions and abuse, that end up resulting in the escape of children from shelters and in the consequent school escape. As well as the school reaffirms these differences becoming the official organ that decrees the failure and the social exclusion.

2 OBJECTIVE –SUPPORTING ENDANGERED CHILDREN

TUIA is a computational program constituted of a base of organized data to recover and to co-relate information associated to the abuse, abandonment and negligence experiences against the child or adolescent. It was projected to facilitate the interaction among specialists of different areas interested in child abuse, and also encouraging researchers to collect information from multiple services. The compilation of these intersubject information allows to cross check information from the various data sources, reinforcing more subtle indications. Cross checking medical and neurocognitive data can exemplify the case. Data measuring child abuse experience from medical sources can be co-related the neurobiological performance (De Bellis MD, 2005), neuropsychological (Beers SR, De Bellis, 2002),

educational and the child's physics. The combination between the two modules aims to find the sequels indexes, esteeming the relative direct consequences to the abuse, abandonment and negligence indexes.

The program enhances the handling endangered children, allowing the concomitant examination of multiple aspects. Traversal of the whole information database can unravel hidden indications, which are not directly accessible, but can be only inferred through the intelligent comparison of the parts. An information system integrated in a national ambit, should be projected to be used jointly with the specialists and authorities, promoting an appropriate sequence of the institutional actions for prevention, identification, evaluation and attendance of this population (Stemberg,K.J.,2004).

3 REVIEW – THEORETICALS

There is now abundant evidence that childhood abuse and neglect can result in permanent changes to the developing human brain. These changes in brain structure and function appear to cause psychological and emotional abnormalities during childhood and adulthood. Behavioral and psychological problems include impulsive and instrumental aggression, learning disabilities, mood disorders, post-traumatic stress disorder and antisocial personality disorder, among others.

Modern neuroimaging techniques, among which magnetic resonance imaging (MRI) methods stand out as the most promising ones. MRI not only is non-invasive (no ionizing radiation or other biological effects have been shown), but it provides powerful ways to directly address brain structure and function in detail both in transversal and in longitudinal studies.

Voxel-based morphometry, for example, is an especially interesting technique which allows the study the structure of virtually the whole brain in a statistically robust manner. By comparing control and patient groups paired by demographic variables (e.g., age, education, physical developmental measures), statistical maps of grey or white matter changes can be generated (Good et al., 2001). Furthermore, continuous variables can be entered as parameters, allowing for testing not only categorical differences among groups, but also dimensionally. Voxel-based-morphometry has been successfully employed to detect subtle anatomical changes in neurologic and psychiatric disorders, such as major depression (increased amygdala volume), antisocial personality disorder (reduced anterior temporal lobe

volume), among others (for a review, see Meyer-Lindenberg and Zink, 2007). Additionally, a new MRI technique dubbed diffusion tensor imaging has been developed during the past 10 years. This modality allows the determination of microscopic water molecule flow (Brownian movement) in the living brain tissue; further developments have used mathematical models of water diffusibility, and now enable researchers to trace the 'brain wiring', or the white matter fibers, based on inferences from preferential water diffusibility. This technique allows for direct visualization of developmental changes in the human brain secondary to genetic and environmental factors. Results from our lab showed that neuroplastic changes can readily be detected using this method (Tovar-Moll et al., 2006).

Finally, functional MRI is another especially powerful non-invasive technique with demonstrated robustness in detecting functional reorganization of the human brain following developmental and cognitive-emotional factors. Our group has been using functional MRI now for about 10 years in the study of complex cognitive-emotional phenomena, which include moral judgments and moral sentiments (Moll et al., 2005). Based on lesion evidence and functional MRI experiments in adults, we have formulated a now influential model of the 'moral brain'. Functional MRI and available cognitive models can now provide important guidelines for studies addressing cognitive-emotional development in normally developing and abused or neglected children. This will certainly be a fruitful line of investigation for our understanding of the complex cognitive and emotional disturbances in these children, which can guide the development of better assessment and treatment schedules aiming to prevent further brain damage or ameliorate established symptoms. Finally, these imaging techniques can be employed together with genetic studies (e.g., gene polymorphisms, endophenotypes, etc), providing an unique opportunity to explore not only structural-behavioral or genetic-behavioral interactions, but direct genetic-structural effects (ex., Meyer-Lindenberg and Zink, 2007).

4 ORGANIZATION – A COLLECTION OF PROTOCOLS

Thirty-two children were appraised in the age group between 7 to 12 years, residents of Ayrton Sena shelter, of the city hall of Rio de Janeiro, that

possess official (juridical, technical or administrative) registration of abuse, negligence or abandonment history and 32 children of control group who go to the same schools the sheltered children go and who live with their biological families in a common home. There is no suspect or record, even informally, of abuse or negligence, by relatives and teachers. This group is similar in age, sex, socio-economic level and school levelling.

The sheltered children had a battery of investigation instruments different from the non-sheltered children referring to the life history, family context data and to the current psych-social situation. It was necessary to diversify, using an abuse checklist (Joseph Pitty) and a specific medical history assessment, in the first group, and an inventory of refined qualitative analysis of family relationships associated to a general medical history assessment, appropriate for the second group. Such procedure looked for comparing different instruments, similar in objectives and adjusting them to measure similar information in importance, relative to its different contexts. In this phase, socio-economic questionnaires and an environmental analysis questionnaire were also applied to evaluate the shelter, and the conventional pediatric and neurological exam.

The exam of psychiatric impairments tracking, the CBCL - (ASEBA) - Child Behavior Checklist (CBCL), the Parent Report Form, and the Teacher Report Form are part of the first evaluation stage. In the positive cases of this screening, some information were explored based on chosen question from K-SADS-PL - diagnoses interview for children and adolescent between the ages of 6 and 18 – Brazilian version of Schedule for Affective Disorders Schizophrenia for School Aged – Children.

Based on these general data, the children with mental and sensorial deficiency were excluded. The children with complications at birth, serious diseases, lesions and wounds in the head, internments in ITC, history of comatose state, previous evaluation of IQ with index below 80, history of treatments with psychotropics, psychiatric impairment, alcohol or drugs abuse, dependence or prenatal exhibition to alcohol or substances, were not excluded, but considered as fundamental part of the research by dealing with most of the subjects.

After this stage, a pedagogic evaluation (CESGRANRIO) of Portuguese and mathematical language was applied jointly with the complete neuropsychological battery, including the language areas (Capovilla battery), moral competence (Moral

Judgment Test (MJT) - Georg Lind.) and cognition using Wechsler Intelligence Scale for Children (WISC III), Tower of London (TOL), Children's Color Trail Test (CCTT), Test of Cerebral Dominance (BTN) and Span Cores (short term memory).

The language evaluation was applied in three sessions of specific abilities exams composed by the vocabulary Test in images, Test of phonological discrimination, Test of words and pseudo-words repetition, Dictation, nomination Test, Test of letters knowledge, Test of fluency of words, Proof of phonological conscience, Proof of syntactic conscience, Test of silent reading competence and by the Test of understanding of written sentences.

The analysis of these preliminary data served as foundation for the development of a protocol of structural (morphological) and functional investigations of the brain using the magnetic resonance imaging (MRI) techniques.

5 IMPLEMENTATION – A WEB SYSTEM FOR CHILDREN CARE

An effective way of caring for endangered children is tracking closely all developments in their lives and handling readily this information to the authorities responsible for their care. Many children continue exposed to critical situations due the lack of perception of health and education authorities of their particular problem. This work propose to mitigate this risk by gathering comprehensive information on critical aspects of children conditions and making this information accessible within a decision support tool.

The application is a Web based system with lightweight componentization and a flexible protocol reconfiguration architecture. The main purpose is to support the creation and maintenance of clinical protocols that can gather the most conspicuous information about endangered children. The protocols are classified into team packages and into specialist forms inside each team division. Team packages can be assemble to concentrate the practices requiring a specific expertise. The packages contain items covering the whole area of the team expertise and consist mainly of engineered information collectors that can be readily processed into decision support reports. In the use cases shown below, researchers can devise protocols and analysing algorithms to provide the state of art children care environment. Institutional teams can

apply the new protocols and analyse the reports to allocate children to the proper treatment.

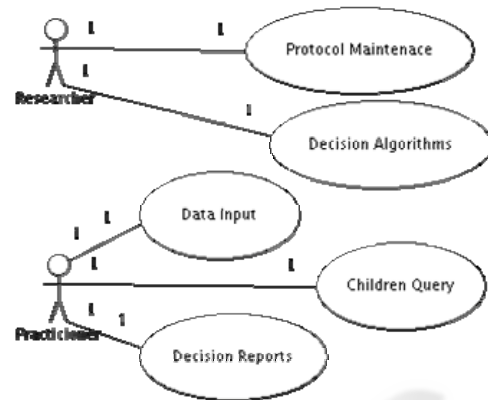


Figure 1: Main Use Cases.

The tool not only supports mainstream handling of current children data, but also is ready to incorporate new research to the immediate benefit of these children. The tool includes an upgrade mechanism to upload new protocols and decision support algorithms to handle new information and requirements to cover current children handling needs. The system is designed to keep up with the evolution of people caring knowledge, supporting protocol modifications while preserving previously collected information. The domain model was designed taking up a three years study, covering the various involved areas and specialists which contribution was analyzed to develop a common denominator. The simplified diagram below shows the tool model, supporting the creation of new protocols capable of gathering children data. Reporting tools can also be attached to the system to provide decision making graphs about a resulting query.

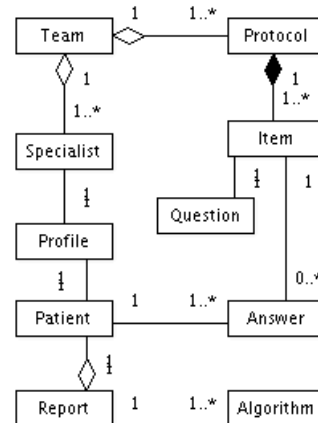


Figure 2: Static Domain Diagram.

The system can be hosted in more than one place and the packages and its information can be componentized through JSON (JSON, 2007) and REST (Khare & Taylor, 2004) communication protocols. Information is transacted across sites using REST requests devised as a DOM (DOM, 2007) like interface. Since information about a patient can be entered in the various hosts maintained by the specialist institutes, each host can request complimentary information to the local specialist data. The requested information is transacted through JSON packets in response to the REST requests.

The application has been given the name TUIA (Test Unification for Indications of Abuse) and is built upon Web 2.0 techniques, to enable simple construction, social interaction, and componentized structure. The idea is to provide easy integration with other systems composing the TUIA system in special the neurocognitive learning acceleration objects. These objects are neuropedagogical games designed to reduce the gaps between strong and weak cognition functions.

The interdisciplinary data is stored in the system database and is processed by algorithms in the machine learning engine. This engine provides inference about the healthcare subjects and classify information to help medical, judicial and political decisions.

The current engine installed is a Bayesian clustering (Binder, 1978) algorithm using the Orange framework. As a proof of concept, a initial set of 44 children was submitted to a clustering analysis. This groups was submitted to a battery of language, mathematics and attention tests. The group is originally composed of 29 children under state custody and a control group of 15 regular school children. The initial groups were assigned as code Alpha for the control group and Bravo for custody children. After a session of interated clustering, the engine worked out six groups, including the original Alpha and Bravo. The new groups were arbitrarily named Charlie, Delta, Echo and Foxtrot. This test was a preliminary probe to determine what kind of information can be inferred, and how it can be reported to consist a decision support. The data was automatically assembled into radar graphs by the engine using matplotlib (Hunter, 2007). The primary results are shown in the charts below:

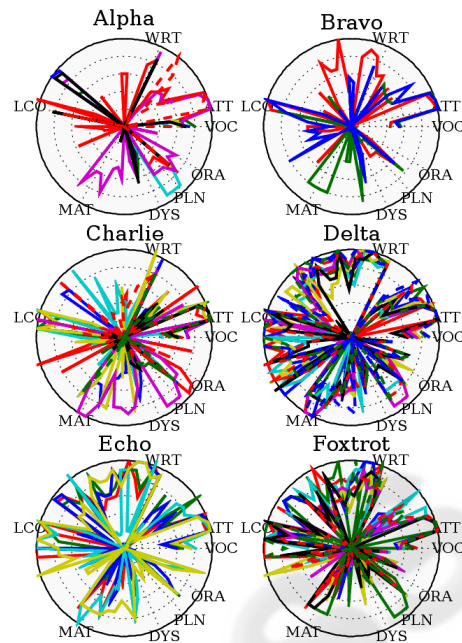


Figure 3: Dysfunction distribution graph.

The charts show the strength and weakness areas as crests and dents. This charts can help to decide which children needs the most urgent handling and which areas are more affected. The labels represent Vocalization, Attention, Writing, Language, Mathematics, Dyslexia, Planning and Orality. Critically damaged Alpha and Bravo children need urgent care and should be highly prioritized in a special learning program, with most areas affected. Echo and Foxtrot children are less impaired but show different education needs with different gaps between weak and strong areas. Language is in need in both and Foxtrot needs more in mathematics and orality areas while Echo have traces of dyslexia. Delta is strong in most areas, while Charlie being good in all logical areas, is rather poor in literacy in general. As a testbed, this experiment gives a good support to the idea of integrating medicals protocols in a computing system. The children classification can help devising a whole overall strategy in dealing with each group, matching the children with its needs.

These reports will be available on line and can be requested as a query on a collection of children. This chart is a sample report with bayesian clustering, but other reports can be devised. The query leaves a formatted file in disk and the filename is passed to a program that analyses it and leaves in return the result chart to be displayed. The system uses a framework similar to another scientific web application, called Enviair (Mota *et al*, 2007) developed by our team for environment control.

6 CONCLUSIONS

Children may undergo unnecessary suffering when indications of their actual conditions are neglected, even after all health care protocols have been already applied to them. This is the most ubiquitous cases, where the concerning authorities are not prompted with the proper information, or even if the information is provided, it is hard to roam across a large amount of raw data to figure out what are the proper measures in each case.

This work proposes a qualitative improvement in the programs of prevention, teaching and, in the therapeutic actions and assistances. A web system provides a tool to validate and implement methodologies of technical and administrative intervention. The TUIA system can maintain an extensive collection of integrated data on endangered children, from a wide range of concerning areas. The system not only provides for immediate communication of children condition alerts among the the concerned parts, but also can aggregate relevant and validated research results to the benefit of community. This can be achieved as the system is a platform to develop and validate new protocols and analytical procedures. The experimental protocols can be applied together with the mainstream procedures and the results compared with cross checking from existing data. New protocols and reports can be then incorporated into mainstream as the results have scientific relevance.

The system is developed using state of art web technology to provide fast and consistent development. A Domain-Driven (Evans, 2004) approach is applied to shorten the turnaround of new software releases as new requirements come in to play to extend the system functionality. A lightweight interprocess communication technology supports distributed hosting if required. It integrates with machine learning engines and other advanced analytical tools to provide support to machine assisted inferences on collected data.

The challenge is to congregate the two aspects of the public power role: to create methodologies of scientific investigation, inside the services and in the universities, capturing the complexity of the theme and to incorporate the actions against violence in the involved professionals' practices and to articulate those practices, not only in the section of Health, but also in the Education practices, Social Attendance and Justice.

In a general way, this work proposes the development of an "algorithm" composed by taxonomy of information transformed in analysis

methods. The observed population is passed through clustering algorithms, leading to the identification of children's sub-groups, according to patterns in input profiles. This discovery opens the possibility of multiple studies accomplishment that will result in a rich knowledge on abuse and its co-morbidities that do intersection with the several abuse types and classes.

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