NEUROSCIENCE TECHNIQUE APPLIED TO THE MEDICAL DIAGNOSTIC SUPPORT SYSTEM

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ABSTRACT

Due to the technological evolution in health, the development of software that helps the doctors in his decisions on the diagnosis of the patient has intensified in recent years. However, adherence by doctors in this regard is still small. The literature shows that doctors form a differentiated group of computer users regarding the acceptance of new technologies. This is justified by the fact that they are generally highly time-pressed, dealing with a wide variety of information and vital decisions. In all professions, the decision-making process is present in most everyday situations and it is important to select the best of them. The Decision Support System (SAD) becomes an ally in this process, especially in the area of health in which the Medical Decision Support Systems (SADM) can contribute to better patient care. It is worth remembering that software to support medical diagnosis may present alternative hypotheses, which will broaden the professional's view on information that he may not be currently associating with. An example of this would be the use of a dermatological software that by capturing the image of a spot on the skin may infer the presence or not of the low, medium and high risk, for example, the SKINVISION software available in the market. Prejudice regarding the use of software that supports the medical decisions may affect directly or indirectly the health care for the population. One of the ways to identify whether or not the medical professional has a prejudice in the use of software in their work practice is through neuroscience techniques applied to the use of Implicit Memory Measurement (Implicit Association Testing -TAI), which does not depend on the participant's conscious attention, and their responses are automatic and spontaneous. The purpose of this work is to use the concepts derived from neuroscience to carry out measures of explicit and implicit memory of medical professors and medical students in order to verify the existence or not of prejudices regarding the use of medical decision support software. This paper presents the results of the pre-test applied to specialists, who are doctors who make use of SADM, and medical students who had the discipline of medical informatics, both groups are from the unit of FAPAC / ITPAC -Porto Nacional -TO. The pre-test was performed in order to verify the internal consistency, that is, if the participants of the chosen association words were understood. For the analysis of the results obtained in this work item, the data were stored in MS Excel® spreadsheets and analyzed with the Statistical Software Statistical Package for Social Sciences (SPSS®), version 23.0, for statistical analysis. SPSS® software was used to calculate Cronbach's alpha, a coefficient in order to measure the internal consistency and reliability of the pre-test of this study (FreeIAT). As a result, the Cronbach's alpha value calculated in the pre-test was 0.838 indicating, thus, good internal consistency.

1. INTRODUCTION

Medicine has benefited from the resources provided by medical physics regarding the prevention and treatment of diseases, coupled with the accuracy and efficacy of imaging

diagnosis, through examinations such as: magnetic resonance imaging, tomography Computed tomography, ultrasonography, among others.

The Nuclear Engineering Center (CEN) of the Institute for Energy and Nuclear Research (IPEN) has a group of medical physics with researchers who have been working hard, both in the development of diagnostic software as well as in new techniques of Cancer treatment.

These new treatments have been widespread due to the growth of cancer records in recent years and this disease has been causing concern for medicine around the world. According to studies conducted by the International Agency for Research on Cancer published in February 2014, the number of cancer cases will increase 50% up to 2030, when nearly 22 million of cases are diagnosed worldwide, compared to the 14 million in 2012. According to the publication of the National Cancer Institute (INCA), it is estimated for Brazil, biennium 2018-2019, the occurrence of 600,000 new cases of cancer, for each year. For non-melanoma skin cancer, the estimate is about 170,000 new cases [1]. This will be due to a strong increase in disease in developing countries. At the same time, deaths will pass from 8.2 million to 13 million per year. These trends are accompanied by the increase and ageing of the population and the adoption of risky habits, such as smoking, sun exposure, radioactive Sources, among others [2].

In Brazil, skin cancer corresponds to 25% of all malignant tumors registered in the country and, being of melanoma type, represents about 1% of malignant neoplasms. This type of cancer, despite being less incident, is considered the most aggressive, because it presents a high mortality rate. The cure may be from the excision of the tumor in its initial phase (in situ), however, the success of this procedure is directly related to its early diagnosis. In the more advanced stages, in which the lesion is deeper, the chance of metastasis increases and, therefore, the chance of Cure is reduced [3][4][5].

To facilitate the diagnosis of skin lesions, physicians use a device known as a dermatoscope. It is a noninvasive technique that allows to visualize the superficial structures of the skin, due to the enlargement of the lesion in hundreds of times. In order to minimize the failures that occur at the moment of the diagnosis of the lesion, due to the morphological similarities between the benign and malignant spots, the concept of Digital Image processing (PID) was introduced, which combined with dermoscopy, Minimizes possible diagnostic failures, this work developed as a doctoral theme by Dr. Talita Sales Coelho at 2016 at CEN [6].

Due to technological developments in the field of health, the development of software that assists physicians in their decisions on the diagnosis of the patient has intensified in recent years. However, adherence on the part of physicians, in this sense, is still small. Doctors form a differentiated group of computer users in terms of the acceptance of new technologies [7]. This is justified by the fact that they are often highly time-pressed, dealing with a wide range of vital information and decisions.

In all professions, the decision-making process is present in most day-to-day situations and it is important to select the best of them. The Decision Support System (SAD) becomes an ally in this process, especially in the health area in which the medical Decision support Systems (SADM) can contribute to better patient care [8].

It is worth remembering that software to support medical diagnosis may present alternative hypotheses, which will broaden the professional's view of the information he may not be

associating at the moment. An example of this would be the use of a dermatological software that, when capturing the image of a stain on the skin, may infer the presence or not of malignancy [6]. Many cases of cancer when they are discovered by the symptomatology of the patient are already in an advanced state, which compromises the success of treatment and a possible cure. The prejudice in relation to the use of software that supports the medical decision may directly or indirectly harm the health care of the population.

One of the ways to identify whether or not the medical professional has prejudice in the use of software in his work practice is by means of neuroscience techniques applied to the use of implicit memory measurement (Implicit association tests-TAI) and Explicit. The first, it does not depend on the conscious attention of the participant, being its automatic and spontaneous responses, while the second requires the conscious attention of the participant at the time of the response [9].

When comparisons are made between information from implicit and explicit measures, there is a possibility of greater reliability in terms of the results obtained. This is due to the fact that, it can be verified by the use of the TAI (implicit memory) what possibly a participant would not declare in a questionnaire about prejudice.

This work will only be used the TAI, which is a neuroscientific technique for assessing prejudices on a topic, and the theory related to Neurosciences will not be studied.

The theme of this research is of interest to doctoral student Larissa, because she is a professor in the discipline of medical informatics in the medical course of Institute President Antonio Carlos (ITPAC PORTO/PALMAS), with which the IPEN established a covenant, signed in Official diary for the formation of new researchers.

The purpose of this work is to conduct a study of the existing prejudices on the part of physicians regarding the use of software to support medical diagnosis using neuroscientific techniques, in which explicit and implicit measures will be made.

The TAI developed in this work will be applied to a control group consisting of physicians and medical students of the ITPAC/Porto Nacional-TO unit, which evaluates the levels of prejudice regarding the use of SADM by the participants. All stages of this work will be described in the methodology.

2. HEALTH AND TECHNOLOGY

In the health area the information changes at an impressive speed, new medications arise, vaccines, treatments, pathologies so that the physician often needs the support of technology to manage this diversity of information, that permeate their work practice. Hence the increasingly clear need for integrated information systems, which can bring health professionals to a more rapid, adequate and effective diagnosis support for the patient.

Of Greek origin, the word diagnostic means to distinguish or discern. Deciding on the diagnosis of a patient is something complex and involves many factors related to the patient's medical relationship, such as clinical examination, family history, results of exams, among other procedures. The decision support software represents a helping tool at the time of the

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professional decision, since the same symptoms in different patients can lead to different pathologies.

2.1. Medical Decision Support Systems (SADM)

The first computerized systems of medical decision support emerged in the decade of 70 and it is considered that the first of them was developed by De Dombal at the University of Leeds in England with the objective of assisting in the diagnosis of abdominal pain [10].

The SADM consists of a software specialized in providing information and assisting physicians in the consultation, recognition and interpretation of images, therapeutic planning, diagnosis and also in the storage and retrieval of information [11][12]. Some of the benefits of using SADM consist in the improvement and diagnostic accuracy for the interpretation and classification of cancers. The main areas of application of SADM are emergency medicine and intensive care units, cardiovascular medicine, pediatric medicine, radiology and Oncology [13].

The development of a system for the classification of skin cancer is presented by Rosado (2009) [14]. Ruiz (2011) presents a decision support system that detects, describes and classifies images with suspicious skin lesions [15].

In the IPEN was developed by the Medical Physics group of CEN, a digital imaging software (PDI), which combined with dermoscopy, minimizes the possible failures of diagnosis of lesions, due to the morphological similarities between the benign pints and the Malignant [6].

2.2. Paradigm Shift

The resistance behavior as a force that acts to interrupt the progress of new ideas and changes, which comprises four levels: apathy, passive resistance, active resistance and aggressive resistance [16]. Apathy consists of distance and lack of interest; Passive resistances comprise excuses and persistence of previous behavior and withdrawal; Active Resistances Express opposing views, asking other people to intervene and aggressive endurance encompasses internal quarrels, threats, strikes, boycotts or sabotage. Doctors often draw a picture of expectorations in their minds about new systems during the pre-implementation phase. If the expected consequences are not met, they will result in resistance behaviors. Therefore, the evolution of physicians in the system design is fundamental to the success of the implementation.

In the perception of Lobo (2017), the adoption of systems to support clinical decision can improve the accuracy of medicine, in relation to medical errors, due to the increase of workload, mainly of physicians in emergency and family clinics [17]. The possibility of crossing prescribed medications (mainly by more than one professional) and patient data, avoiding inappropriate interactions or doses, with the support of these systems may reflect on a safer drug prescription.

Actively involving the physician, who will be the end user of the system, from the design of the requirements to the implantation phase can decrease the resistance of the same in using computational systems that present reliable results.

2.3. Implicit Association Tests

The following implicit association tests were found in the literature: The Implicit Association Test, the Priming, the Visual Organization Test (VOT), and the Inquisit.

Introduced by [9], the TAI (designated in the literature by IAT-Implicit Association Test) had its first version but has undergone several alterations in order to improve its psychometric qualities, becoming the most Known to measure implicit associations in psychology. This technique has been highlighted in the literature as an effective tool to measure implicit attitudes, especially related to prejudices.

The TAI is considered an indirect measure, due to the fact of evaluating a cognitive bias (implicit memory), starting from an association of items, which is independent of conscious reflection [18].

The logic of the TAI is anchored mainly in the response time, in which it can be inferred that the shorter the response time compared to the stimuli presented, i.e., during the association between categories and attributes, the more strongly these concepts are related With the individual and vice-versa [9].

Another relevant feature of the TAI is its ability to produce considerable results from relatively small samples, around 20 to 30 participants. It should be noted that the size of the recommended sample may vary, according to the statistical calculation's procedures used or in the case of analyses associated with explicit measures [9].

The TAI has been applied in several researches, in the most varied areas of psychological knowledge, such as: Obsessive Compulsive Disorder (OCD) [18], Attention deficit hyperactivity disorder (ADHD) [19], Adoption of children [20], Consumer Behavior (neuromarketing) [21], Condom use [22], obesity [23], alcoholism [24], risky sexual behavior [25], Loving relationship [26], Animal Phobia [27], Environmental Psychology [28], evaluation of professional preference in psychology [29], evaluation of human values [30], Food Preference [31], among others.

This test, although simple, is effective, is validated and has been carried out in several nationalities. There are several tests available in the literature for TAI demonstration, which can be found on the Yale University website (https://implicit.harvard.edu/implicit/).

The methodology used in the work carried out implicit and explicit memory measures, arising from the neurosciences to quantify the prejudices existing among medical professionals. As already mentioned, in order to quantify the level of prejudice regarding the use of SADM, the FreeIAT was used. Additionally, a graphic post-processor was developed, with the following characteristics: A more user-friendly interface to present the results in the form of spreadsheet and graph.

2.4. Implicit Association Tests

FreeIAT is a free software that considers opposing adjectives (positive and negative). It was originally written in English, developed in the Visual Basic programming language and can be run on the Windows platform. It is distributed free of charge by Microsoft, which differentiates it from other commercial software such as Inquisit, DirectRT and Superlab. In addition,

FreeIAT provides the user with a result file with response time at each stage of the test and also the D-score, which will be explained later. To check the main results, it is necessary to open the ScoresOnly. txt file of Notepad [26].

The FreeIAT consists of five blocks, three of which are test (blocks 1, 2 and 4) and two Tests (3 and 5). The D score ranges from-2 to + 2, so that the negative values indicate a negative attitude, contrary to the object of research (INFORMATICS) and the positive values represent a positive attitude, favorable to it. As for the strength of association, values of score D up to 0.15 indicate the absence of a clear preference, whereas between 0.16 and 0.35 represent a weak association between 0.36 and 0.65, moderate and, finally, above 0.65, a strong association [32][26].

2.5. MS Excel and the VBA Language

The MS Excel software allows you to automate repetitive tasks and routines through macros and, together with VBA, provides the user with a set of tools that allows you to create custom applications with the use of menus and toolbars, as well as Activities with Forms and dialog boxes [33].

2.5. Statistical Methods

The statistical method that will be used in this work is the Statistical Package for Social Sciences (SPSS) software, through a link present in the post-processor. The Statistical Package for Social Sciences (SPSS) software is widely used to perform basic and advanced statistical tests, such as correlation of variables and test of assumed hypotheses. It can also provide the researcher with frequency counts, sort data, rearrange the information, and serve as a data entry mechanism. This software uses both univariate and multivariate statistical analysis (SPSS, 2013).

3. RESULTS

In this work item are presented the explicit (questionnaire) and implicit (FreeIAT) results obtained in the pre-test applied to the medical specialists and the same tests applied to the control group (physicians)

3.1. Pretest Application

When an instrument for measurement is under development in a given study, all the terms selected to measure its coherence should be tested before the main tests are conducted [34].

To evaluate the effectiveness of the test, that is, to verify the comprehension and consistency of the selected stimuli for the target and attribute categories chosen to be used in the FreeIAT software, a pre-test was applied to 20 physicians from the Instituto Tocantinense President Antonio Carlos. The test was conducted with the consent expressed by the signature of the ICF. The participants were 60% men and 40% women, aged between 26 and 57 years (Figure 8), with teaching time ranging from 1 to 15 years (Figure 9) and belonged to different specialties such as: cardiology, radiology and diagnostic imaging, rheumatology, clinical Medical, family and community Medicine, gynecology and obstetrics, occupational medicine, pathology,

dermatology, Neurology, endocrinology, General Surgery and Gastroenterology (Figure 10). The explicit and implied tests were previously scheduled with each of the specialists and applied on the day determined by them.

3.1.1. Pre-Test results - *FreeIAT*

Of the 20 specialists (physicians), 60% were men and 40% were women. 50% had positive automatic associations with respect to the manuscript and 50%, with regard to informatics. Observing the total results, it was observed that 50% of the total participants were indifferent to both target categories. This reveals that the specialists are well balanced about the use of informatics in medical practice, as shown in Figure 11.

The time of professional activity equally to the previous case showed balance in the results, again in this case practically 50% is indifferent to any of the two target categories (manuscript and Informatics), as shown in Figure 12.

Regarding gender, 60% of men and 40% of women had positive automatic associations with regard to informatics applied to medicine. The strength of the positive associations of men had higher values than that of women, as shown in Figure 13.

In the case of the age group there was also the same behavior as in previous cases, that is, it was well balanced; The youngest participant had more positive association with informatics, but with low intensity, as shown in Figure 14, the result expected.
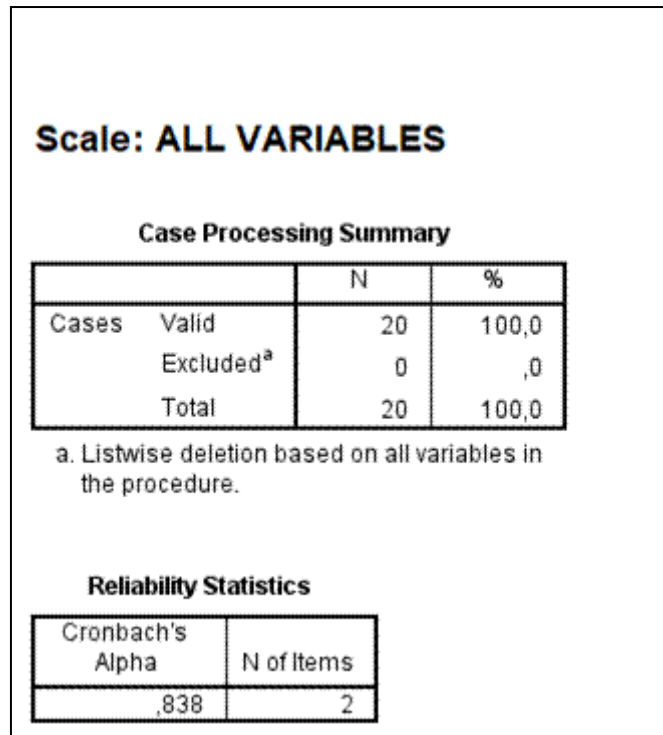
3.1.2. Statistical treatment

For the analysis of the results obtained in this work item, the data were stored in spreadsheets of the Software MS Excel® and Analyzed with the statistical software statistical Package for Social Sciences (SPSS®), version 23.0 (SPSS, 2016) for the analyses Statistics.

The SPSS® software was used to calculate the Cronbach's alpha coefficient in order to measure the internal consistency and reliability of the pre-test of this study (FreeIAT). The alpha value varies from zero (unacceptable) to 1 (excellent reliability), and the value of 0.70 or more is considered acceptable [35]. The values describing the internal consistency using the Cronbach's alpha are shown in table 1 below.

Table 1: Reliability coefficient – Cronbach's alpha

Consistência Interna	Inaceitável	Pobre	Questionável	Aceitável	Bom	Excelente
Alfa de Cronbach	$0.5 > \alpha$	$0.6 > \alpha \geq 0.5$	$0.7 > \alpha \geq 0.6$	$0.8 > \alpha \geq 0.7$	$0.9 > \alpha \geq 0.8$	$\alpha \geq 0.9$

As a result, the Cronbach's alpha value calculated for this study was 0.838, indicating good internal consistency (Figure 1).

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	20	100,0
	Excluded[a]	0	,0
	Total	20	100,0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
,838	2

Figure 1: Cronbach's alpha using the SPSS®

3.1.3. Application of the explicit test – questionnaire

From the questionnaire applied to medical professionals (Group of Specialists), that is, the test of explicit or concise association, the following results were obtained. In the question about having the computer discipline in the graduation 30% of respondents affirmed that they had and 70% stated that they did not. With respect to the meaning of the SADM the results show that 90% know it meaning and 10% do not. In the question that was asked whether the respondent knew any software support system the answer was that 65% have knowledge, 25% do not have and 10% did not inform.

It was asked if respondents think that the SADM is important and the answer was that 70% stated that yes, 20% did not and 10% did not respond. Complementing this question was asked if respondents use or have used any SADM, the result was that 65% yes and 35% no. It was still asked if they would use SADM in the work practice and the answer was that 55% yes and 45% did not. Respondents were asked about the use of specific skin cancer detection software if they were dermatologists and the answer was that 70% Yes would trust and 30% would not trust.

Comparing the answers of the conscious questions (questionnaire), in which many statements were in favor of the SADM, with the unconscious ones (FreeIAT), the results were discrepant, because in FreeIAT the answers were well balanced, 50% in favor of informatics and 50 % not. This comparison came to prove that not always what is answered consciously reflects the willingness/real desire of the respondent, because the FreeIAT is a test that evokes implicit memory, which represents the behavior of the individual.

3.2. Application of The Multisensory Methodology

Learning can produce new brain connections, thus reconfiguring the brain [36]. Based on the work of Barabás (2018) a multisensory program can significantly change the concepts of a person on a given subject. For this reason, in this work a multisensory methodology will be applied to verify whether there will be changes in the perception of the participants of this research regarding the use of informatics in the assistance of medical diagnosis.

This work uses only the existing neuroscientific tools and does not aim to deepen the theories of neurosciences.

4. CONCLUSIONS

The methodology based on neuroscience proposed in this direct doctorate was tested, applied and proved to be effective in promoting changes in the implicit associations of individuals.

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