BASIC EMOTIONS ANALYSIS BY MEANS OF ELECTROENCEPHALOGRAM FOR COGNITIVE EMOTIONAL AGENT

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ABSTRACT

This article shows progress of brain signals interpretation which identifies some of the primary emotions; those primary emotions are learned by the cognitive Agent. As a result we expect collaborative work between two or more robots that have empathy with different emotions. As part of this article development, we present the following case study. Given that human beings feel and perceive all primary emotions, we are considering doing an experiment with 6 people forming 2 groups, group A will be made up of 3 women and group B will consist of 3 men, it is worth mentioning that the ages are between 20-24 years, and that such groups do not have mental problems. These groups were shown a set of images that express the primary emotions. For Group A: Anger, Surprise, Joy and Disgust for group B: Anger, Fear and Sadness.

KEYWORDS

Intelligence Systems; Emotional intelligent, study of brain, Intelligents agents.

1 INTRODUCTION

By avoiding conscience, emotions allow you to "think" on an urgent basis, preparing the body for a course of quickly and efficiently action, avoiding the lingering complex inferential processes. Their focus is the events and they help to consider only what is important.

Recently was introduced the term "emotional intelligence" as research topic areas of psychology and artificial intelligence. It can be defined as a very important role, since emotions are involved in the process of decision making and consequently their role in human intelligence.

It is also worth noting that as far as troubleshooting is concerned, there are many ways of thinking and representing these problems and therefore there are many possibilities to find a solution, some more efficiently and with better results than others. Some authors define emotions that influence deliberation and practical reasoning of an agent as heuristics that prevent excessive deliberation.

We define personality as a behavior pattern also called features, which includes feelings and thoughts that are maintained throughout the life of an individual, an element that plays an important role in the personality are emotions because there are present in the beginning and end of the decision making of human beings; in recent years has increased the interest of intelligent agents and autonomous robotics communities to develop models and architectures that enable adaptive agents designing.

2 EMOTIONAL INTELLIGENCE

Opinions are unconscious emotional memories that are stored in the amygdale. The research conducted by [1] other neuroscientists seems to suggest that the hippocampus —which had long been

considered the key structure of the limbic system— has less to do with emotional responses emissions as the fact of recording and make sense of perceptual patterns. The main activity of the hippocampus is to provide a sharp memory of context, which is vital to emotional significance. The hippocampus is the one which recognizes the different meaning of, say, a bear in the zoo and a bear in the garden of his home. And if the hippocampus is one that records the pure facts, then the amygdale is responsible for emotional climate registration that accompanies these facts. If, for example, we try to pass a car on a two way street, make a wrong distance estimate and have a frontal collision, the hippocampus records the specific details of the accident, road width, who was with us and how the other vehicle looked. But it is the amygdale which, from that moment, triggers a boost of anxiety every time we prepare to pass in similar circumstances.

As he said [1]: «The hippocampus is a fundamental structure to recognize a face like his cousin, but it is the amygdale which adds the emotional climate that seems not to have her in great esteem».

The brain uses a simple but ingenious method to record with particular emotional intensity the memories, as these neurochemical warning systems prepare the body to react to any threat — fight or escape— will record vividly this moment in the memory. If stress or anxiety, or even in case of intense joy, a nerve that connects the brain to the adrenal glands (located above the kidneys), stimulates secretion of adrenalin and noradrenalin hormones, providing the body to respond to an emergency. These hormones activate specific receptors of the vagus nerve, responsible, among other things, to transmit messages from the brain that regulate heartbeat and returns signals to the brain, also activated by these hormones. The main recipient of such signals are the amygdale neurons that, once activated, are responsible that other brain regions strengthen the keepsake of what is happening. In order to forge a better idea of what could be the key elements we must look to other theorists who follow the path opened by Gardner [5], among which the most prominent perhaps Peter Salovey, a noted psychologist from Harvard, has established with great detail how to bring more intelligence to our emotions.

E.L. Thorndike [2], for example, an eminent psychologist who played a major role in the popularization of IQ in the twenties, proposed in an article published in Harper Magazine [3] that "social" intelligence —an aspect of emotional intelligence that allows us to understand the needs of others and «act wisely in human relations»— is a factor that should be taken into account in determining IQ. For example, when Robert Stenberg [4], another psychologist at Yale, asked different people to define an "intelligent person", the main features were the practical skills [5].

3 EMOTION AND EMPATHY

All emotions are essentially impulses that lead us to act, automatic response programs with which evolution has endowed us. The same etymological root of the word emotion comes from the Latin verb movere (which means "move") plus the prefix "e-", meaning something like "move to" and suggesting thereby that every emotion there is an implicit tendency to action. Just look at children or animals to realize that emotions lead to action, it is only in the "civilized" world of adults where we find this strange anomaly in the animal kingdom in which the emotions —basic impulses that prompt

us to act— appear to be divorced from reactions.

Certain psychological schools of thought contend that human mind has in common sensations and feelings. The only difference between two people is the time when such feelings are causing emotions that motivate action. That a person doesn't feel like another one in a given time is for educational reasons, genetic predisposition and hormonal conditions that induce channel stimuli in one form or another. Therefore, is inferred that empathy is possible in an individual capable of reasoning about himself, assess his feelings and reason about other people so that he doesn't tend to justify his own desires. Desire it would be the unit of degeneration of objective thought, and degree of accuracy will be distorted to a greater or lesser extent depending on the depth of knowledge of him, or what is the same, of emotional intelligence.

It also seems that empathy plays a significant role in game theory and economic life:

Even expressions of popular psychology such as "we", "us citizens", "our people", etc., will be impossible without such empathy (i.e. without the hypothetical expression of existence of "people like me"). It appears that capacity for empathy is not only important for observation of moral or social behavior, but also is parallel to experience feelings such as envy, hatred, religious wars, etc. Philosopher Edith Stein [6] has made a thorough study of the empathy problem, with a great philosophical and scientific rigor. Her doctoral thesis, published in Spanish entitled "On the Problem of Empathy" is about the essence of acts of empathy in general, as well as the notion of a person that is obtained through the analysis of those actions.

4 AGENTS AND EMOTIONS / PERSONALITY

Emotion is key in human social activity, and the use of computers and robots is no exception. Agents that can recognize a user's emotions, display meaningful emotional expressions, and behave in ways that are perceived as coherent, intentional, responsive, and socially/emotionally appropriate, can make important contributions towards achieving human-computer interaction that is more 'natural', believable, and enjoyable to the human partner. Endowing social artifacts with aspects of personality and emotions is relevant in a wide range of practical contexts, in particular when (human) trust and sympathetic evaluation are needed, as in education, therapy, decision making, or decision support, to name only a few. Believability, understandability, and the problem of realism are major issues addressed in the first three chapters of this section, all of them concerned with different aspects of how to design (social) artifacts' emotional displays and behavior in a way that is adapted to, and recognizable by humans [7, 8.].

5 ELECTROENCEPHALOGRAPHY

Brain activity determination using electroencephalography (EEG) can be performed by so-called generators analysis. These mathematical techniques try to find the precise location of generators of electrical activity recorded by EEG. This procedure is usually done by using algorithms and programs which computed these locations and represented them by a series of dipoles. The location of these dipoles can then be drawn on projections of an ideal spherical head, which gives a rough estimate of their anatomical position. From the areas on which the dipoles are located we can make a diagnosis, although the spherical

head model representation does not provide details of the underlying anatomy. For example, in epileptic patients this method is used to find the area that causes the crisis that they suffer. The diagnosis of these techniques can be improved if the dipoles are located in a 3D image of the patient's head, usually obtained by magnetic resonance imaging (MRI). By this you can diagnose from the anatomical position of dipoles in a much more accurate way. The most common method to find dipoles in the MRI is to place in the patient's skin markers that are visible in the acquired image. These markers can be place where the electrodes are placed or in the anatomical markers that the reference system 10-20 defines. Identification of these points in the MRI helps define the coordinate system needed to represent the dipole in its anatomic position. In many cases this procedure is not suitable, for example if the MRI image has been acquired without the purpose of locating the dipole, or if there are no facilities to use markers. Therefore, it would be interesting to solve this problem with a method that doesn't require the use of external markers.

6 VI. 10-20 SYSTEM

2.1 Electrodes

a) They are responsible for transforming into electrical currents load changes that occur in the cortical nerve cells membranes as a product of brain activity. Their electrical characteristics are directly determined by the type of metal used.

b) You can also improve their performance by applying a conductive gel between the scalp and the metal, reducing in this way the impedance between contact and skin. The 10-20 System is a protocol which indicates the positions that electrodes can take on the patient's scalp; these are summarized in Fig 1.

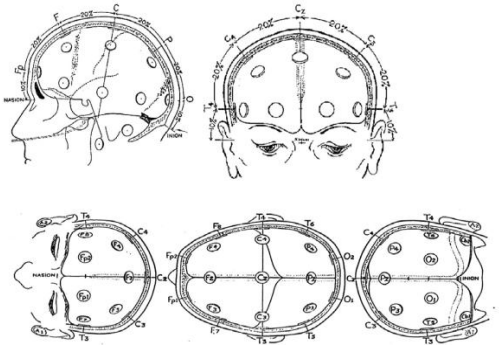

Figure 1. International 10-20 Standard.

The 10-20 system is an internationally recognized method to describe and apply the location of scalp electrodes in the context of an EEG test or experiment. This method was developed to ensure the reproducibility standard by which a subject studies can be compared over time and subjects can be compared with each other. This system is based on the relationship between the location of an electrode and the area of the underlying cerebral cortex. The "10" and "20" refers to the fact that the actual distance between adjacent electrodes are 10% or 20% of the total distance from front to back or right to the left of the skull.

2) Each site has a letter to identify the lobe and a number to identify the location of the hemisphere. The letters F, T, C, P and O represent frontal, temporal, parietal, central, and occipital lobes, respectively. It should be noted that there is no central lobe, the letter "C" is used for identification purposes only. A "z" (zero) refers to an electrode placed in the midline. Even numbers (2,4,6,8) refer to positions of electrodes in the right hemisphere, while the odd numbers (1,3,5,7) refer to those in the left hemisphere [11].

2.2 System

Using the International 10-20 standard for electrode placement (illustrated below), consider the following Fig 2.

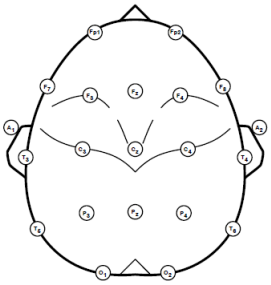

Figure 2 International 10-20 Standard

Channel 1a is connected to Fp1 and channel 1b is connected to Fp2. The signal that would be sent to your computer on channel 1 would be the difference between Fp1 and Fp2. This is represented in EEG nomenclature as Ch 1 = Fp1-Fp2, fig 2

One standard configuration (or montage) for EEG neuromapping is known as linked-ear referential.

This is Mindset's default neuromapping montage. In a linked-ear referential montage, all channels' "b" inputs are connected to ear clip positions A1+A2. This is accomplished by connecting the included Linked-Ear B Inputs montage selector to the Expansion Connector on the Mindset front panel. Doing so ties each channel's "b" input together. By inserting the input jacks from your electrode system's ear clip leads into any two "b" inputs, you tie each channel's "b" input to A1+A2.

The default neuromapping connection between Mindset's input channels and the 10-20 standard electrode positions is as follows, Fig 3.

Channel	"a" input	"b" input
1	Fp1	A1+A2
2	Fp2	A1+A2
3	F7	A1+A2
4	F3	A1+A2
5	F4	A1+A2
6	F8	A1+A2
7	T3	A1+A2
8	C3	A1+A2
9	C4	A1+A2
10	T4	A1+A2
11	T5	A1+A2
12	P3	A1+A2
13	P4	A1+A2
14	T6	A1+A2
15	O1	A1+A2
16	O2	A1+A2

Figure 3 Standard 10-20 Electrode Positions

This default connection is provided for convenience only. The Mindset MS-1000 has 16 channels, so 3 of the 10-20 electrode positions are unconnected. In this default configuration, Fz, Cz, and Pz are not connected. You may choose to connect any of the 10-20 electrode positions to any Mindset input channel. If you differ from this default, however, you must instruct the Mindset software that you have done so (this is covered in the software reference section).

7 COMPRESSED SPECTRAL ARRAY (CSA) TOOL

The Compressed Spectral Array (CSA) tool permits visualization of spectral EEG data over time. The data are displayed with frequency along the horizontal (X) axis, amplitude in microvolt units along the vertical (Y) axis and time along the diagonal (Z) axis. (Refer to the CSA Tool window figure below.)

The CSA tool accepts array data from the FFT tool or Averaging tool and outputs these data to a CSA tool window.

CSA parameters are set in the CSA Tool Properties window. CSA tool(s) are invoked in the Create/Edit Scheme window by right-clicking on the CSA tool icon.

CSA Tool Properties Window Number of channels pane: set the number of channels to be displayed. If you display

less than 16 channels, all data still accumulates to save file names in the Storage tool, if invoked.

Display band pane: determines the frequencies that are displayed. You can limit the amount of data displayed by selecting a narrower range of frequencies. Each trace in a CSA tool window represents the amplitude of signals which fall within that band. For example, if you select the Passband option, the amplitude of the trace varies in accordance with frequencies in the 2 Hz to 34 Hz range.

Select fixed parameters (Passband or Full scale) for the range of frequencies to be displayed or customize the range by selecting Other.

- Passband (2 Hz to 34 Hz): click to display the listed frequencies.
- Full scale (1 Hz to 63 Hz): click to display the listed frequencies.
- Other: click to specify your custom range between 1 Hz and 63 Hz:
  - Low freq: enter the lowest frequency to be displayed.
  - High freq: enter the highest frequency to be displayed.

Maximum amplitude pane: enter the maximum vertical amplitude that can be displayed. The amplitude may be from 1 μV to 120 μV.

Colors pane: click the Edit… button to access the standard Windows O/S Color window (refer to the Channel Properties pane discussion in paragraph 4.3.3) to select the background, foreground and pen colors for a CSA tool. Be aware that certain color combinations for the foreground and background color are visually more readable than others.

Channel map pane: select the display position to correspond with each hardware channel. Clicking on each numbered Position button displays the Assign Position window in which to select the hardware channel to show at the selected numbered display position.

All the information set in the CSA Tool Properties window is saved when you save a scheme.

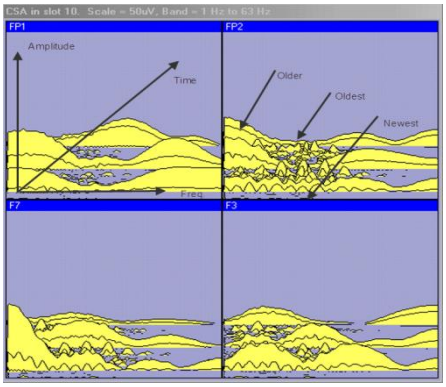

Figure 4 CSA Tool Window (4 Channel example)

When any scheme is invoked for which you indicated a CSA, the CSA tool window automatically displays with the appropriate properties shown. The CSA tool window title identifies the reference slot (refer to paragraph 5.1), maximum amplitude (i.e., the vertical scale) for the scale and frequency band (i.e., the horizontal scale) information for this CSA, Fig 4.

8 COLOR PSYCHOLOGY

Expression of colors from the psychological point of view seems to have a general agreement on the fact that each color has a specific expression. Experimental research on the subject is not abundant. Goethe's descriptions of colors are still the best source.

Appearance of a color depends greatly on the context in space and time as well as the accurate dye, lightness value and degree of saturation.

Color produces different sensations in us and we have our own ideas about sympathies or antipathies, likes or dislikes about this or that color, but in general, all feel a physical reaction to the sensation of a color, such as cold in a room painted blue or hot on another

painted red.

In color psychology there are basis of certain relationships between colors and geometric shapes and symbols, and also Heraldry representation.

Warm colors are considered as stimulants, joyful and even exciting were the cold are considered tranquil, sedative and in some cases depressing.

Although these determinations are purely subjective and due to personal interpretation, all investigations have shown that commonly occur in most individuals, and are determined by unconscious reactions of these, and also by various associations that relate to nature.

Yellow is the color associated with the sun and mean radiant light, joy and encouragement. The red is related to fire and heat and excitement. Blue is the color of the sky and water that represent calm and also infinite coldness. Orange, yellow and red mix has the qualities of these, to a lesser degree. Green, the color of wet meadows; it's cool, calm and comforting. Purple, maturity and in a clearer hue expresses delicacy. In these six basic colors include all the huge variety of shades that can be obtained by mixtures between them and also for each one with white and black, each of these variations involve the character of the color that they come from, but with predominance of those involved in higher proportion. White is purity and innocence, black, sadness and mourning; gray, resignation; brown, maturity; gold, wealth and opulence; and silver, nobility and distinction.

As said, colors that have more excitation power, are red, orange and red-orange; more calm, blue and green or purplish blue. A turquoise is a little more restless than an ultramarine blue because the intervention of yellow in the first and blue in the second, which derives to violet. The most soothing and comfortable colors in decor are green, light blue and light violet; shades of cream, ivory, beige, suede, and others with warm quality, are happy, and have some exciting action, but all should be used properly and in wide areas.

Full saturated colors are used very rarely in large surfaces, the reds, oranges, yellows, blues and other bright colors in all their purity are never present in large areas in nature but as accents or small animation areas.

Colors convey moods and emotions with very real psychological significance, they also exert physiological action. We will learn more about these properties later when we discuss color therapy.

Red stands for blood, fire, passion, violence, activity, impulse and action and is the color of movement and vitality, increases muscle tension, activates breathing, stimulates blood pressure and is the most suitable for withdrawn people with interior life and slow reflexes.

Orange is enthusiasm, burning, glowing, euphoria, and acts to facilitate digestion, mixed with white constitutes flesh rose that it has a very sensual quality. Yellow is the sun, power, arrogance, joy, good humor and will, is consider a nervous centers stimulant.

Green is rest, hope, spring, youth and by being the color of nature suggests outdoors and freshness; this color frees the spirit and balances sensations.

Blue is intelligence, truth, wisdom, meditation, space, immortality, sky and water and also means peace and quiet, acts as a tranquilizer and blood pressure reduction, and when mixed with white expresses purity and faith. Violet is deep, mystical, mysterious, melancholy and its purple hue, royalty, luxury and dignity; is a delicate color, fresh and somewhat with a sedative action.

Warm colors in light shades: cream, pink, etc., suggest delicacy, femininity, kindness, hospitality and rejoicing; and

dark shades with a predominance of red, vitality, power, wealth and stability.
Cool colors in light shades express delicacy, freshness, growth, rest, solitude, hope and peace; and dark shades with a predominance of blue, melancholy, reservation, mystery and depression [12].

9 METHODOLOGY

For this paper development, we present the following case study.
Given that human beings feel and perceive all the primary emotions, we are doing an experiment with 6 people, 3 women and 3 men, and they formed 2 groups, group A will be made up of 3 women and group B will consist of the 3 men, it is worth mentioning that the ages are between 20-24 years, and that such groups do not have mental problems.
These groups were shown a set of images that express primary emotions

- For Group A: Anger, Surprise, Happiness, Disgust
- For Group B: Anger, Fear, Sadness

It should be mentioned that primary emotions are divided between positive and negative, this is to have affinity and empathy between the different members of each group, the primary emotions are evaluated by means of EEG. The task entrusted to these people is based on emotions they feel as a group and then to have or express the empathy that is reached.
The values generated by EEG are introduced in to the Cognitive Emotional Agent [] which generates cognitive emotion behavior, Cognitive Emotional Agent visually express the behavior of such values and is intended to demonstrate that those values are similar or close to those expressed by the group A and B, for this experiment is used as a labyrinth work setting, the aim is that the Cognitive Emotional Agent has additional work to decision making.

10 RESULTS

Below are the results of study developed to group A.
Group A were presented with the images emotions of surprise, anger and disgust, and the regions of the brain that were activated.
To the first person in the group was presented with images that expressed emotion of disgust, and area Fp1 activated; mental signals were displayed that determine mental activity as shown in Fig 5.

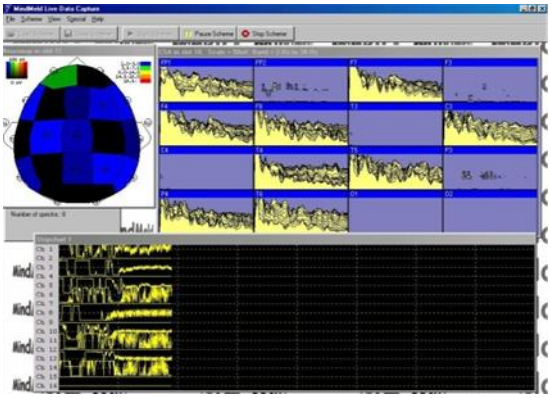

Figure 5 CSA Tool Window

To the second person in the group was presented with images that expressed emotion of anger, and area F8 activated, mental signals were displayed that determine mental activity as shown in Fig 6.
The third person in this group was presented with images that expressed emotion of surprise, and Fz area was activated, mental signals were displayed that determine mental activity as shown in Fig 7.
Results show that the Node Agent presented paths in the maze, and based in the classification of positive and negative

emotions, it is shown that positive emotions work together and create empathy between these entities, as shown in Fig 8.

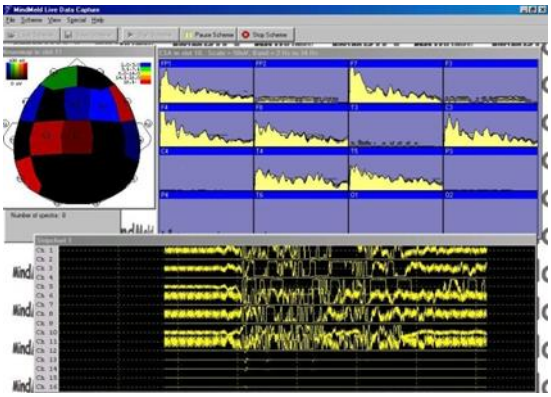

Figure 6 EEG study of second person with anger emotion

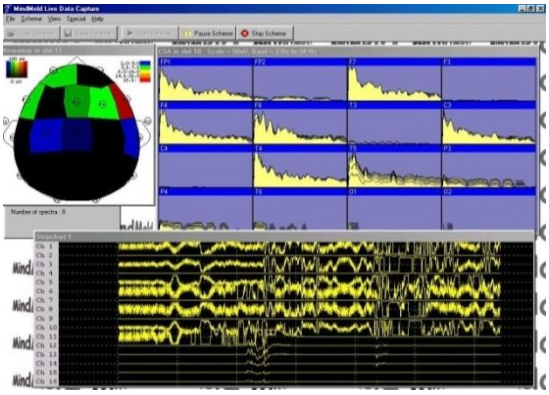

Figure 7 EEG study of third person with surprise emotion

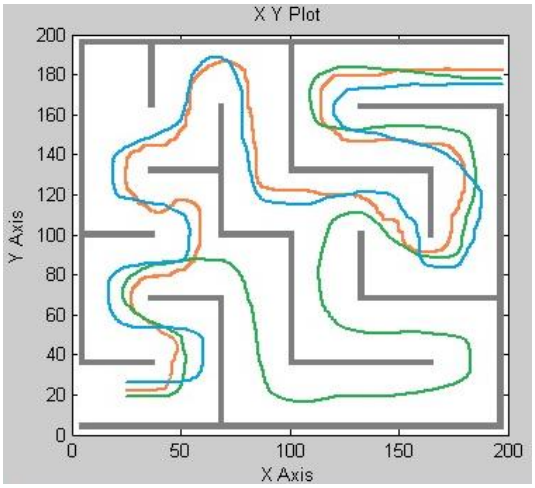

Figure 8 Empathy in disgust and anger emotions

11 REFERENCES

In the text, use square brackets and consecutive numbers: [1], [2], [3] for citations. References should be listed in the order they appear in the text. Use Times Roman 10 point font format.

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