Retention And Productivity In Industrial Search And Scan Tasks

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RETENTION AND PRODUCTIVITY IN INDUSTRIAL SEARCH AND SCAN TASKS

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RETENTION AND PRODUCTIVITY IN INDUSTRIAL SEARCH AND SCAN TASKS

by

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THESIS

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Abstract

An experiment was developed in order to study the interaction between individual factors (gender and mood) and the retention ability in search and scan activities. 54 subjects between 18 and 30 years old participated in a computer-based memory test from the North of Mexico area. A full factorial design was used to analyze the variables. Two factors, one with two levels (gender: male and female), and the second factor with three levels (mood: positive, neutral, and negative) were used in the analysis. The output was measured as the amount of characters memorized in a string of random alphanumeric characters. Data gathered showed that gender was not a significant factor (P=0.09), yet mood was a significant factor (P<0.005). Based on Tukey test, each level in the mood factor is significantly different among them. Positive mood showed the highest value, followed by neutral, and negative mood (sad, angry, depressed) showed the lowest amount of characters memorized.
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Chapter 1: Introduction

Computerization in manufacturing has resulted in significant visual display unit (VDU) activities. Operators now interact significantly with computers. This has led to significant scan and search activities, compared to physical tasks. Therefore, changes in the way that workers perform their daily activities, like the case of computer-interaction tasks, such as typing information during manufacturing tests, checking process information, and updating or uploading information in databases. For computerized tasks, different factors may be involved in the decrease of worker productivity. Several factors have been shown to affect worker productivity due to computerization. We briefly review these factors:

- Mental stress or mental overload. This can lead to performance reduction or human errors during the task (Ibrahim et al., 2007). The symptoms of Techno Stress are the inability to pay attention to a single task, increased irritability and commonly the feeling of loss of control. Mental stress is measured by subjective methods such as surveys.
- Difficulty to identify or understand information required.

We also know that as the information given increases more than can usually be accepted by the user, the user or person creates different self-protective mechanisms that help the user to overcome the mental stress applied. This has been categorized by Miller (1960) as:

- Omission – temporary non-processing of information.
- Error – Processing incorrect information, which may enable the system to return to normal processing afterwards
- Queuing – Delaying the response during a period of high overlap of input information in the expectation that it may be possible to catch up during a temporary time.
• Filtering – neglecting to process certain categories of information while processing others.
• Cutting categories of discrimination – responding in a general way to the input, but with less precision that would be done at lower rates.
• Employing multiple channels – processing information through two or more parallel channels at the same time.
• Escape from the task.

1.1 **Real world scenario for search and scan activities**

Production settings in countries with low production costs require workers to interact with visual applications. A good example is the Mexico–United States border area. Due to migration of the labor population from all regions of Mexico, workers in manufacturing facilities come from diverse regions of Mexico. Most of these workers have only performed physical tasks and in some cases, these workers have never used a computer or performed scan and search activities as part of their tasks. A good example for this problem is the following scenario in a computer manufacturer.

After the assembly of computers, servers or laptops, the manufacturer is required to perform diagnostic tests to check the final assembly and overall functionality of the computer product. The diagnostic tests check not only installed components, but also include input devices and video tests. To ensure the proper functionality of a computer, a critical test requires the production operator to input the following data:

• Employee badge number - the operator can memorize the badge number, or search for it in the employee badge;
• Serial number of the product - typing the unique serial number of the product;
Part number - in most cases, the part number refers to the model or product family.

Input test - the diagnostic tool will ask the user to input a series of keystrokes to check the proper functionality of the keyboard, to click left / right or to move the mouse, or use any other input device installed in the product;

Video test - in this phase of the test, a series of colors will be shown to the operator to check the video display;

The tasks above may sound like a very simple function for the operator. However, when the operator has to check two, three or more computers requiring this information at the same time, the task becomes burdensome on the worker.

Part of the question for this research comes from a real world scenario. For cost-reduction strategies, one global corporation is moving its manufacturing operations to low cost countries. The goal for the corporation is not only cost reduction in manufacturing headcount and facilities, but also improving the output quantity and quality, so during the transition of the assembly lines, some operations are improved and adapted to the new facilities. The two plants were moved from one city in the United States to Juarez, Mexico and the other facility to Shanghai, China. One process which is part of this line is the testing procedure which is very similar to the task described above. In the United States, there was one operator for each computer performing this test, but because these companies wanted to minimize headcount, supervisors started to assign one, two or even up to eight computers per operator.

1.2 Finding a way to measure productivity in search and scan activities

From a capacity analysis standpoint, the worker is able to test up to eight computers at the same time, because each activity has delays during the test, allowing the operator to use delay times for testing
another unit. But after several minutes of performing these tests, it has been observed that the operators slow down in their tests between the different units, especially when the operator tries to type different part numbers from memory and starts searching for part numbers in information sheets or Work instructions. These part numbers varies between six and nine alphanumeric characters, and are relatively similar - for example 123456-111, 234561-111, and so on.

It is not mandatory for the operator to memorize each part number. The part number is printed on the computer itself, and each workstation has visual aids to identify part numbers. But, for productivity purposes, instead of looking in each unit or looking at the visual aid, the operator tries to memorize each number, making references to the unit shape, or physical attributes. Also, with the help of the barcode readers, the part number printed in barcode format is also on the unit. Yet some operators find it easier to type the part number, due to label location. This raises the main question for this research which is: What is the relationship between retention of information in memory for visual tasks and productivity?

It is known that a decrease in search and scan productivity can be caused by the following variables:

- Environmental aspects like temperature, auditory and visual distraction;
- Physical ergonomics factors such as worker posture, and machine (conditions of the computer or machine), and
- Psychosocial and individual factors such as gender, age, and work policies.

Using these different factors, and based on the literature review (presented in Chapter 2 of this thesis), an important premise of the research is that individual factors may be significantly related to information retention ability (working memory). Therefore, the main question explored in this research is whether information retention in visual search and scan tasks impacts productivity in task performance. Further, is the relationship between information retention ability and productivity
different for gender and mood or the interaction of these two variables in young adults in the industrialized area of Northern Mexico?
Chapter 2: Literature Review

In this chapter, we will look at the frame of documentation that is relevant to the development of this thesis. First, the concept of mental workload is explained, and how individual characteristics are important or could affect the performance of the mental workload capacity per each person, and how mental deployment affects directly the performance in terms of capacity analysis for manufacturing facilities. It is explained also how mental workload can be measured, and the differences among empirical and analytical methods. Also, how mental workload capacity can be related to quality levels in a productive area is presented in this chapter.

After mental workload, concepts of visual search performance definition, visual memory concepts and mood affecting the cognitive ability are explained in more detail.

2.1 Mental Workload

Mental workload can be defined in a set of concepts that includes multiple-attribute of workload measures, for example instantaneous, peak, average, overall and accumulated workload (Xie and Salvendy 2000). So far, there exists a large literature and many excellent reviews (Eggemeier and Wilson, 1991; Eggemeier, Wilson, Kramer, and Damos, 1991; Gopher, and Donchin, 1986; Linton, Plamondon, and Dick, 1989; Lysaght et al., 1989; Moray 1979, 1988; O’Donnell and Eggemeire, 1986; Tsang, and Wilson 1997; Wilson, and Eggemeier, 1991) on the topic of mental-workload measurement.

In the performance of complex systems such as flying an aircraft, monitoring a process-control, and also interacting with computing devices, mental workload it is related as an important factor for the effective and precise development of the planned activity. It has been documented that different levels of mental
workload (such as overload and underload) could am inorate the performance of the employee and also it could affect the whole efficiency of the system.

Referring to mental workload, it has been studied as an important factor regarding individual performance in complex systems (Gopher and Donchin, 1986; Hancock, and Meshkati, 1988; Moray, 1979; O’Donnell, and Eggemeier, 1986). In spite the fact of differences regarding mental workload and individual effectiveness are previously cited (Vidulich, and Wickens, 1986; Wickens and Yeh, 1983), it is also documented that extreme mental workload (underload and overload) are related to a low performance development (Lysaght, Hill, Dick, Plamondon, Linton, Wierwille, Zaklad, Bittner, and Wherry, 1989), and as previously mentioned, the whole system performance degradation.

Gopher, and Donchin (1986) mentioned that mental workload is better addressed as a hypothetical construct rather than an interceding variable. This interceding variable could be described as a theoretical concept for a quantity resulted by manipulations made in the values of empirical variables. This involves no hypothesis on the existence of entities not observed. In spite of this, mental workload carries the additional meaning characteristic of hypothetical constructs that involve terms that are not wholly reducible to empirical terms and refer to processes or entities that are not directly observable (Xie and Salvendy, 2000).

In order to establish the concept of mental workload, it can be summarized as the amount of mental work or effort needed for a person or team to achieve a task over a certain period of time. It cannot be detected directly, but it can be part of the measure of other variables that are close related, such as subjective rating, performance and also physiological data. Mental has static and dynamic attributes, and they respectively reflect the load of work in a time interval and in a specific moment.

We need to consider also that mental workload is a multi-dimensional variable. Reid and Nygren (1988), with their work of Subjective Workload Assessment Technique (SWAT), organized mental workload in
three sections such as time load, mental effort load and also psychological stress load. In another hand, Hart and Staveland (1988), in their National Aeronautics and Space Administration Task Load Index (NASA – TLX), they calculate mental workload based on six points: mental demand; physical demand; temporal demand; performance; frustration level; and effort. Based on these two approaches, mental workload can be easily obtained through different areas. Meshkati (1988) categorized the different variables that affects mental workload into causal factors, which are the task and environmental variables, the characteristics of the operator, and the variables moderating, and effect factors (difficulty, response and performance variables, and mental workload measures).

2.1.1 Individual capacities affecting the task workload

The mental workload can be altered by several ways, so it is not just by the task complexity, but it also involves individual factors and how they interact. This means that each area or dimension of workload can be directly affected by different variables and internal variables. Commonly, a structure stepped can be utilized to refer the variables and sub-variables that affect mental workload. For any research, it is recommended to keep the model simple, only adding the factors that dominate the impact on subject’s workload.

The more difficult task requires increases limited resources, and performance is ameliorated when demand exceeds available resources. Wilson, and Eggemeire (1991) mentioned about the actual psycho-physiological assessment techniques for multi-task scenarios, proposing that in order to have a more real and complex understanding of the correlation between workload in multiple tasks and physiological responses, obviously more physiological analysis needs to be performed.
2.1.2 Capacity calculation based on mental workload

Commonly, in operations that require physical effort, capacity can be calculated in a known and easy way. The number of operators needed is distributed among the assembly stations based in the takt time calculation. Physical operations such as assembling, screwing, etc. are assigned to specifically workstations. The idea is to distribute all operations to have equally processing times in all stations based on the required output. The efficient operation of computing devices demands carried out on operators does not exceed their aptitude.

Mental Workload is not only obtained by tasks, but also individual factors are involved, since different personnel may have different mental workload for the same operation, and even the same people could also have different workloads across different stages. The demands of information processing that could exceed operator limitations can lead to less performance in both (the operator and the system). It is also known that multiple tasks performance requires higher demands than one task performance and this could create overload more easily. The efficiency required for the system can be obtained when tasks are delegated to appropriate operators, and also through some appropriate learning and training (Vidulich and Pandit, 1986). This decrease of mental workload obtained after the training can be deduced as the decrease of non effective workload and as previously mentioned the improvement of workload efficiency. Each person has limited processing capacity. High workload diminishes the mental resource faster than ‘low’ workload.

Mental workload is totally defined and has direct involvement on operator’s responsiveness to keep or sustain a performance level. Each attribute describes one aspect of mental workload, analogous to some load-related concepts in electrical or mechanical theory, i.e. instantaneous power, peak power, average power and work. (Xie and Salvendi, 2000). Tsang and Wilson (1997) categorized mental-workload in four
categories: subjective measures; performance measures; psychophysiological measures based on empirical techniques; and analytical measures.

2.1.3 Methods to measure mental workload

Empirical methods are the most commonly used (O’Donnell, and Eggemeier, 1986), since they gather data, i.e. opinions, surveys, and physiological measures from operators. Subjective measure techniques such as SWAT (Reid, and Nygren, 1988), NASA-TLX (Hart, and Staveland, 1988), Modified Cooper-Harpe Scale (Wierwille, and Casali, 1983), and Subjective Workload Dominance (SWORD) (Vidulich, and Tsang, 1986; Vidulich, Ward, and Schueren, 1991) help us to show the perceptions of the user about mental workload. In the specific case of Psycho-physiological research methods, data gathered are differences in operator physiology related with cognitive task load, such as heart rate, Oxygen consumption, ongoing EEG, etc. Moray (1988, p. 123) stated that ‘It was in the area of subjective measures that most progress has been made. Performance measures, particularly dual-task measures, remain disorganized and largely arbitrary. Some progress in physiological measurement has been made, but it is of little practical use. Theory remains undeveloped’.

Analytical methods are based in techniques without using an operator in the analysis, such as simulation, models, etc. Linton et al. (1989) categorized the analytical techniques into five segments: 1) comparison; 2) expert opinion; 3) mathematical models; 4) task analysis; and 5) computer simulation. In previous research from Patel et al. (1999), an Ohm’s Law analogy was developed for mental workload based on individual factors and the individual’s ability to process information. In this analogy, current was the information transmission rate and was measure by bits per second, as a measure of workload.
2.1.4 Quality constrains due to mental workload ability

Workmanship issues can be directly related to physical operations in a timeframe. When the operator starts feeling tired for a specific operation, the physical response can be reduced and as a result, a quality issue. But also mental workload could make the overall response during the process more or less effective (Xie, Salvendy 2000).

Also, Moray (1988) mentioned that optimizing the quota of mental workload to production associates could amiorate human errors, increase safety in the system, improve efficiency and obtain operator overall satisfaction.

2.2 Visual search performance and memory

Han (2007) studied the effects of locating and timing on visual scan accuracy and velocity and the effects on remembrance regarding animated strings. This accuracy was taken based in the of sensitivity measurement in signal detection theory (SDT). Results showed that black-and-white animations do not significantly affect visual search, while colored displays have a significant reduction on search speed, but not on accuracy.

In a study on color coding of displays, Chang et al., (2009) studied the influence of color coding and duration of display to get an accurate rate of visual codes working memory using different gender and two groups with different ages (university and high school). Results show that there is a relation between gender and the corrective rate of visual codes working memory. There is also evidence that the length of time of display affected the corrective rate of the working memory. The optimal corrective time was reported to be 0.3 seconds.
Liu et al., (2009) studied the tracking of different objects on human observers. In this research, the subjects were asked to scan multiple dynamic (moving) objects but at the same time, maintaining their qualities. Main findings from this study are that the capacity to maintain different moving elements are between three or four items. Further, the uniqueness enhances the performance of the tracking. It was also determined that the capacity of the observer depends on the type of feature tracked. The interesting part of this research is that it is more related to the design of the items or attributes in an application window, but it is not related to individual factors.

In a study by Olsen et al., (2009) qualitative attributes of large displays, compared to a smaller monitor or display. The experiment was about using a mental rotation task made in two different displays, the first in a 230 inches display, and the smaller secondary display, a 14.1 inches monitor display. Results indicate that females rotated objects faster than men in large displays, influenced by the idea that the large display could provide a better performance. Again, this study indicates a gender difference in a visual task. Here the interesting part is the “positive expectation” aspect, which influenced in the performance of the female during the research.

According to Troche and Rammsayer, T., (2009), higher temporal resolution power (TRP) could be reflected in a better performance during psychophysical tasks in time, due to faster processing of information and improved efficiency generating a better performance on tests of intelligence in terms of psychometrics. Another explanation of individual factors related to psychometric intelligence denotes that differences in working memory (WM) capacity, which is closely related to psychometric intelligence. This experiment measured 200 subjects between 18 to 30 years. This study relates one specific aspect in terms of measure the psychometric intelligence and the working memory capacity.

In a study by Keith et al. (2008) sex differences are studied using the Woodcock – Johnson Test. Cognitive Abilities were studied for infants, adolescents, and adults (from 6 to 59 years). A structural
equation model was developed to measure sex differences in cognitive abilities and developmental changes from 6 to 59 year span. Main results shown that females showed a significant advantage on the latent processing speed, and males a consistent advantage on the comprehension – knowledge, quantitative reasoning and visual – spatial ability factors, while there were no significant differences in auditory processing, short – term processing, short – term memory, long – term retrieval, or fluid reasoning between different genders.

In an EEG study, Jausovec and Jausovec (2007) conducted three experiments to measure the differences between gender and ability, using EEG methodology. The experiment was to solve a spatial rotation task and identifying emotions in faces while performing it. The most relevant difference related to gender in brain activity terms were observed in the lower-2 alpha band. Both displayed inversed IQ-activation relation. As main conclusion, females had shown a better performance in the emotional intelligence and males in visuospatial ability. Another conclusion is that to compensate the difference of problem solving skills, they improved their level of attention.

A study by Booth et al (2006) showed the impact of personality on performance in different cognitive domains. The experiment was conducted with 398 elderly individuals. A multiple linear regression was used to look for the variance. Personality differences were found to significantly affect cognitive functions, basically the individual factor of mood it is studied on this research.

2.3 Visual Working Memory

Based on Olson, Moore, and Drowos (2008) the basic function of attention is to separate which information needs to be stored into visual memory. This information will be useful for the user in a specific period of time. Palmer (1990) developed this study making participants to visualize and record
line lengths in short periods of time and having two different conditions: the first one, the subjects were recording two cued items out of four, or two out of two items. Results showed that the attention variable was the responsible to separate which data was forming part of the visual working memory (VWM), and which not. Summarizing this study, Palmer found that distractors were not included into VWM, and also there are same effects found in VMS regarding colors, based on Jiang, Olson, and Chun (2000).

It is also known that shifting the attention to cued places can improve the information transferring into iconic memory, based on studies from Averbach and Coriell (1961), and also from Sperling (1960). An example is that a brief array of alphanumeric characters were shown to a certain group of study; the results were that arrays of four to five characters were the optimal quantity to store.

2.4 Mood as an individual factor of retention

First, the concept of mood needs to be defined. Based on Morris (1989), mood can be described as: “affective states that are capable of influencing a broad array of potential responses, many of which seem quite unrelated to the mood-precipitating event. As compared with emotions, moods are typically less intense affective states and are thought to be involved in the instigation of self-regulatory processes.”

Now, understanding that mood is a set of ideas in a period of time that influences the person to take directions or choices, it also affects the person to the attention given to a task. The attention ability is not reduced or diminished, but the subject basically is paying attention to other different issues that according to its mood are important in that window of time. Using an example, a person that has many problems could feel stressed due the quantity of unsolved issues in a frame of time. While the person is
trying to focus on solving a simple job-related task, the cognitive abilities might not be only focused in that task; it is also recalling those issues that are previously stressing him or her.

Another useful example is a person under a negative mood, which can be related to a physical or psychological pathology, or simply to a set of events that have created negative emotions to the person, could be trying to close the issues by simply eliminating it, or finishing that task. A very common and useful case in point could be a student before an exam: The retention ability and basically cognitive abilities are not reduced by the stress prior the test, but the focal point for that person could be influenced by the emotions by that time, forcing the student to lost that focus in a simple task, like solving a test. Isen (1984) makes the suggestion that the affect resultant by any event can make more accessible from memory recall events. Also in other experiments, such as Clark and Waddell (1983), mood is an important factor to decision making. In this example, three main stages of mood are defined: negative mood, no mood (neutral), or positive mood.

Trying to understand the definitions stated; a negative mood can be considered as the set of emotions or ideas that could harm a person in any physical, psychological or physiological aspect. Feelings of depression, sadness, or anger are part of this concept of negative mood.

In the other hand, it is the positive mood which is the set of ideas that could lead into a positive reaction for the subject. It could be also the case that the subject could not have any positive or negative idea. In this case, a neutral mood is defined.

Since mood is a set of ideas, this turns into a hypothetical concept, so mood cannot be measured by a numeric value; it needs to be set in categories. And the way to collect this information is based in two basic principles: self reports and behavioral measures. Self reports are commonly used in field and laboratory analysis. A practical “positive – negative” scale has been used, like in study already mentioned from Clark and Waddell (1983), or in Johnson and Tversky (1983), and Wilson et al. (1982).
Like mentioned in the concept of mood given by Morris (1989), mood should be not mistaken with emotions. An emotion could be observed as a simple stimulus given to a person that could affect the actual mood of the subject.
Chapter 3: Research Objectives

Based on the literature reviewed in chapter 2 and the problem description explained in chapter 1, and in order to understand more the memory retention ability in the search and scan activities performed in the computer related manufacturing areas the research objectives of this thesis can be summarized in the following statements:

- Understand which the amount of alphanumeric characters in a visual displayed string of nine alphanumeric characters a person can search and scan.
- Analyze if gender is related to the productivity of search and scan activities.
- Analyze if mood is related to the productivity of search and scan activities.
- Analyze if there is a relation among the two previously cited variables, gender and mood.

The input and output variables for this analysis will be explained in more detail in chapter 4. Research Methods. Also, based on the literature review, it is already known the amount of average number of digits that could be stored, yet the purpose to measure this average number is also to base the improvement or decrease in memory retention numbers found.

As also mentioned in the introduction of this thesis, this research will be taken place for Mexico population, between 18 and 30 years old, with no ophthalmologic diseases or any other visual disparity.
Chapter 4: Research Methods

4.1 Experimental Design

In this section, Independent and dependent variables will be explained and total number of variables will be set in order to define the best analysis approach required. Also the design of the experiment is defined.

4.1.1 Independent variables

Considering the research question stated in chapter 1, two personal factors will be the focal point variables that will be studied in this research:

a. Gender. Variable gender is the core variable of this study and we have two possible results for this variable which are “male” and “female”. Based in papers reviewed, gender could affect the output or dependent variables described in section 3.1.2

b. Mood. As previously studied, mood could affect the retention performance of a subject due to concentration related issues. Based on the paper reviews, mood can be summarized in three basic types: Positive, Neutral, and Negative. In this case we will have three factors.

4.1.2 Dependent variables

The dependent variable needed is the amount of characters memorized by each subject in a test performed. The output will be a numeric value from 0 to 90, understanding that 0 is the lowest value that could be achieved (only one character retained).
4.1.3 Design

For the output expected, it is necessary to find a method to measure the memory retention capacity for each person. This can be achieved performing a memory retention test. The test consists of displaying information to the user, and finding the maximum amount of information retained in a short period of time. Using a brief example, if a person can remember from seven to eight characters, he or she has more memory retention compared to a person that can only store three or four characters in the same period of time and using same type of characters (random letters and numbers).

How is related the amount of information that can be memorized and the productivity in search and scan activities? Going back to the example given in the introduction chapter of this research, the employee that can store more information would not be repeating the same search and scan activity, and this will imply an increase of productivity.

4.2 Subjects

For the research question, it is necessary to set boundaries to the source of information that is gathered. Basically, geographical, age and ophthalmologic health variables need to be controlled. And also it is needed to set the number of subjects needed to have enough statistical power in the design. The subjects will first fill an anonymous survey with information about age, gender, academic level, academic level, actual mood and occupation. After filling this survey, the participant will perform the retention test in a provided laptop (from three to five minutes). That will be all the interaction from the participant.
4.2.1 Characteristics of subjects

In order to ensure that subjects taken for this research are following the same patterns and consider that this investigation is taking samples from the same type of population, the set of requirements for the subjects that could apply for this experiment are:

a. **Actual resident of the North of Mexico.** Considering geographically as “North” the states of Chihuahua, Sonora, Baja California, Coahuila, Nuevo Leon and Tamaulipas. The reason of selecting only people living on these states is that all these states belong to the border between Mexico and the United States. It is not studied yet if there could be a difference among retention and geographic zone – culture.

b. **Ages between 18 to 30 years.**

c. **No ophthalmological diseases.** Any eye injury, glaucoma or corneal disease will affect the output of the person and it would not be related to retention and Search and scan activity time will be incremented.

Like mentioned before in this thesis, all people is gathered from a call center located in Juarez Mexico. This facility in order to hire their employees for the “call agent” position sets specific qualifications that need to be fulfilled in order to get this vacant.

One of the limitations is that all employees need to have completed their high school degree. This is needed because the nature of the job requires tasks where: computer interaction is required, verbal interaction with the client is required, and also simple troubleshooting tasks are required before escalating the issue for the customer. People with bachelor’s degree or major studies are not hired for this position, since they will be overqualified in terms of ability and also the salary is targeted to technical – assistant range.
The limitation on high school requirement for employees will help to ensure that sample data is taken from the same type of population since subjects have the same academic knowledge, based on the Mexico educational system. In this case, High School is called “Preparatoria” in Mexico, which is the last three years before going to college. In terms of overall employment the minimum academic level required to start working is Middle School.

4.2.2 Number of subjects

The number of subjects that will be necessary to perform this experiment will be based on 54 participants, 27 males and 27 females. All subjects needs to cover the characteristics described in section 3.2.1 of this chapter. As mentioned in the experimental procedure section, each set of experimentation will require six different combinations. In this case nine replicates will be generated.

4.3 Tools and Equipment to be used

This research will need the input of the user in two different ways. The first one is to fill a basic anonymously survey. This survey is described in section 3.3.2. After filling this survey, each person will perform a computer-based memory test. This test will be detailed in section 3.4.1

4.3.1 Survey instrument

As mentioned in section 3.3, a survey will be needed to collect basic personal information for the subjects performing the retention test. The information gathered will be:

Personal facts
Age  
Gender  
Place of birth

This information will be useful during the information analysis phase, and a design of experiments, we can mix those factors to see if any of these could be relevant to the numeric output that we could get, but the basic information that needs to be analyzed are gender and mood of the person performing the test. The external factors should not be considered for the first phase of the experiment, but can be recorded for further analysis or to create a secondary design of experiments mixing more variables.

4.4 Experimental Procedure and Tasks

In this segment it is shown how the experiment will be performed, using the application already proposed in previous segment. It will explain in a detailed way the purpose and structure of the application and also how the data will be gathered.

4.4.1 Experimental tasks

The basic idea for this application is to read or measure how much can a person can search and memorize a string of characters, considering the following sequence:

1. Maximum number of characters scanned in optimal time (What is the maximum number of characters or numbers that a person can read and memorize). In order to have a more close to reality example, each set of characters will follow the same type of information string that was mentioned in the example at the beginning of the document.

In a more structured way, the application will work in these steps:
a. Login window. The first stage of the application requires signing in into the application. This is used in order to have a traceability of information gathered. During the survey, a unique user id will be given to each user. The password is the same passkey for all users. As mentioned above, the purpose of this window is only to have a more structured way to maintain the results provided from each user.

b. Application. A blank window will appear with the first string, which will follow the following structure: 000000-00$ (where $ is any alphanumeric random character). The string will appear only for about three seconds and then it will disappear. After the string fades out, a question box will appear asking the user to input the exact same string that was displayed, including the dash (-). If the user types the correct string, a pop-up window will display “correct” or “incorrect” if the user typed wrong the string. The second string will have two randomized alphanumeric characters, but following the same string format: 000000-0$S, and so on. Finally, the ninth string will appear showing nine different alphanumeric characters. Each correct answer will add ten points to the final score.

c. Final score and information upload. When the user types the last string, a total window will show the sum of correct strings and it will email to a personal email account the total score with the login id, and the total time for each user.

4.4.2 Application development

One of the biggest challenges for this thesis is the development of a computer-based memory test. Different programming platforms were tried to be used, finding that flash application was the easiest and closer to the basic idea of the application.

Following the same algorithm, the application was created using the “Flash Builder demo 2.0®”. This application allows generating flash applications in an object – oriented platform. What was not
allowed (because demo version) is to calculate the random strings. In this case, an Excel worksheet was generated in order to collect a randomized run of strings.

This Excel file works in the following algorithm:

1. In one part of the sheet, all numbers and letters were numbered, as shown in table 4.1

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>A</td>
</tr>
<tr>
<td>1</td>
<td>B</td>
</tr>
<tr>
<td>2</td>
<td>C</td>
</tr>
<tr>
<td>3</td>
<td>D</td>
</tr>
<tr>
<td>4</td>
<td>E</td>
</tr>
<tr>
<td>5</td>
<td>F</td>
</tr>
<tr>
<td>6</td>
<td>G</td>
</tr>
<tr>
<td>7</td>
<td>H</td>
</tr>
<tr>
<td>8</td>
<td>I</td>
</tr>
<tr>
<td>9</td>
<td>J</td>
</tr>
<tr>
<td>10</td>
<td>K</td>
</tr>
<tr>
<td>11</td>
<td>L</td>
</tr>
<tr>
<td>12</td>
<td>M</td>
</tr>
<tr>
<td>13</td>
<td>N</td>
</tr>
<tr>
<td>14</td>
<td>O</td>
</tr>
<tr>
<td>15</td>
<td>P</td>
</tr>
<tr>
<td>16</td>
<td>Q</td>
</tr>
<tr>
<td>17</td>
<td>R</td>
</tr>
<tr>
<td>18</td>
<td>S</td>
</tr>
<tr>
<td>19</td>
<td>T</td>
</tr>
<tr>
<td>20</td>
<td>U</td>
</tr>
<tr>
<td>21</td>
<td>V</td>
</tr>
<tr>
<td>22</td>
<td>W</td>
</tr>
<tr>
<td>23</td>
<td>X</td>
</tr>
<tr>
<td>24</td>
<td>Y</td>
</tr>
<tr>
<td>25</td>
<td>Z</td>
</tr>
<tr>
<td>26</td>
<td>0</td>
</tr>
<tr>
<td>27</td>
<td>1</td>
</tr>
<tr>
<td>28</td>
<td>2</td>
</tr>
<tr>
<td>29</td>
<td>3</td>
</tr>
<tr>
<td>30</td>
<td>4</td>
</tr>
</tbody>
</table>
2. After numbering these characters, a list of random sets was generated, to be utilized, shown in table 4.2.

<table>
<thead>
<tr>
<th></th>
<th>31</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>32</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>9</td>
<td></td>
</tr>
</tbody>
</table>

Table 0-2 Random sets creator

Random sets
0.341978
0.097752 0.381755
0.765123 0.424947 0.827213
0.390094 0.88559 0.266301 0.968935
0.763032 0.221752 0.016089 0.504805 0.073067
0.376753 0.341193 0.495204 0.714617 0.50927 0.864872
0.166914 0.340852 0.272751 0.868931 0.462965 0.0965 0.533848
0.140889 0.519496 0.13609 0.778475 0.13648 0.074285 0.891296 0.537838
0.682831 0.41488 0.699851 0.064595 0.218307 0.951173 0.608675 0.053082 0.646595
0.417858 0.346113 0.350485 0.55732 0.580857 0.230045 0.404324 0.604689 0.059241 0.16857

3. After this data was generated, each number was multiplied by 35 (the last number of the table 4.1). This automatically assigns one number or letter to each number in table 4.2, translating this into Table 4.3.

Table 0-3 Sets of random characters

| Set 1 | L |
| Set 2 | D N |
| Set 3 | 0 O 2 |
| Set 4 | N 4 J 7 |
| Set 5 | 0 H A R C |
| Set 6 | N L R Z R 4 |
| Set 7 | F L J 4 Q D S |
| Set 8 | E S E 1 E C 5 S |
Finally, those numbers were called in a string – format, so the whole sets of characters are generated (Table 4.4). This procedure was used in order have a completely randomized non-dependent strings.

Table 0-4 Sets of strings, using the part number format.

|   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 1 | random | 0 | 0 | 0 | 0 | 0 | 0 | - | 0 | 0 | L |
| 2 | rand | 0 | 0 | 0 | 0 | 0 | 0 | - | 0 | D | N |
| 3 | rand | 0 | 0 | 0 | 0 | 0 | 0 | - | 0 | O | 2 |
| 4 | rand | 0 | 0 | 0 | 0 | N | - | 4 | J | 7 |
| 5 | rand | 0 | 0 | 0 | 0 | H | - | A | R | C |
| 6 | rand | 0 | 0 | N | L | R | - | Z | R | 4 |
| 7 | rand | 0 | 0 | F | L | J | 4 | - | Q | D | S |
| 8 | rand | 0 | E | S | E | 1 | E | - | C | 5 | S |
| 9 | rand | X | O | Y | C | H | 7 | - | V | B | W |

4.4.3 Data Analysis

All data generated will help to understand an average of characters that a person could store during a common search and scan activity and also the time needed for saving this amount of information. For further analysis, it is possible to use this information to start using real world scenarios and modify environmental variables such as illumination, sound, or even temperature (in a controlled room) to search if there is a difference among the previous data found.

As mentioned above in the document, the personal factors studied are gender and mood. Since the output is a number from 1 to n, we want to find if there is a difference of the two variables and the response n. And also to find the variable that has a higher n response. Having two variables, one with
two levels of variable and the second with five levels, a full factorial design of experiments will be needed to perform the analysis.
Chapter 5: Results

In this chapter, information is analyzed and summarized in order to solve the questions stated about gender and mood as relevant factors in productivity for search and scan activities oriented to computer assembly processes.

5.1 Research Results

The recruitment process took place in a call center located in Juarez, Mexico, and the way to invite people to help in this research was by placing posters in the building. Around 70 employees of that call center applied to participate in this research. This call center was an excellent recruitment place, since most of hourly employees were young adults, and every participant took place in this research by its own choice. Previous sentence is important to consider because if the recruitment was considered by the supervisor or the manager of the area, the personal mood could be affected since instead of being a personal choice, it was a task issued, and seeing as part of a responsibility. There was no retribution to participate in this research, and each subject followed the experimental tasks previously mentioned in Chapter 4 (Methodology).

5.1.1 Institutional Review Board Considerations for Human Research Subjects

Since this research implies the human psychological research, it was needed to get the revision and approval from the Institutional Review Board in order to establish that no human rights were inflicted during the research. The IRB department from the University of Texas at El Paso allowed this research, requesting data confidentiality, ensuring the safety of the participant in the research, submitting a written protocol to the board, and completing a tutorial and test from the main researcher.
The IRB proposal can be studied in detail in Appendix A (IRB research proposal). This research proposal is indeed a summary of the research for the board committee, and helps to have a general idea about the experiment and its implications for the researcher and the person who was taking part of the research. Part of the IRB package approval, also it was needed to provide an example about how the recruitment will be promoted.

The way how the invitation was provided to the possible candidates for the experimentation was posting information sheets in the call center building. An example of the information posted is in Appendix B (Recruitment Poster – English Version). General requirements are posted and the contact information from the researcher is provided. Since the audience or target group is people from the North of Mexico states, a Spanish version was posted and it is shown in Appendix C (Recruitment Poster – Spanish Version). Translated version is sharing same information about requirements and contact information.

In order to be able to post this information in the building, the Institutional Review Board requested for a written approval. This written approval was provided and included in the information package submitted for the board review.

As also previously mentioned, the confidentiality of data was an important point to review for the IRB committee. The way that we ensure that data was treated in an anonymous and safe way is that all written documents (information survey) are stored in a locked cabinet that are only available for the researcher, and the total score from the application was only linked by a “username” provided also from the researcher. The usernames provided were MX001, MX002, MX003, ... to MXnnn. In that way, the score resultant was linked to a specific user account and not by name or any other type or personal information that could relate the score to a person.
The Institutional Review Board also requests that every participant in the experiment needs to read and sign an Inform Consent Format. This format will explain to the subject the implications, purposes, and scope of the project. This Informed consent can be reviewed in Appendices section, Appendix D, Informed Consent. Again, since this consent was reviewed and signed by Spanish speaking population, Spanish – based format was created, and also available in Appendix E, Informed Consent (Spanish Version).

Once the file was read and signed, the experiment took place in an empty cubicle with only one laptop available and in normal illumination conditions (using the same illumination from the call center). No neon or any other illumination was provided around the cubicle. A brief description of the cubicle area can be described in figure 5.1. One of the benefits of the experimentation area is that the closest cubicles were empty, so there was no movement or any unusual noise that could affect the deployment of the experiment. Also not any other information or displays were affecting the user (photo frame, personal information, post-it notes).
A Hewlett-Packard laptop (model nc8430) was used for all users, using the generic display with no eye or protective film, and using the laptop keyboard and the touchpad as only input devices. Since the brightness of the display is modified if it is not connected to a power outlet, the computer was always running plugged in. The seat was a regular office seat, and the seat could be adjusted if requested by any user. In this case, the seat height was not modified.

After each subject was in the cubicle seated, the prior to test survey was applied. This survey is available in Appendix F for its review, and Spanish version in Appendix G, prior to test survey (Spanish Version).

Gender was a very obvious and straight way to catalogue the male-female variable, but since mood is more a subjective variable, was not easily to find or to target specific people with specific feelings. So a pool larger than 54 subjects was needed.

In total 66 participants were needed in order to have the nine complete replicates to have the full factorial design information. Details about total people gathered and differences among gender and mood are shown in table 4.1. From the total of subjects that were part from the test, the most difficult combination to find was gender female and mood negative. From a personal perspective, this was a result from a psychosocial variable; it is more common to mention or to be sincere in actual mood if the person that is performing the research is a relative or a close friend instead of an unknown person.

The most common mood from males and females was “positive”, and trying to finding the reason performing informal background research was due that the person was doing some kind of a “memory game”.

Table 0-1 Total people who participated in test
The descriptive statistics of the information found can be recalled from table 4.2. What is interesting from this information is the mean found from all data. If we go back to the concept that the application returned a result between 0 and 90, where each 10 points is one character correctly placed in a string of characters, we can deduct that the mean of alphanumeric characters memorized are about 4.3. This confirms that the average human can store four to five characters while performing search and scan activities (Averbach and Coriell (1961), and Sperling (1960)).

Minimum value was found only once for the levels “male” and “negative” with a response of 20 points, while the maximum value was found twice for the levels “female” and “positive” with a value of 70 points.

<table>
<thead>
<tr>
<th>Total people who participated in test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
</tr>
<tr>
<td>Positive</td>
</tr>
<tr>
<td>Neutral</td>
</tr>
<tr>
<td>Negative</td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td>Positive</td>
</tr>
<tr>
<td>Neutral</td>
</tr>
<tr>
<td>Negative</td>
</tr>
<tr>
<td>Sum</td>
</tr>
</tbody>
</table>

Table 0-2 Overall Descriptive Statistics

<table>
<thead>
<tr>
<th>Descriptive Statistics found for total Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
</tr>
<tr>
<td>Mean of data</td>
</tr>
<tr>
<td>StDev</td>
</tr>
<tr>
<td>Minimum data</td>
</tr>
<tr>
<td>Median</td>
</tr>
<tr>
<td>Maximum</td>
</tr>
</tbody>
</table>
Another way to visualize this information is creating a boxplot of overall data (Figure 4.1). In this boxplot we are just confirming the location of the mean between all data gathered and the numeric boundaries (minimum and maximum) resulting from the data gathered. Also, using the descriptive statistics from Table 4.2, the standard deviation from the data is 13.29 points.

![Boxplot of overall score](image)

Figure 0-2 Boxplot of overall score

Trying to understand if there is a relation among the gender and/or the mood, the full factorial design was analyzed using Minitab 15®. Residual plots of the total score are shown in Figure 4.2.

![Residual Plots from Total Score](image)

Figure 0-3 Residual Plots from Total Score
Going back to the design of the experiment, we already stated two factors. One factor denominated “gender” with two text-type levels which are “male” and “female”, and another factor called “mood” with three text-type levels called “positive”, “neutral”, and “negative”. The main results obtained from the full factorial analysis are summarized in table 4.3. Based on the P-value, we consider that gender was not a significant factor (P=0.097), while mood factor (P<0.05) was indeed a significant factor among the different results of the test.

Considering also an R-Sq of 0.9169 AND an R-Sq adjusted of 0.9083, we conclude that the variability of the data is explained by the variables utilized on the research. In other words, the variables and model utilized indeed explains the variability of the results obtained.

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Seq SS</th>
<th>Adj SS</th>
<th>Adj MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>1</td>
<td>46.3</td>
<td>46.3</td>
<td>46.3</td>
<td>2.85729</td>
<td>0.097</td>
</tr>
<tr>
<td>Mood</td>
<td>2</td>
<td>8470.4</td>
<td>8470.4</td>
<td>4235.2</td>
<td>261.3649</td>
<td>0</td>
</tr>
<tr>
<td>Gender * Mood</td>
<td>2</td>
<td>70.4</td>
<td>70.4</td>
<td>35.2</td>
<td>2.172281</td>
<td>0.125</td>
</tr>
<tr>
<td>Error</td>
<td>48</td>
<td>777.8</td>
<td>777.8</td>
<td>16.20417</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>53</td>
<td>9364.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

S = 4.0254 R-Sq = 91.69% R-Sq (adj) = 90.83%

The main effects are shown in Figure 4.3. As mentioned above, the factor Gender had not a significant difference between the “male” and “female” levels, but what about mood? If we consider that the mean is about 43 and the median is found in data 40 and we match this information with the Mood factor, we find that the “neutral” level is actually in that number mean.
People with negative self-described mood, got 10 less points compared to neutral subjects (1 less character memorized in the string), yet for “positive” level, we find a mean up to 60 points (six characters).

![Main Effects Plot for Total Score](image)

**Figure 0-4 Main Effects for Total Score**

### 5.2 Post hoc Analysis

Do we already know that Mood is a significant factor for the amount of information that can be stored by a person, but how much difference is between each level of the factor? The gap previously mentioned between Negative – Relax – Positive, needs to be analyzed in order to understand if there is a statistical difference among them.

Tukey’s test was chosen to measure the comparison intervals, with a 95% confidence level, and the interpretation of the results are the following:

As previously mentioned, mood is a significant factor, and as showed in table 5.4, since there is no overlapping in any of the three levels, each level is significantly different from each other.

*Table 0-4 Total Score versus Mood*
Individual 95% CIs for Mean Based on Pooled StDev

<table>
<thead>
<tr>
<th>Level</th>
<th>N</th>
<th>Mean</th>
<th>StDev</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>18</td>
<td>60.000</td>
<td>4.851</td>
</tr>
<tr>
<td>Neutral</td>
<td>18</td>
<td>39.444</td>
<td>4.162</td>
</tr>
<tr>
<td>Negative</td>
<td>18</td>
<td>30.000</td>
<td>3.430</td>
</tr>
</tbody>
</table>

Pooled StDev = 4.188

Now, comparing each level we deduce that the mean from each level is significantly different. We have the negative level, with a mean of 30 and a standard deviation around 3.4. This means that an average amount of characters that can be stored under a negative mood are between 2.7 and 3.3. In the Neutral level, an average person can store from 3.5 to 4.4 characters, with a mean of 3.9 characters. This gap is very close, but it is not statistically in the same range. And the positive mood which is around 5.5 to 6.5 characters with a mean of 6 characters.

Table 0-5 Tukey’s 95% Simultaneous Confidence Intervals for Mood Factor

<table>
<thead>
<tr>
<th>Mood</th>
<th>Lower</th>
<th>Center</th>
<th>Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutral</td>
<td>-23.922</td>
<td>-20.556</td>
<td>-17.190</td>
</tr>
<tr>
<td>Negative</td>
<td>-33.366</td>
<td>-30.000</td>
<td>-26.634</td>
</tr>
</tbody>
</table>

We can summarize the difference between three levels in Table 5.6. As shown, the negative level has an impact for about fifty percent less retention ability compared to positive level. In the following chapter, the conclusions and recommendations will be based on the assumptions found in this chapter.
<table>
<thead>
<tr>
<th>Mood</th>
<th>Mean</th>
<th>Difference from major</th>
<th>Percentage of retention decrease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>6.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>Neutral</td>
<td>3.94</td>
<td>2.06</td>
<td>34%</td>
</tr>
<tr>
<td>Negative</td>
<td>3.00</td>
<td>3.00</td>
<td>50%</td>
</tr>
</tbody>
</table>
Chapter 6: Conclusions

Based on the data analyzed, we can conclude that young adults from the North of Mexico states productivity in search and scan activities are related to the actual mood from the employee, and gender showed no significant difference among the number of characters that can be stored. The average amount of characters that can be store are four alphanumeric characters. Also as mentioned in the post analysis section, the three levels of mood are significantly different between them, considering the positive level with the highest score found.

6.1 How this result matches with the literature reviewed at the beginning of this project?

In the literature review for the thesis, several papers were related to cognitive ability and individual factors. This information is summarized in table 6.1. Basically, in terms of mental workload and specifically for mental overload, three papers were studied [ Miller (1960), Lysaght et al. (1989), Moray (1988), and Sperling (1960)], and the relationship found with the results of this thesis is that indeed the productivity of search and scan activities are directly affected by the mental workload, in this case measure by the short – term memory cognitive ability.

For gender differences, studies from Chang et al. (2009), Olsen et al. (2009), Keith et al. (2008), Jausovec and Jausovec (2007) explains about the possible differences related to gender in terms of visual memory and rotation memory.
For the mood factor, papers from Booth et al. (2006), Clark and Waddell (1983), Johnson and Tversky (1983) and from Wison et al. (1982), mood is proposed as a relative factor in cognitive abilities and the Positive – Negative mood scale is presented.

<table>
<thead>
<tr>
<th>#</th>
<th>Reference</th>
<th>Principal contribution</th>
<th>Relationship with thesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Miller (1960)</td>
<td>Different self-protective mechanisms</td>
<td>Observed error processing when more complex random character strings were shown to the user</td>
</tr>
<tr>
<td>2</td>
<td>Lysaght et al. (1989)</td>
<td>System degradation due to mental overload.</td>
<td>Also related to Miller (1960), the task is degraded due the system complexity in terms of mental retention ability</td>
</tr>
<tr>
<td>3</td>
<td>Moray (1988)</td>
<td>Optimization of mental workload quota for improving efficiency</td>
<td>Retention ability directly related as a process improvement variable</td>
</tr>
<tr>
<td>4</td>
<td>Chang et al. (2009)</td>
<td>Visual codes and working memory, a gender approach</td>
<td>Research showing differences in gender in visual coding ability.</td>
</tr>
<tr>
<td>5</td>
<td>Liu et al., (2009)</td>
<td>Scanning multiple dynamic objects (iconic). Optimal quantity of objects is from three to four objects.</td>
<td>Mean observed for scan and retain alphanumeric characters: 4.3 characters</td>
</tr>
<tr>
<td>10</td>
<td>Keith et al., (2008)</td>
<td>Sex differences among short - term memory processing</td>
<td>Same resultant from this research</td>
</tr>
<tr>
<td>11</td>
<td>Jausovec and Jausovec (2007)</td>
<td>Gender differences are compensated improving the level of attention in the task</td>
<td>From background research (personal research observation), Females answered faster the test.</td>
</tr>
<tr>
<td>12</td>
<td>Booth et al (2006)</td>
<td>Impact of personality on performance in different cognitive domains.</td>
<td>In this research, mood is a significant factor that modifies the retention ability.</td>
</tr>
</tbody>
</table>
Sperling (1960) iconic memory ability, arrays of characters shown to certain group of study, arrays of four to five characters are the optimal answer. Same resultant from this research.

Clark and Waddell (1983) Johnson and Tversky (1983) Mood scale divided in three areas Mood was catalogued using same structure, three main mood levels, positive, neutral and negative.

6.2 How this result could help to improve the productivity in the search and scan activities in assembly plants?

As previously mentioned in the beginning of this thesis, process improvement and optimization is the key to competitiveness in a global oriented market, and we could take advantage of these individual findings in order to have a more productive area. Mood is not an easy to control variable, since it is a subjective matter, but in most of the cases, is part of the manager and / or supervisors to maintain a good climate in the work area, in psychosocial terms. In this research, alphanumeric characters were used as an example of how retention ability can be modified due to the actual mood, but what about other psychological – related tasks that we commonly perform every day?

In section 6.4 it will be explained in more detail about the informal findings during the experimentation phase, but one issue that can be addressed for further research, is to understand the relationship between mood and the ability to focus in one activity in a period of time.

Also, considering the findings that the average person could store from four to five digits, this could be helpful during the design of search and scan activities, for example in database search codes or boxes; it would be easier for the user to remember four digits blocks instead of trying to remember more digits and loosing time repeating the search and scan task.

6.3 Wrapping up results and research objectives.
The research questions were primarily if there is a relation between gender and mood in terms of retention ability. As discussed in previous chapter, there is a relation between moods, but not for gender, neither the interaction of these two variables. Mood factor appears the same way in both male and female variables. In the example given of the part number, since this is a fixed nomenclature for the part number description (six characters, dash, three characters), the recommendation will be that the calculation for capacity should be based dividing the total amount of characters that the person needs to memorize, in sets of 4.5 characters, to have a more close to reality calculation capacity.

For instance, if a person is testing only one unit, according to the research the operator will need to perform the search and scan activity two times (ten characters in the part number string, if we consider the dash as a bit of information). So if the person has around eight different part numbers, he or she would need to type about 80 alphanumeric characters, so it can be counted as twenty search and scan activities.

Also, in order to optimize the search and scan activities, we already found that mood has a considerable and significant effect on this ability. There are already different ways to measure the psychosocial well-being inside a company, and several companies started to have activities in order to improve this metric.

6.4 Background findings during the experimentation phase.

While applying the surveys and performing the test for the subjects that applied for this research, we found that while trying to complete the replicates for the Design of Experiments, the mood with the
lowest amount of candidates was the “negative” level. In the personal experience, this does not necessarily reflects that the working environmental is in good shape; obviously people with non-optimistic attitudes will be less interested on performing a test.

Also, it was interesting that people who stated a negative mood level, was not paying the same amount of attention to the test, compared to neutral and positive mood. This could imply the introduction of the “focus” cognitive ability. It seems like while people with positive attitude were easier to pay full attention to the test, people with negative mood were trying to pay attention, but at the same time, it was much easier to lose a string of characters.

For further research, one interesting finding was the time to complete the test. There could be a difference in the total time of the test completion and also a relation between the time and the score. Also gender and mood could affect the amount of time spent to recall this information. Also, what can be useful for future investigation is the mood effect prior and after the test, this in order to identify if there is any change in the mood scale during the test, in this case, if the test could be an effect on the mood.
Bibliography


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Appendix
Research Proposal

I. **Title.** Retention and Productivity in Industrial Search and Scan Tasks

II. **Investigators (co-investigators).** Camilo Aguilera

III. **Hypothesis, Research Questions, or Goals of the Project.**

The research question is: Is retention related to improve or diminish productivity in search and scan tasks based on gender and mood as individual factors of young adults in the North of Mexico area?

IV. **Background and Significance:**

Computerization in manufacturing has resulted in significant visual display unit (VDU) activities. Operators now interact significantly with computers. This has led to significant scan and search activities, compared to physical tasks. Therefore, changes in the way that workers perform their daily activities, like the case of computer-interaction tasks, such as typing information during manufacturing tests, checking process information, and updating or uploading information in databases. For computerized tasks, different factors may be involved in the decrease of worker productivity.

Low cost countries production settings require to interact with visual applications and a good example is the Mexico – United States border area. People from all over the country is working in manufacturing facilities, and most of these employees have only performed physical tasks and in some cases, these employees have never used a computer or performed scan and search activities as part of common tasks. To bring a good example of these types of activities, we can use the following scenario:

After the assembly of computers, servers or laptops, commonly in the manufacturing facility it is required to perform tests or diagnostics to check the final assembly overall functionality. This type of diagnostic tests not only installed components, but will also include input devices and video tests. To ensure the proper functionality of a computer, one test is performed which will require the production operator to input some of the following data:
- Employee badge number (the operator can memorize the badge number, or search for it in the employee badge)
- Serial number of the product (typing the unique serial number of the product)
- Part number (in most cases, the part number refers to the model or family of the product).
- Input test (the diagnostic tool will ask the user to input a series of keystrokes to check the proper functionality of the keyboard, to click left/right or to move the mouse, or use any other input device installed in the product).
- Video test (in this phase of the test, a series of colors will be shown to the operator to check the video display)

This could look like a very simple function of the operator, and he or she can complete the test without any problem, but what about if instead of checking one computer at the same time, we add two, three or more computers requiring this information at the same time?

Part of the question for this research comes from a real world scenario. For cost-reduction strategies, one important company is moving its manufacturing operations to low cost Countries looking for particularly one thing: the costs reduction in terms of manufacturing headcount and facilities, but keeping or improving the output quantity and quality, so during the lines transition, some operations are improved and adapted to the new facilities. Brought up from a real situation, two plants were moved from one city in the United States to Juarez, Mexico and the other facility to Shanghai, China. One process which is part of this line is the testing procedure which is very similar to the task described above. In the United States, there was one operator for each computer performing this test, but since these companies wanted to minimize headcount, supervisors started to assign one, two or even up to eight computers per operator.

From the basic standpoint, in terms basic capacity analysis, the user is able to perform up to eight computers at the same time, since each activity has some delays during the test, allowing the operator to use those gaps testing another unit. But after several minutes of performing these tests, it has been observed that the operator start decreasing the speed of reaction between the different units, especially when the user tries to type different part numbers memorized and start searching for part numbers in information sheets or Work instructions. These part numbers varies between six and nine alphanumeric characters, and are relatively similar, for example 123456-111, 234561-111, and so on.

It is not mandatory to memorize each part number, and actually the part number is printed in the computer itself, and each workstation have visual aids to identify part numbers, but for productivity purposes, instead of looking in each unit or looking at the visual aid, the operator tries to memorize each number, making reference on the unit shape, or physical attributes. And also, with the help of the barcode readers, the part number it printed in barcode also in the unit, yet some users still finds easier to type the part number, due to label location.

This raises the main question for this research which is: What is the relationship between retention and productivity?

Also it is known that decrease in search and scan productivity is caused by the following variables:
- Environmental aspects like temperature, auditory and visual distraction;
- Physical (posture, etc.), machine (conditions of the computer or machine), and
- Psychosocial or individual factors (gender, age, situational factors).

Using these different factors, individual factors are directly related to retention ability (working memory), so creating a more complex and defined question for this research previously cited in part III of this proposal:

Is retention related to improve or diminish productivity in search and scan tasks based on gender and mood as individual factors of young adults in the North of Mexico area?

V. Research Method, Design, and Proposed Statistical Analysis:

Approximately 100 participants will be enrolling in this study at one call customer center facility. A full factorial design of experiments will be utilized to analyze data obtained. Two factors will be considered:

- Gender. Two variables, male and female.
- Mood. Three variables which are positive (attitudes such as content, happy), relax, and pessimistic (sad, stressed, nervous, depressed).

These factors will be mixed to find the optimal maximum output (the output will be the total of characters remembered by each person). Minitab 15® student version will be utilized for the analysis of information.

VI. Human Subject Interactions

A. Sources of potential participants:
This experimentation will take place in a call center located in Juarez, Mexico. The Human Resources personnel has already granted written permit to perform this research with the conditions that the company name or logos should not be included in any part of the research and that employees could attend this experimentation only with the approval of the manager or supervisor in charge.

Information posters will be placed in the building to collect people who could help during the research, and who fulfills the requirements stated below. If the person matches with the requirements, it will contact the researcher by personal email.

The first step is to provide and get the signature of the informed consent from the subject. After the informed consent is signed, the survey sheet will be filled and it will take a basic training explaining the basic concept of the experiment. The user will run the experimental application in a laptop provided by the researcher in the same facility, in one specific cubicle provided also by the researcher. The user will input the information requested using the keyboard from the laptop, and the screen used will be the same from the laptop screen.
Finally the user will perform the test and it will include the score obtained in the application in the same survey sheet. This survey is anonymous and should not content any name, last name, or any other variable that could easily match the user with the result of the survey; this is in order to protect the confidence of the person who is helping during the experimentation.

The set of requirements for the subjects that could apply for this experiment are:

d. **Actual resident of the North of Mexico.** Considering geographically as “North” the states of Chihuahua, Sonora, Baja California, Coahuila, Nuevo Leon and Tamaulipas. The reason of selecting only people living on these states is that all these states belong to the border between Mexico and the United States. It is not studied yet if there could be a difference among retention and geographic zone – culture.

e. **Ages between 18 to 30 years.**

f. **No ophthalmological diseases.** Any eye injury, glaucoma or corneal disease will affect the output of the person and it would not be related to retention and Search and scan activity time will be incremented.

C. **Procedure for obtaining informed consent.**

A written informed consent will be printed and signed by each participant.

D. **Research Protocol.**

As mentioned above, a survey will be needed to collect basic personal information for the subjects performing the retention test. The information gathered will be:

- **Personal facts**
  - Age
  - Gender
  - Actual mood
  - Place of birth

- **External facts**
  - Time of the test

This information will be useful during the information analysis phase, and a design of experiments, we can mix those factors to see if any of these could be relevant to the numeric output that we could get, but the basic information that needs to be analyzed are GENDER and mood of the person performing
the test. The external factors should not be considered for the first phase of the experiment, but can be recorded for further analysis or to create a secondary design of experiments mixing more variables.

Experimental Procedure and Tasks

The basic idea for this application is to read or measure how much can a person can search and memorize a string of characters, considering the following sequence:

2. Maximum number of characters scanned in optimal time (What is the maximum number of characters or numbers that a person can read and memorize).

In a more structured way, the application will work in the following basis. Nine sets of strings will be shown to the user, each one will appear only for three seconds and it will request to the user to type the information that appeared.

Each string will have also 9 characters following the same structure: six alphanumeric characters followed by a dash ‘-’ and three more alphanumeric random characters. The initial set will look like the following: 000000-000.

In the first set, the first character from right to left will be replaced for a random alphanumeric character (in example. 000000-00A). The second set of characters will have two different and independent characters (000000-0AZ), and so on, until we finally have the ninth set of characters that all zeros will be replaced by random characters (A1B2C3-D4E).

For all strings that are correctly remembered will add 10 points to the total score for the user, so the total points could be in the range from 0 to 90 points.

E. Privacy and confidentiality of participants

All information gathered is confidential. Not any information has to identify any name of the research team. All records will be stored in a locked file.

G. Research Resources.

Only one computer is needed to perform this test (personal computer used), and a printed survey.

VII. Potential risks.
Not any potential or minimum risk is related to this research.

VIII. Potential benefits.
There will be no direct benefits to you for taking part in this study. This research could help to understand if there is a relationship between gender and mood and the productivity in search and scan common tasks due to retention ability.

Reference list:

Want to be part of an experiment to identify your retention ability?

• This will take only for about 3 to 5 minutes and your participation is voluntary.
• Requirements:
  – Being born in any of the following states: Chihuahua, Baja California, Coahuila, Nuevo Leon or Tamaulipas
  – From 18 to 30 years old
  – Not any visual pathology (any disease that is already affecting you in your visual ability)

• For more information, please contact Camilo Aguilera at 656.215.1365 or send an email to Camilo.Aguilera@hp.com

(Investigation from the University of Texas at El Paso (UTEP) and the Engineering Graduate Department. There is no relation between this or any other affiliated company.)
¿Quieres formar parte de un experimento para identificar tu habilidad de retención?

• Sólo tomará de 3 a 5 minutos y tu participación es voluntaria.
• Requisitos:
  – Haber nacido en cualquiera de los siguientes Estados: Chihuahua, Baja California, Coahuila, Nuevo León ó Tamaulipas
  – Tener de 18 a 30 años de edad
  – No tener alguna enfermedad patológica (cataratas, heridas recientes en los ojos que puedan afectar tu visión)

• Para más información contacta a Camilo Aguilera a el número 656.215.1365 o envía un correo a Camilo.Aguilera@hp.com

(Investigación llevada a cabo por la Universidad de Texas en El Paso (UTEP) y el colegio de posgrado de Ingeniería Industrial. No existe relación alguna con cualquier otra compañía o cualquiera de sus afiliados)
1. Introduction

You are being asked to take part voluntarily in the research project described below. Please take your time making a decision and feel free to discuss it with your friends and family. Before agreeing to take part in this research study, it is important that you read the consent form that describes the study. Please ask the study researcher or the study staff to explain any words or information that you do not clearly understand.

2. Why is this study being done?

You have been asked to take part in a research study of the effects of gender and mood in performing search and scan activities.

Approximately 100 participants will be enrolling in this study at one customer service facility located in Juarez, Mexico.
You are being asked to be in the study because you have Mexican nationality between 18 to 30 years old and freely decided to take this survey and test.

If you decide to enroll in this study, your involvement will last about three to five minutes.

3. What is involved in the study?

If you agree to take part in this study, the first part that is needed to be signed from your part is this consent format in a paper-based format. After signing this document, a blank sheet will be given, asking specifically for your Sex, Age, Place of birth, and your actual mood.

The mood is based in three types. The first type is Positive, that includes moods such as Happy, Optimistic, or generally, having positive thoughts. Second type is neutral; neutral state can be described as relax or not having a specific mood at the moment of filling this survey. Finally, the third state is Pessimistic which includes angry, sad, depressive, or any mood that could be considered as a negative feeling to the human.

After filling the survey, you will be prompted to perform a computer test. This computer test is a flash application that it will count the total amount of characters that you can store in a nine-string alphanumeric character set. If desired, a tutorial can be shown to explain in a more graphical way how to solve this test.

The methodology of the application is the following:

A login window will appear with two empty boxes (Nickname and Password). The Nickname field will be provided by the researcher and the Password is the set “car123 “for all nicknames.

After clicking in the “submit” button, the application will start showing the first set of characters. All sets are groups of nine alphanumeric characters; six characters followed by a dash and three more characters. (This format is used in order to get closer to the real scenario manufacturing applications). An example is the following: 000000-000.

In order to set difficulty for the test, the zeros (0) will be replaced from right to left with any alphanumeric randomized character. In each string, one character will be added from the total of the nine characters.

Example of character strings:

Set 1 – 000000-00A
Set 2 - 000000-01B
Set 3 – 000000-13E
Set 9 – A456F3-NX1

Each set will be shown for about three seconds and then a blank fill box will appear with the legend “Which characters were shown?” Asking you to type exactly the same character string (including the dash), there is no time limit for the user to input this information.

After clicking the blue button, a dialog box will appear showing “Correct” or “Incorrect” as appropriate.

At the end of the application, the total score will be shown which will be measured from 0 to 100. Each correct set of strings will give 10 points for total score.

4. What are the risks and discomforts of the study?

There are no known risks associated with this research

5. What will happen if I am injured in this study?

The University of Texas at El Paso and its affiliates do not offer to pay for or cover the cost of medical treatment for research related illness or injury. No funds have been set aside to pay or reimburse you in the event of such injury or illness. You will not give up any of your legal rights by signing this consent form. You should report any such injury to Camilo Aguilera at (+521.656.215.1365) or caguilera6@miners.utep.edu and to the UTEP Institutional Review Board (IRB) at (915-747-8841) or irb.orsp@utep.edu.

6. Are there benefits to taking part in this study?

There will be no direct benefits to you for taking part in this study. This research could help to understand if there is a relationship between gender and mood and the productivity in search and scan common tasks due to retention ability.

7. What other options are there?
You have the option not to take part in this study. There will be no penalties involved if you choose not to take part in this study.

8. Who is paying for this study?

Internal Funding:
Funding for this study is provided by UTEP Department of Industrial Engineering

9. What are my costs?

There are no direct costs. You will be responsible for travel to and from the research site and any other incidental expenses.

10. Will I be paid to participate in this study?

You will not be paid for taking part in this research study
11. What if I want to withdraw or am asked to withdraw from this study?

Taking part in this study is voluntary. You have the right to choose not to take part in this study. If you do not take part in the study, there will be no penalty.

If you choose to take part, you have the right to stop at any time. However, we encourage you to talk to a member of the research group so that they know why you are leaving the study. If there are any new findings during the study that may affect whether you want to continue to take part, you will be told about them.

The researcher may decide to stop your participation without your permission, if he or she thinks that being in the study may cause you harm, or any other reason that could affect the regular development of this test.

12. Who do I call if I have questions or problems?

You may ask any questions you have now. If you have questions later, you may call Camilo Aguilera at (+521.656.215.1365) or send an email to caguilera6@miners.utep.edu.

If you have questions or concerns about your participation as a research subject, please contact the UTEP Institutional Review Board (IRB) at (915-747-8841) or irb.orsp@utep.edu.

13. What about confidentiality?

Your part in this study is confidential. None of the information will identify you by name. All records will be stored in a locked file, and in any time it is prohibited to write up names or any reference in the survey or the test that could be used to match the test with any subject.
14. Mandatory reporting

This research cannot be applied to people under 18 years old.

15. Authorization Statement

I have read each page of this paper about the study (or it was read to me). I know that being in this study is voluntary and I choose to be in this study. I know I can stop being in this study without penalty. I will get a copy of this consent form now and can get information on results of the study later if I wish.

Participant Name: ___________________________ Date: ________________

Participant Signature: ___________________________ Time: ________________

Consent form explained/witnessed by:

Signature: ___________________________

Printed name: ___________________________

Date: ________________ Time: ________________
Universidad de Texas en El Paso (UTEP) Institutional Review Board
Formato de Consentimiento Para Investigación con Seres Humanos

Título del Protocolo: RETENCIÓN Y PRODUCTIVIDAD EN TAREAS DE LOCALIZACIÓN Y BÚSQUEDA.
Investigador Principal: Camilo Aguilera
UTEP College of Engineering

1. Introducción

Se le ha solicitado participar voluntariamente en el proyecto de investigación descrito posteriormente en este documento. Por favor tome su tiempo para tomar la decisión de participar y síntase libremente de discutir su decisión de participación con familiares y amigos. Antes de confirmar su participación en esta investigación, es importante que lea este formato de consentimiento que describe su interacción con el proyecto. Por favor pregunte al investigador o al staff cualquier palabra o información que no entienda claramente.

2. ¿Para qué se está desarrollando esta investigación?

Se le ha invitado a participar en un estudio de los efectos de género y estado de humor en el desempeño de actividades de localización y búsqueda.
Aproximadamente 100 participantes se van a solicitar en este estudio en tres plantas manufactureras y un centro de servicio al cliente.

Se le ha pedido que participe en este estudio porque cumple con los requisitos de nacionalidad Mexicana, tener entre 18 y 30 años de edad, y libremente ha tomado la decisión de participar tanto en la encuesta y en la prueba.

Si decide tomar el estudio, le tomará solamente una sesión de tres a cinco minutos para completar el estudio.

3. ¿Qué está involucrado en este estudio?

Si decide participar en este estudio, la primer parte requiere que usted firme este formato de consentimiento en hojas impresa. Después de firmar este documento, se le entregará otro formato en blanco, donde se le pide su Sexo, Edad, Lugar de nacimiento y estado de humor actual.

El estado de humor consta de tres géneros básicos. El primer tipo es Positivo; dicho tipo incluye sentimientos tales como felicidad, optimismo, o generalmente, teniendo pensamientos positivos. El segundo tipo es el neutral; dicho estado puede describirse tal como relajado, o no teniendo inclinación a algún sentimiento en este momento en particular. Finalmente, el tercer estado es Pesimista, el cual incluye sentimientos tales como enojo, tristeza, depresión, o cualquier emoción que pueda ser considerada como negativa para el ser humano.

Después de llenar esta encuesta, se le pedirá que realice una prueba de computadora. Dicha prueba es una aplicación que contará el total de caracteres que puede memorizar en una serie de nueve caracteres alfanuméricos. Si lo desea, se le puede mostrar un tutorial el cual explica el desarrollo de esta misma prueba en una manera más grafica.

La metodología de esta aplicación es la siguiente:
1. Una ventana de login aparecerá con dos cuadros vacíos (Nickname y Password). El campo de Nickname será provisto por el investigador y el password será llenado con los siguientes caracteres “car123” para todos los usuarios.

2. Después de dar clic en el botón “submit”, la aplicación iniciara mostrando el primer set de caracteres. Todos los sets son grupos de nueve caracteres alfanuméricos; seis caracteres seguidos de un guion (-), y tres más caracteres alfanuméricos. (Este formato es usado para poder generar una experimentación más cercana a ejemplos de manufactura). Un ejemplo es el siguiente: 000000-000.

3. Para poder asignar un nivel de dificultad para esta prueba, los ceros (0) serán reemplazados de derecha a izquierda con cualquier numero aleatorio alfanumérico. En cada cadena, un carácter será añadido a la serie total de caracteres.

Ejemplo de cadenas de caracteres:
- Set 1 – 000000-00A
- Set 2 – 000000-01B
- Set 3 – 000000-13E
- ...
- Set 9 – A456F3-NX1

4. Cada set se mostrara por un total de tres segundos y después un campo vacio aparecerá con la leyenda “¿Qué caracteres aparecieron?” Pidiendo que teclé la cadena tal cual y apareció (incluyendo el guión). No hay tiempo límite para teclar dicha información.

5. Después de dar clic en el botón azul, una ventana de dialogo le mostrará si la información que teclé es correcta o incorrecta.

6. Al final de la aplicación, la calificación total se mostrará, la cual se medirá de 0 a 100. Cada set correcto le acumulará 10 puntos de la puntuación total.

4. ¿Qué riesgos e inconvenientes pueden surgir durante la investigación?

No hay riesgos asociados con este proyecto.
5. ¿Qué ocurre si me accidento durante el desarrollo de esta investigación?

La Universidad de Texas en El Paso y sus afiliados no ofrecen remuneración alguna para cubrir algún costo por tratamiento médico o daño. No existe un fondo o reembolso en el evento de algún accidente. Al firmar este formato de consentimiento, se considera como enterado de dicha política. En el caso de algún accidente, favor de notificar a Camilo Aguilera a el número (+521.656.215.1365) ó bien a el correo caguilera6@miners.utep.edu y al Institutional Review Board de UTEP a el número (915-747-8841) ó dirección electrónica irb.orsp@utep.edu.

6. ¿Existen beneficios por formar parte en esta investigación?

No existe algún beneficio directo para usted si decide tomar parte en esta investigación. Este proyecto pudiera ayudar a entender una posible relación entre la diferencia de sexo y estado de ánimo con la productividad o nivel de retención de información en tareas de localización y búsqueda.

7. ¿Qué otra opción existe?

Tiene la opción de no tomar parte en el estudio. No existe alguna penalización por no tomar parte en este estudio.

8. ¿Quién está pagando por este estudio?

Fondo Interno:
Cualquier cargo que se pudiera generar en este estudio, es cubierto por el Departamento de Ingeniería Industrial de UTEP.
9. ¿Cuáles son mis costos?

No existen costos directos. Usted será responsable por su transportación al centro donde se esté desarrollando la investigación y cualquier otro gasto no programado.

10. ¿Tendré alguna remuneración?

Usted no recibirá remuneración alguna por tomar parte en este estudio.

11. ¿Qué ocurre si decidido retirarme durante la investigación?

Tomar parte en este estudio es voluntario. Usted tiene el derecho de no participar. Si esta es su decisión, no existirá penalización alguna.

Si decide participar, tiene el derecho de detenerse en cualquier momento que lo decida. Sin embargo, se le invita a hablar con cualquier miembro perteneciente al equipo de investigación, para que se conozcan las razones de por qué decisión dejar la investigación. Si existe cualquier nueva información durante el estudio que pudiera afectar su decisión de continuar en el proyecto, se le será informado inmediatamente.

El investigador puede decidir detener su participación con o sin su aprobación, si él o ella consideran que participar en este estudio pudiera ocasionarle algún daño, o cualquier otra razón que pudiera afectar el desarrollo regular de esta prueba.

12. ¿Con quién me comento si tengo algún problema?

Puede realizar cualquier pregunta en este momento. Si tiene alguna duda durante la prueba, puede llamar a Camilo Aguilera al número de teléfono (+521.656.215.1365) o enviar un correo
Si tiene alguna pregunta o preocupación referente a su participación como sujeto de experimentación, por favor contacte el departamento de Institutional Review Board (IRB) de la Universidad de Texas en El Paso a el número (915-747-8841) o a el correo electrónico irb.orsp@utep.edu.

**13. ¿Qué hay en referencia de la confidencialidad de mis datos?**

Toda la información que sea recolectada durante la investigación será anónima y confidencial. Ninguna de la información se le identificará por su nombre o identidad alguna. Todos los records serán recolectados y almacenados en algún lugar seguro y bajo llave, y en cualquier momento es prohibido escribir nombres o cualquier información que lo pueda vincular a usted directamente en la prueba o durante la misma.

**14. Reporte Mandatorio**

Esta investigación no se puede aplicar a menores de 18 años.

**15. Autorización**

He leído cada página en este documento referente al estudio previamente mencionado (o se me fue leído). Sé que es una decisión voluntaria participar en este estudio y he decidido tomar parte en este estudio por mi cuenta. También tengo conocimiento de que puedo detener este estudio en cualquier momento sin penalización alguna. Puedo obtener una copia de esta carta de consentimiento en cualquier momento y solicitar información de los resultados de la investigación si lo deseo.

Nombre del Participante: ___________________________ Fecha: ___________________________
Firma del Participante: ___________________________ Hora: ____________

Testigo de firma de Formato de consentimiento:
______________________________

Nombre Impreso: ___________________________

Hora: ____________ Fecha: ______________
Appendix F. Prior To Test Survey

Read the following before starting the application!

Please be sure that you already read and signed the informed consent format. All data obtained is confidential and any information provided should not be directly linked to any personal information.

Please provide the username provided by the researcher: ______________

Gender ☐ Male ☐ Female

Age ________ years.

Place of birth (City, State, Country)
____________________________________________________

How can you describe your actual mood?

☐ Happy, Optimistic, Positive.

☐ Neutral.

☐ With problems, worried, stressed, angry, sad.

Please, start the memory test and write down the total score achieved.

Final Score: _______ points.
Appendix G. Prior To Test Survey (Spanish Version)

¡Lea lo siguiente antes de realizar la prueba!

Por favor asegúrese de haber leído y firmado el formato de consentimiento de información. Todos los datos obtenidos son confidenciales y en ningún momento deberá ser ligado directamente a su nombre o apellidos.

Escriba el número de usuario asignado por el investigador: ______________

Sexo  □ Hombre  □ Mujer

Edad  ______ años.

Lugar de nacimiento (Ciudad, Estado, País).

¿Cómo puede catalogar su estado de ánimo actual?

□ Alegre, optimista, contento.

□ Neutral.

□ Con problemas, demasiadas preocupaciones, tenso, enojado / molesto, pesimista.

Por favor, inicie la prueba de memoria, y escriba al final el total de puntos obtenidos.

Resultado final de la prueba: _______ puntos.
Curriculum Vita

Camilo Aguilera was born in Ciudad Juarez, in the state of Chihuahua, Mexico. At his 21 years, he got his bachelors degree of Industrial Engineering from the University of Juarez (Universidad Autonoma de Ciudad Juarez), presenting a thesis based in Ergonomics improvements measured by superficial EMG. Working in the manufacturing and assembly industry since its 18 years, Camilo had the chance to work in multi-cultural companies starting as quality technician, production supervisor, training coordinator, and actually, he works for Hewlett-Packard as New Product Introduction coordinator for suppliers located in Juarez, Mexico.

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