Computer program in the treatment for major depression and cognitive impairment in university students

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Abstract

Introduction: A depressed patient presents cognitive impairment that remains in spite of depression’s remission. This study intends to evaluate the impact of cognitive training in the treatment of depression, and also of the impairment that depression causes.

Method: A program for cognitive training (Alcor) was designed for and applied to a group of patients (n = 10) with non-medicated MDD; a group (N = 10) with MDD that was treated with the program and with anti-depressants, and to another group (n = 11) that was given anti-depressors only. The impact of this intervention was assessed by applying the following instruments: Beck Depression Inventory, WAIS, Spielberger State-Trait Anxiety Inventory, Externalized Problems Assessment Scale for Adolescents and Young Adults, and Attention Problems Assessment Scale. The program was applied to University students with MDD twice a week, until they had reached adequate levels of execution.

Results: The patients of all three groups showed MDD event remission. Those who received cognitive training showed a substantial increase of intellectual performance. The cognitive treatment group increased IQ in 12.9 units and the combined group increase in 13.3 units. There was a slight decrease of 1.9 units within the anti-depressant treatment group. The changes in attention and in externalized problems showed the same trends.

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1. Introduction

This study makes a proposal to improve cognitive functioning in subjects with Major Depression Disorder (MDD), through a cognitive treatment assisted by a software designed and developed for this purpose.

In Mexico, depression has a prevalence of 7.9% in general population (Secretaría de Salud, 2003), and in university students it increases up to 11.8% (Manelic & Ortega-Soto, 1995).

Patients with major depression disorder (MDD) show cognitive deficits (Austin, Mitch-ell, & Goodwin, 2001; Austin et al., 1992), for instance, failures in executive functions such as cognitive flexibility, problem solving (Merriam, Thase, Haas, Keshavan, & Sweeney, 1999; Paelecke-Habermann, Pohl, & Leplow, 2005), psychomotor speed (Sobin & Sack-eim, 1997), deficits in domains in memory (Marcos, Salamero, Gutiérrez, Catalán, & Lázaro, 1994; Weiland-Fiedler et al., 2004), and deficits in domain of attention (Marcos et al., 1994; Weiland-Fiedler et al., 2004). As a consequence of these failures, depression also causes disabilities in cognitive functioning which will then lead patients to show social, working performance, academic and intellectual impairment. Massel et al. (1990) evaluated work efficiency in 600 subjects with mental disorders and found that there was a significant relationship between the severity of psychiatric symptoms and productivity. Among depressed patients, psychomotor retardation was the most important factor in work reduction. Mintz, Mintz, Arruda, and Hwang (1992) evaluated the effects of anti-depressants and psychotherapy on work impairment in depressed patients. Original databases from 10 published treatment studies were compiled and analyzed (N = 827). Functional work impairment was common at baseline, manifested by unemployment (11%) or on-the-job performance problems (absenteeism, decreased productivity, interpersonal problems, 44%), only 55% fulfilled the criteria required to go back to work after treatment. According to the Global Burden Disease Study (GBD), MDD ranks fourth as a cause for loss of years due to work disability; in the projection towards 2020 it is considered as the second cause (Murray & Lopez, 1996; Murray & López, 1997a, 1997b).

Academic deterioration is evidenced mainly in absenteeism, low academic performance, bad interpersonal relationships and wrong perception of academic competence. Rapport, Denney, Chung, and Hustace (2001) presented a lineal structural model which co-relates children’s school performance with anxiety and depression. They used intellectual quotient as the control variable of the model and conjectured that academic performance is related to the severity of depression and to the child’s isolation due to his/her classroom execution and cognitive functioning. Children who were most depressed presented deficiencies in cognitive functioning and those more introverted had the worst performance in the classroom. On the other hand, depression in university students affects academic performance, satisfaction with studies and social relationships which, in turn, generate stress and thus reinforce the depressive state (De la Peña, Estrada, Almeida, & Paez, 1999; Heiligenstein, Guenther, Hsu, and Herman (1996) found out that 92% of the students diagnosed with depression presented academic impairment. Cognitive damage persists in spite of the
remission of depressive symptoms (Paelecke-Habermann et al., 2005; Weiland-Fiedler et al., 2004).

There are some studies that report the efficiency of cognitive rehabilitation through computer programs, for those patients with attention and concentration deficits. Slate, Meyer, Burns, and Montgomery (1998) used the program Captain’s Log Cognitive Training, combining EEG/neurofeedback, to treat children with ADD. There were four cases involved in this study of children aged between 7 and 11, with severe emotional damage, diagnosed with psychosis and ADHD. A pre-test, post-test design was used. Treatment was given for 16 weeks, for a total of 64 sessions. In all the patients symptoms were reduced and they were able to generalize the learned abilities Table 1.

In another case study made by Kotwal, Burns, and Montgomery (1996), it was demonstrated that “Captain’s Log Cognitive Training” program was capable of operating changes in the brain-waves patterns measured by a EEG/neurofeedback equipment. These changes were evaluated in 13 years old patients with a diagnosis of ADDH. A pre-test, post-test design was used. The patient received 35 treatment sessions upon which he attained a very important improvement of the symptoms, and changes remained seven months after having concluded the experimental process.

Sartory, Zorn, Groetzinger, and Widgassen (2005) applied the “Cogpack” program three times a week to schizophrenic patients who, after three months of therapy, improved cognitive functions such as verbal memory and speed processing. Cognitive rehabilitation through computer programs offers great advantages: besides being amusing for the patient, computers do not make mistakes, provide immediate feedback and allow working with several patients at a time, which is beneficial for social assistance institutions.

On behalf of the cognitive impairment due to depression, we propose an intervention in order to reduce it and at the same time, to rehabilitate cognitive impairment.

2. Method

2.1. Subjects

In the study, participants were university students of the Universidad Nacional de México who presented a MDD diagnosis according to the DSM-IV criteria (American Psychiatric Association, 1995), and were assessed through the MINI Spanish computer version of the International Neuropsychiatric Interview (Heinze & Cortés, 2000; Sheehan et al., 1998), based on the DSM-IV and the CIE 10. Patients who presented psychotic disorders, bipolar disorder or suicidal risk were excluded. From a total of 34 patients who were selected, 31 finished the study. One female patient was excluded because she showed bipolar disorder symptoms after inclusion, two other patients quitted because they did not have time to be assessed. Subjects were assigned to three experimental conditions: one group \( (n = 11) \) with no anti-depressant treatment which was given cognitive training included six women and four men with an age mean of \( 21.0 + 2.9 \); a second group \( (n = 10) \) which was given anti-depressant treatment and cognitive training included five women and five men with an age mean of \( 23.3 + 3.7 \), and a third group which received only anti-depressant treatment, formed by seven women and four men, with an age mean of \( 23.8 + 2.7 \). All participants showed academic impairment, with a proficiency mean that was equal to 7 or lower, and had failed at least one subject. They were between the second and the pre-penultimate semester of their career. The three groups were comparable in age.
Table 1
Means and standard deviations of clinical and cognitive variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Assessment period (T)</th>
<th>Cognitive treatment (n = 10)</th>
<th>Cognitive + antidepressive treatment (n = 10)</th>
<th>Antidepressive treatment (n = 11)</th>
<th>Effect-F, p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depression BDI</td>
<td>Initial</td>
<td>23.8 ± 9.4</td>
<td>25.8 ± 10.6</td>
<td>23.4 ± 4.7</td>
<td>G-0.56, 0.575 T-106.3, &lt;0.001 GxT-2.9, 0.038</td>
</tr>
<tr>
<td></td>
<td>Intermediate</td>
<td>9.7 ± 8.5</td>
<td>14.8 ± 9.7</td>
<td>12.5 ± 7.8</td>
<td>T-106.3, &lt;0.001 GxT-2.9, 0.038</td>
</tr>
<tr>
<td></td>
<td>Final</td>
<td>5.3 ± 4.4</td>
<td>6.7 ± 6.1</td>
<td>11.7 ± 8.3</td>
<td>GxT-2.9, 0.038</td>
</tr>
<tr>
<td>Trait Anxiety STAI</td>
<td>Initial</td>
<td>54.1 ± 10.8</td>
<td>58.2 ± 11.3</td>
<td>54.1 ± 7.7</td>
<td>G-1.4, 0.263 T-19.5, &lt;0.001 GxT-2.8, 0.052</td>
</tr>
<tr>
<td></td>
<td>Intermediate</td>
<td>43.8 ± 6.9</td>
<td>48.6 ± 12.1</td>
<td>50.2 ± 9.2</td>
<td>T-19.5, &lt;0.001 GxT-2.8, 0.052</td>
</tr>
<tr>
<td></td>
<td>Final</td>
<td>40.2 ± 4.8</td>
<td>41.2 ± 12.4</td>
<td>51.4 ± 10.0</td>
<td>GxT-2.8, 0.052</td>
</tr>
<tr>
<td>State Anxiety STAI</td>
<td>Initial</td>
<td>49. ± 13.5</td>
<td>52. ± 9.4</td>
<td>54. ± 8.7</td>
<td>G-5.6, 0.009 T-13.4, &lt;0.001 GxT-1.23, 0.310</td>
</tr>
<tr>
<td></td>
<td>Intermediate</td>
<td>38.7 ± 7.</td>
<td>43.5 ± 10.9</td>
<td>48.8 ± 11.2</td>
<td>T-13.4, &lt;0.001 GxT-1.23, 0.310</td>
</tr>
<tr>
<td></td>
<td>Final</td>
<td>36.9 ± 8.</td>
<td>36.6 ± 8.9</td>
<td>49.3 ± 5.8</td>
<td>GxT-1.23, 0.310</td>
</tr>
<tr>
<td>CI verbal WAIS</td>
<td>Initial</td>
<td>101.9 ± 8.2</td>
<td>98.1 ± 6.3</td>
<td>97.8 ± 9.7</td>
<td>G-5.4, 0.010 T-78.9, &lt;0.001 GxT-27.6, &lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Final</td>
<td>116.5 ± 11.5</td>
<td>110.1 ± 6.5</td>
<td>96.5 ± 9.2</td>
<td>T-78.9, &lt;0.001 GxT-27.6, &lt;0.001</td>
</tr>
<tr>
<td>CI performance WAIS</td>
<td>Initial</td>
<td>95.3 ± 14.5</td>
<td>97.7 ± 12.1</td>
<td>103.4 ± 11.4</td>
<td>G-0.06, 0.946 T-47.5, &lt;0.001 GxT-20.3, &lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Final</td>
<td>109.5 ± 12.8</td>
<td>110. ± 13.7</td>
<td>101.1 ± 10.3</td>
<td>T-47.5, &lt;0.001 GxT-20.3, &lt;0.001</td>
</tr>
<tr>
<td>CI total WAIS</td>
<td>Initial</td>
<td>98.2 ± 9.8</td>
<td>97.7 ± 8.9</td>
<td>100.3 ± 10.5</td>
<td>G-1.2, 0.327 T-114.5, &lt;0.001 GxT-44.9, &lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Final</td>
<td>111.4 ± 9.4</td>
<td>111. ± 8.2</td>
<td>98.4 ± 9.6</td>
<td>T-114.5, &lt;0.001 GxT-44.9, &lt;0.001</td>
</tr>
<tr>
<td>Externalized problems EPA</td>
<td>Initial</td>
<td>37.4 ± 11.9</td>
<td>32.9 ± 14.2</td>
<td>32.8 ± 11.6</td>
<td>G-267.7, &lt;0.001 T-25.9, &lt;0.001 GxT-5.6, 0.002</td>
</tr>
<tr>
<td></td>
<td>Intermediate</td>
<td>28.1 ± 8.1</td>
<td>23.9 ± 11.6</td>
<td>32.9 ± 11.4</td>
<td>T-25.9, &lt;0.001 GxT-5.6, 0.002</td>
</tr>
<tr>
<td></td>
<td>Final</td>
<td>21.1 ± 6.8</td>
<td>18.2 ± 10.0</td>
<td>31.9 ± 10.7</td>
<td>GxT-5.6, 0.002</td>
</tr>
<tr>
<td>Attention problems EPAS</td>
<td>Initial</td>
<td>59.5 ± 12.1</td>
<td>47.2 ± 18.5</td>
<td>53.5 ± 7.8</td>
<td>G-312.5, &lt;0.001 T-22.9, &lt;0.001 GxT-35.7, &lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Intermediate</td>
<td>44.2 ± 23.6</td>
<td>34.1 ± 20.1</td>
<td>53.8 ± 8.3</td>
<td>T-22.9, &lt;0.001 GxT-35.7, &lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Final</td>
<td>31. ± 12.9</td>
<td>22.7 ± 20.1</td>
<td>51.5 ± 9.2</td>
<td>GxT-35.7, &lt;0.001</td>
</tr>
</tbody>
</table>

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Participants were asked to give their informed consent.

2.2. Treatment

A psychiatrist was in charge of the anti-depressant treatment; fluoxetine, paroxetine or imipramine was selected according to the patient’s characteristics.

For the training of cognitive abilities a computer program named “Alcor” with two routines was elaborated. In the first routine named “Juego de las Series” (Series Game), the patient has to learn to induce the element that follows in a series. Series are arranged according to increasing difficulty, there are 92 levels of difficulty from inducing series with only one number or letter, to others with even four characters which may be either numbers or letters. In the second routine named “Juego de la Oca” (Goose Game) the patient has to do, mentally, arithmetical operations (addition, subtraction, division and multiplication); in the same manner, operations are also arranged according to increasing difficulty, there are 70 levels of difficulty. Both routines have other elements which regulate difficulty: as answering against time, delay in opportunities to answer and use of visual hints. The level of difficulty is automatically increased depending on the rate of correct answers which may be manipulated by the researcher. The program was elaborated in Visual Basic 6.0, in Microsoft Windows platform (for version 98 and upper).

2.3. Measures

(1) Depression: Beck Depression Inventory (BDI) (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961). Standardized version for Mexico City (Jurado et al., 1998). (2) Anxiety: Spielberger’s State-Trait Anxiety Inventory (STAI) constructed by Spielberger, Gorsuch, and Lushene (1994), in its Spanish adaptation published by TEA in Madrid (1994). To evaluate the effect of the computer program. (3) Intelligence: Weschler Adult Intelligence Scale (WAIS) (Weschler, 1955); for its application to this study the American Norms were used. (4) Attention: Attention Problems Assessment Scale (APAS) (Cruz-Elizondo, 1998), in its adolescents version, measures inattention, hyperactivity and impulsivity. (5) Externalized problems: Externalized Problems Assessment Scale for Adolescents and Young Adults (EPA), this scale determines the presence and severity of the main symptoms in externalized expectrum: ADHD, oppositional defiant disorder and dissocial disorder (Palacios, 2003).

2.4. Procedure

In order to correct possible errors in design as well as in the operation of the new program, after concluding the computer program, the following actions were taken: two clinical psychologists experienced in using computer software with clinical applications were invited to use the new package during two months, and to give out a written report informing if they considered it useful for the treatment of cognitive disorder or else if they thought it contained any errors. Later, a pilot study was done, with eight patients, and following the same guidelines as for the present study. Once the participants were selected, the following steps were taken: It was explained to him/her of what the study consisted. Informed consent was required. The instruments were applied to establish the baseline.
The first treatment session began with the “Series Game”. The participant was asked to seat before the computer and a “demo” was shown as a tutorial. The patient was asked to work on five exercises of level 12. If the patient was capable of answering those five consecutive exercises correctly, then the degree of difficulty was increased. If he/she was not capable of answering those five consecutive exercises correctly, the researcher decreased difficulty until the patient was capable to answer four out of the six exercises being presented. When noticing that the patient knew the answer but did not have time to give it, the researcher increased the responding time indicated on the program entry screen and told the patient to answer more quickly, because that would be the only occasion when more time for answering would be given. In every case the researcher activated on the same screen “automatic change of level”, and inactivated the function “patience”. In the option “number of errors”, the researcher limited to three the number of errors allowed in order to move onto the next level, and in the option “time of the game” he/she was assigned 30 min. Each patient received two weekly sessions of approximately 30 min.

From the moment the patient reached level 60 of the program “Series Game”, he/she stopped working with this game and started with the program “Goose Game”. In this case, the participant started from the first level. Configuration used in this case was the same as that of the “Series Game”, except for the activation of the option “Patience”. The patient concluded his/her treatment when reaching level 70 of the “Goose Game” or when left with more than five sessions at the same level, which actually happened. The latter happened with only one participant.

The second evaluation was done after three months of treatment. The same instruments were used to obtain the baseline, except for WAIS, in order to avoid probable previously learned effects. The third evaluation was done when the patient concluded the treatment. In this case, all the instruments used in the baseline were applied. The answers were captured by a capturer who did not know what was the purpose of the research. A computer program analyzed all the answers of the instruments; this program was designed for such aim.

2.5. Data analysis

All variables were analyzed through ANOVA for repeated measures. The results for intra-subject contrasts were corrected using the Greenhouse–Geisser Epsilon Coefficient, to control the effect of the non-spherical covariance matrix. Effect Size were calculated by Square Eta Statistics. The contrasts post hoc were done using Fisher’s LSD (less significant difference) contrasts. The results in means and standard deviations are presented (Cohen, 1977).

3. Results

3.1. Beck Depression Inventory (BDI)

The severity of depression assessed through BDI resulted to be significant in the interaction Evaluation-Group \[F(3.58, 50.17) = 2.845, p = 0.038, \eta = 0.169\]; interaction shows significance in the initial vs. final comparison \[F(2, 28) = 3.462, p = 0.045, \eta = 0.198\]; the post hoc comparison in the final evaluation shows a difference between the cognitive treat-
ment and the anti-depressant treatment [LSD = 6.42, \( p = 0.033 \)]. All the patients, except for three, two of the group with anti-depressant treatment and one of the combined group, did not meet the criteria for a reduction higher than 50% in the BDI punctuation. In the evaluation after three months, groups did not show any differences in severity of depression. In the final evaluation the group with the lower anti-depressant response was the one that only received anti-depressant treatment while the groups having cognitive training maintained their rate of depression severity reduction.

3.2. Anxiety Trait Scale (STAI)

The severity degree of anxiety trait evaluated through the Spielberger Scale of Anxiety Trait was marginally significant in the interaction Evaluation-Group \([F(2.88, 38.83) = 2.855, \ p = 0.052, \ \eta = 0.175]\); interaction appears to be significant in the initial versus final comparison \([F(2, 27) = 4.357, \ p = 0.023, \ \eta = .244]\). Post hoc comparison in the final evaluation shows a difference between the cognitive treatment and the anti-depressant treatment \([LSD = 11.2, \ p = 0.015]\) and between the cognitive treatment condition and the combined condition \([LSD = 10.2, \ p = 0.025]\). In the final evaluation, the group treated only with anti-depressants showed differences from the other groups. The reduction of anxiety trait was discrete in the groups with program.

3.3. Scale of Anxiety State (STAI)

The severity degree of anxiety state evaluated by the Spielberger Anxiety State Scale was not significant in the interaction Evaluation-Group \([F(2.86, 39.97) = 1.233, \ p = 0.310, \ \eta = 0.081]\), which indicates a parallelism between conditions along the comparison; the post hoc comparison in the intermediate evaluation shows a difference between the cognitive treatment and the anti-depressant treatment \([LSD = 010.1, \ p = 0.027]\). The comparison post hoc in the final evaluation shows a difference between the cognitive treatment and the anti-depressant treatment \([LSD = 12.4, \ p = 0.003]\), and also between the cognitive treatment and the combined one \([LSD = 12.7, \ p = 0.002]\). The group treated with anti-depressants only did not show any improvement in the anxiety while state the cognitive treatment group and the combined treatment group reduced their anxiety moderately.

3.4. Verbal Intelligence Quotient (WAIS)

The verbal intelligence quotient of WAIS resulted significantly in the interaction Evaluation-Group \([F(2, 28) = 27.566, \ p < 0.001, \ \eta = 0.663]\); the comparison post hoc in the final evaluation shows a difference between the cognitive treatment and the anti-depressant treatment \([LSD = 19.9, \ p < 0.001]\), and between the cognitive treatment and the combined condition \([LSD = 13.6, \ p = 0.002]\). At verbal level, the group with anti-depressant treatment did not improve its verbal performance, while the cognitive treatment and combined groups increased very significantly their verbal IQ.

3.5. Performance Intelligence Quotient (WAIS)

The Performance Intelligence Quotient of WAIS resulted significantly in the interaction Evaluation-Group \([F(2, 28) = 020.332, \ p < 0.001, \ \eta = 0.592]\); the comparison post hoc in
the final evaluation showed neither a difference between the cognitive treatment and the anti-depressant treatment \([LSD = 8.41, p = 0.128]\) nor between the cognitive treatment and the condition combined \([LSD = 8.91, p = 0.107]\). At the performance level, the anti-depressant treatment group did not modify its performance, while the groups with cognitive treatment, and combined, increased their performance CI very significantly.

### 3.6. Intelligence Quotient (WAIS)

The Intelligence Quotient of WAIS resulted significantly in the interaction Evaluation-Group \([F(2, 28) = 44.892, p < 0.001, \eta = 0.762]\); the comparison post hoc in the final evaluation shows a difference between the cognitive treatment and anti-depressant treatment \([LSD = 13.0, p < 0.001]\), and between cognitive treatment and combined group \([LSD = 12.64, p < 0.001]\). The results are shown in the total IQ obtained for verbal IQ and Execution IQ. The anti-depressant treatment, in spite of showing a remission in the depressive condition, did not improve its intellectual performance. There was a very significant CI increase for the groups under cognitive and combined treatment.

### 3.7. Externalized Problems Assessment Scale for Adolescents and Young Adults (EPA)

Externalized problems assessed by EPA were significant for the interaction Evaluation-Group \([F(3.05, 42.7) = 5.604, p = 0.002, \eta = 0.286]\), interaction is significant in the initial versus intermediate comparison \([F(2, 28) = 0.20, p = 0.2239]\); and also in the initial versus final comparison \([F(2, 28) = 7.358, p = 0.003, \eta = 0.345]\); the comparison post hoc in the final evaluation shows a difference between the cognitive treatment and the anti-depressant treatment \([LSD = 10.8, p = 0.013]\) and between combined group and anti-depressant treatment \([LSD = 13.7, p = 0.002]\). Externalized problems associated with impulsivity and attention deficit improved significantly in the group with cognitive and combined treatment. The anti-depressant treatment did not improve its externalized problems.

### 3.8. Attention Problems Assessment Scale (APAS)

The attention problems assessed through de APAS was significant in the interaction Evaluation-Group \([F(3.81, 53.39) = 7.617, p < 0.001, \eta = 0.352]\); interaction appears to be significant in the initial versus intermediate comparison \([F(2, 28) = 6.501, p = 0.005, \eta = 0.317]\) and also in the initial versus final comparison \([F(2, 28) = 15.127, p < 0.001, \eta = 0.519]\). Post hoc comparison in the final evaluation shows a difference between the cognitive treatment and the anti-depressant treatment \([LSD = 20.5, p = 0.003]\) and between the combined group and the anti-depressant treatment \([LSD = 28.8, p < 0.001]\). Particularly, attention problems showed significant improvement in the cognitive treatment and the combined group. The anti-depressant treatment did not improve its problems of attention.

### 4. Discussion

Pharmacological treatment and cognitive treatment were capable of improving the depressive state in patients, although those who only received the former, in spite of the
remission of their depressive state, continued to show externalized problems associated with impulsivity and attention deficit. Also, those patients working with the cognitive treatment showed a slight decrease in the level of anxiety, while patients receiving only pharmacological treatment had no change in this regard.

Participants who received the cognitive treatment showed an increase in their IQ, in performance IQ and in total IQ. This may be due to the fact that they obtained reductions per time in some of the WAIS scales. Probably improvement of the psychomotor retardation was observed in depressed patients (Massel et al., 1990).

Results indicate that pharmacological treatment was able to reduce depressive symptoms, although the cognitive treatment is a better alternative because besides reducing cognitive impairment and externalized problems, it does not have the side effects of anti-depressants, such as sexual dysfunctions, urinary retention and constipation (Calderón-Narváez, 2005; Claxton, Li, & McKendrick, 2000; Fabre & Putman, 1988; Labbate, Grimes, Hines, Oleshansky, & Arana, 1998).

Eight months after finishing treatment, the patients were contacted by phone with the exception of one of them who could not be reached; all patients who had worked with the computer program had improved their academic performance. Four patients concluded their studies and are about to graduate; three decided to study another career at the University and had continued studying without failing in any subject. The remaining patients showed a moderate improvement in their marks mean differing from those who received only pharmacological therapy: only one of these reported to have improved academically, and the rest informed that they still had academic problems. One patient asked for permission to suspend studies temporarily and two others quit for good. This information corroborates the findings of Massel et al. (1990), Mintz et al. (1992) and Heiligenstein et al. (1996).

These results could be related to the loss of volume in the hippocampus shown in patients with non-treated depression, measured through magnetic resonance (Jacobs, Van Praag, & Gage, 2000; Sheline, Gado, & Kraemer, 2003; Sheline, Sanghavi, Mintun, & Gado, 1999; Sheline, Wang, Gado, Csernansky, & Vannier, 1996). The hippocampus is an essential structure accomplishing in memory processes, and on the other hand, it is known that new neurons are produced in the hippocampus dentate gyrus of human adults (Eriksson et al., 1998) and that these neurons emigrate to the cortex in the posterior, prefrontal and temporal inferior areas. These areas are related with cerebral plasticity, memory and learning process (Gould, Reeves, Graciano, & Gross, 1999). The new neurons are related with the memory and the learning process is related with survivor neurons (Shors et al., 2001).

5. Limitations

This study lacks external validity; it is necessary to duplicate research with this program using more refined tests for the neuropsychological evaluation.

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