

Results of a Stress Management Program for Graduate Students based on Relaxation associated with HRV Biofeedback

September 1, 2008

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Acknowledgements

The author expresses thanks to the following people who contributed in different ways to this study:

Monique Zuyderhoff, Annick Fraselle, Marie-Claude Hublet ("Haute Ecole Léonard de Vinci") and Danielle Hallet ("Univers Santé", "Université Catholique de Louvain") who encouraged this emerging area of applied research in our education setting.

Dominique Van Asbroeck, PT, ("Haute Ecole Léonard de Vinci") who provided assistance to the realization of the practical sessions with students, as well as comments for the manuscript, together with Marie-Claude Hublet.

Rollin McCraty, from the Institute of HeartMath, who supported this research by providing Freeze-Framer systems and research materials.

Adélaïde Berthelot, Master student in Physical Therapy at the "Haute Ecole Léonard de Vinci", who contributed to the data collection and processing and realized her Master dissertation on this subject.

Objective

The objective of our intervention is to help students overcome stress and anxiety, by introducing them to a new stress management technique, and heart rhythm coherence biofeedback (cardiac coherence). They can thus best know themselves and gain more confidence in their resources.

Introduction and Background

In the present study, we use the emWave[®] PC (formerly Freeze-Framer) system to measure the degree of coherence attained by using a combination of relaxation techniques inspired from "sophrology" and HRV biofeedback.

Sophrology is a holistic relaxation method, proposed by Caycedo in 1970 [7], which uses respiration, dynamic exercises and static relaxation techniques. It develops the awareness of one's body, of the muscles tension/relaxation and of a calm state of mind. Starting from the physical relaxation of the muscles one achieves the "sophro-liminal" level, which leads to a harmonious state of being (physical, mental and emotional).

HRV coherence biofeedback uses the heart rate variability HRV, captured by plethysmography and displayed on the computer screen in real-time using the emWave[®] PC (formerly Freeze-Framer) system, developed by the Institute of HeartMath. HRV measures the amount of variability in the beat-to-beat heart rate. It is an important physiological index of stress and has been described in a number of studies [3, 8, 13].

Research conducted by the Institute of HeartMath [10] on the link between heart rhythms and emotions has introduced and developed the notion of “coherence”. The coherence is defined as a “distinct mode of physiological functioning that is associated with the experience of heartfelt positive emotions”. The physiological coherence result in a highly efficient state in which body and brain function with increased harmony.

On the screen, correlates of coherence include a smooth, sine-wave pattern in the HRV graph. By displaying their HRV pattern on the computer screen, students were able thus to see when they were in coherence or not.

In the last decade, HRV coherence biofeedback has been used in education in various settings with good results [1, 2, 4, 9, 10, 12]. It has been found to directly correlate with improvements in cognitive performance: increasing focus, attention, and reduction in the perception of stress.

Intervention

The intervention consisted of 10 sessions of stress management using sophrology and HRV coherence biofeedback (1 hour, once a week, from October 2007 to May 2008).

We used the emWave[®] PC (formerly Freeze-Framer[®] program from session 2 to 10. As we had less Freeze-Framer units than students, each student used it approximately 4 times along the 10 sessions.

Several stress management techniques were used:

- “sophrology” exercises, inspired from yoga, including progressive muscle relaxation.
- Static “sophrology” techniques of relaxation and visualisation, autogenic training and the Rapid Coherence Technique proposed in the emWave[®] PC (formerly Freeze-Framer) user’s guide.
- Information about HRV and its relations to respiration, well-being, and coherence.
- Biofeedback using emWave[®] PC (formerly Freeze-Framer), using the HRV (heart rate variability) screen starting from session 2. For the last 3 sessions students had the possibility to train using the Freeze-Framer games.
- Discussion about “coherence” from the students point of view (balance between resources and limitations).

Students followed their HRV pattern and the coherence ratio on the screen as indicators of the degree of coherence achieved as a result of the relaxation exercises associated to biofeedback.

Subjects

Students aged 18 to 24 years participated on a volunteer basis; 3 groups of approximately 10 students were formed: two groups from “Université Catholique de Louvain” and one group from “Haute Ecole Léonard de Vinci, Institut d’enseignement supérieur Parnasse-Deux Alice”.

Overall 26 students participated at almost all 10 sessions. Among them, 17 filled in questionnaires to evaluate their scores of stress, social inhibition and negative affectivity at the beginning of the first session and at the end of the last session.

Psychometric variables

The stress was measured by a questionnaire developed by Dr. Charly Cungi [5]. This questionnaire measures 11 constructs measuring manifestations of stress (like for example, presence of tensed muscles or sleep problems). For each of them, the student evaluates the degree of presence on a scale from 1 (no presence) to 6 (extremely present). For each student, the global score evaluates the degree of presence of stress. The interpretation of the global stress score is : a value comprised between:

- 11 and 17 corresponds to a “very low level of stress”
- 17 and 21 corresponds to a “low level of stress”
- 21 and 28 corresponds to a “high level”
- 28 and more corresponds to a “very high level”.

The social inhibition and the negative affectivity were evaluated by the J. Denollet questionnaire [6]. This questionnaire evaluates the presence of the so-called “type D personality”. The questionnaire comprises 7 questions assessing negative affect and 7 questions assessing social inhibition. Each question has 5 possible answers: “false, rather false, neutral, rather exact, exact” and each is assigned a number of points, depending on the question.

- The negative affectivity is defined as “a tendency to feel negative emotions (worry, pessimism, anxiety, ...) in specific situations and at specific moments”.
- The social inhibition is defined as “a tendency to inhibit emotions and behaviour in the context of social interactions”.

The student has a tendency to “negative affectivity” or to “social inhibition” if his (her) score is equal to or superior to 10, respectively. In our sample of students, the ranges of negative affectivity and social inhibition are 2-22 and 5-21, respectively.

We compared scores obtained for these items before and after the program for the 17 students who have complete data.

Results

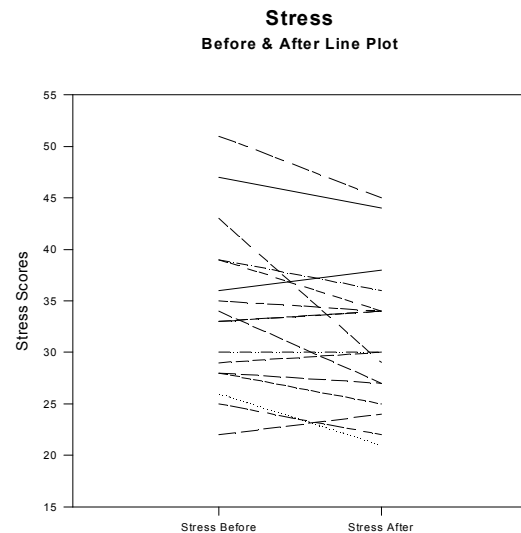
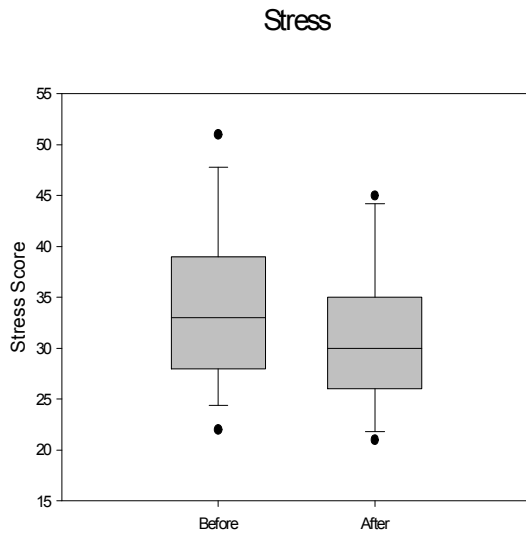
The results are as following (all the statistical tests are in the Appendix):

Stress scores

The stress reduction that occurred with the stress management program is greater than would be expected by chance; there is a **statistically significant reduction of stress** (p -value = 0.009 paired t-test) from the beginning to the end of the program.

The figure below shows a box-plot and a line plot of the stress scores before and after:

- The box-plot: the median of the stress scores is lower after the stress management program, whereas the IQR range looks comparable.
- Before and After Line Plot: 12 students decrease their stress scores, 4 students present a slight increase and 1 student has no change.



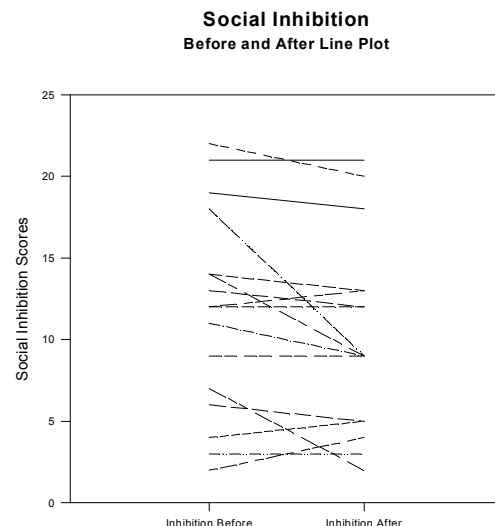
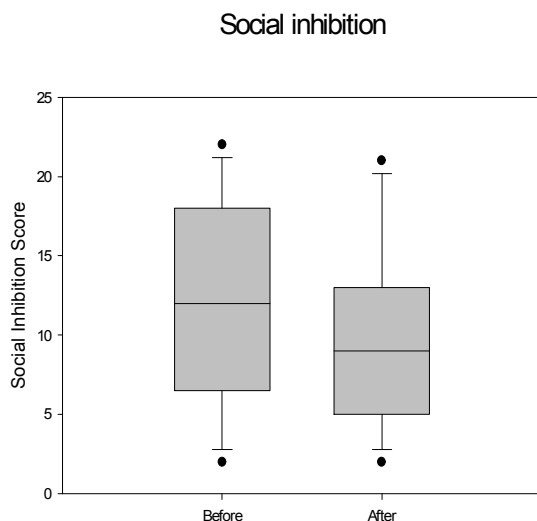
Before the stress management program, the minimum and maximum of the stress scores are 22 and 51, respectively. All the students fall in the ranges “high” and “very high” for the level of stress. After the stress management program, the minimum and maximum of the stress scores decrease to 21 and 45, respectively. The ranges of stress are still “high “ and “very high”, despite a significant stress reduction.

Social Inhibition

There is a significant reduction of the social inhibition scores after the stress management program, compared to values obtained before (p -value = 0.033 Wilcoxon Signed Rank test).

In the figure below, for the social inhibition scores:

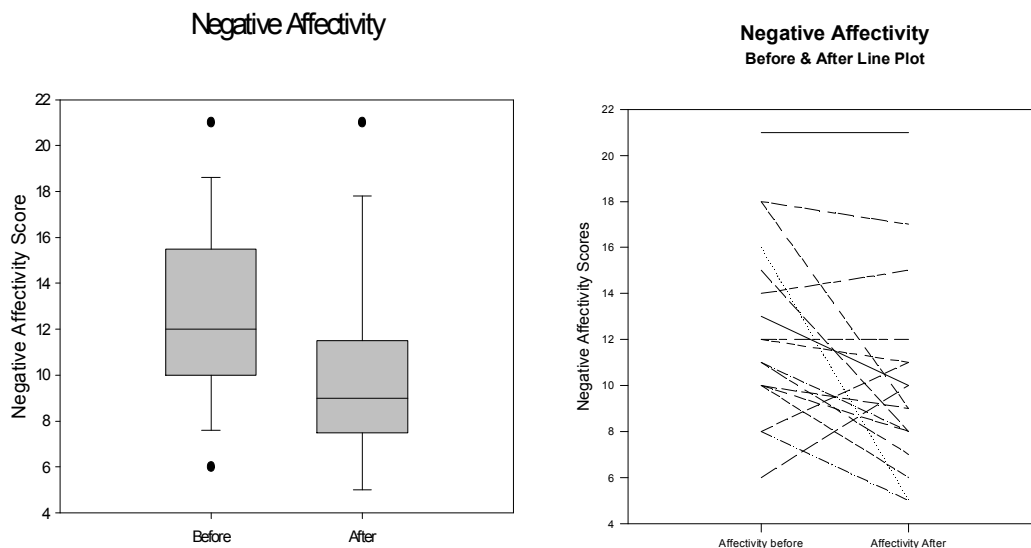
- the box-plot shows that the median decreases from a value of 12 to a value of 9 after the stress management program.
- the line plot of Before and After values shows that 11 students decrease their scores (3 of them have an important decrease), 3 students present a slight increase and 3 students have no change.



Negative affectivity

There is a significant reduction of the negative affectivity scores after the stress management program, compared with values obtained before (p -value = 0.022 paired t- test).

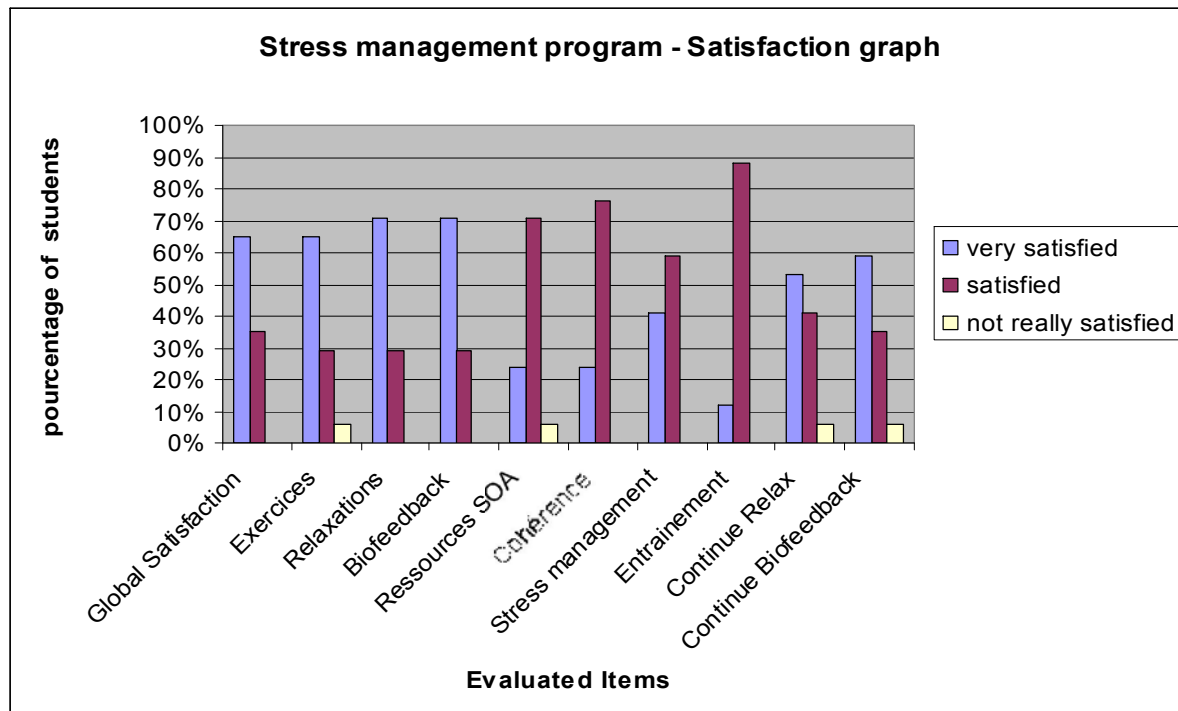
- the box-plot shows that the median decreases from 12 to 9 after the stress management program.
- the line plot of Before and After values shows that 11 students decrease their scores (3 of them have an important decrease), 3 students present an increase and 2 students have no change.



Overall satisfaction of the students after the stress management program using biofeedback

At the end of the last session, students completed a satisfaction questionnaire, evaluating their satisfaction on a scale from 1 to 6 (1 and 2 = "not satisfied", 3 and 4 = "satisfied", 5 and 6 = "very satisfied"). The items represented in the graph-bar below correspond to the following questions:

1. Global satisfaction = are you satisfied of this stress management program ?
2. Exercises = did you appreciate the "dynamic sophrology" stretching exercises at the beginning of each session ?
3. Relaxations = did you appreciate the guided static relaxations ?
4. Biofeedback = did you appreciate the coherence training with Freeze-Framer ?
5. Resources = did you discover (or develop) your personal resources (based on the discussions on coherence between resources and limitations from students point of view) ?
6. Coherence = did you discover /develop a certain coherence with yourself ?
7. Stress management = did you learn useful stress management techniques ?
8. Entrainment = do you feel trained for managing stressful situations ?
9. Continue Relax = would you like to continue relaxation without biofeedback ?
10. Continue Biofeedback = would you like to continue to train with biofeedback ?



- More than 60% of the students were “very satisfied” of the stress management program and of the relaxation exercises (at the beginning of the session)
- 70% of the students were “very satisfied” of the static guided relaxations and of the biofeedback training.
- 70% of the students discovered or developed their resources and a coherence with themselves (“satisfied” level).
- 40% answered “very satisfied” and 60% “satisfied” to the question whether they learned useful Stress management techniques,
- 10% consider to be very well trained (“very satisfied”) and 90% consider to be moderately trained for managing stressful situations (“satisfied”).
- 50% would like very much (“very satisfied”) to continue relaxation (without biofeedback)
- 60% would like very much (“very satisfied”) to continue relaxation training with biofeedback.

Overall, the stress management techniques mostly appreciated by the students were the static relaxations associated with the visualisation of their HRV pattern. In the bar-graph chart, the higher blue “very satisfied” bars correspond to items 3 and 4, namely “Relaxations” and “Biofeedback”.

For items 5, 6 and 8 (“Resources”, “Coherence”, “Entrainement”) the percentage of students who answered “satisfied” is higher than that of students answering “very satisfied”. 70% answered “satisfied” for these items, which is already a good result. It is coherent with the initial objective of this stress management program.

Open comments of the students

The students also answered written open ended questions about the advantages and disadvantages of using biofeedback in a stress management program and the most important concepts learned from the program. Their answers were as follows:

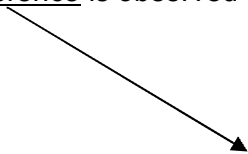
Advantages of biofeedback:

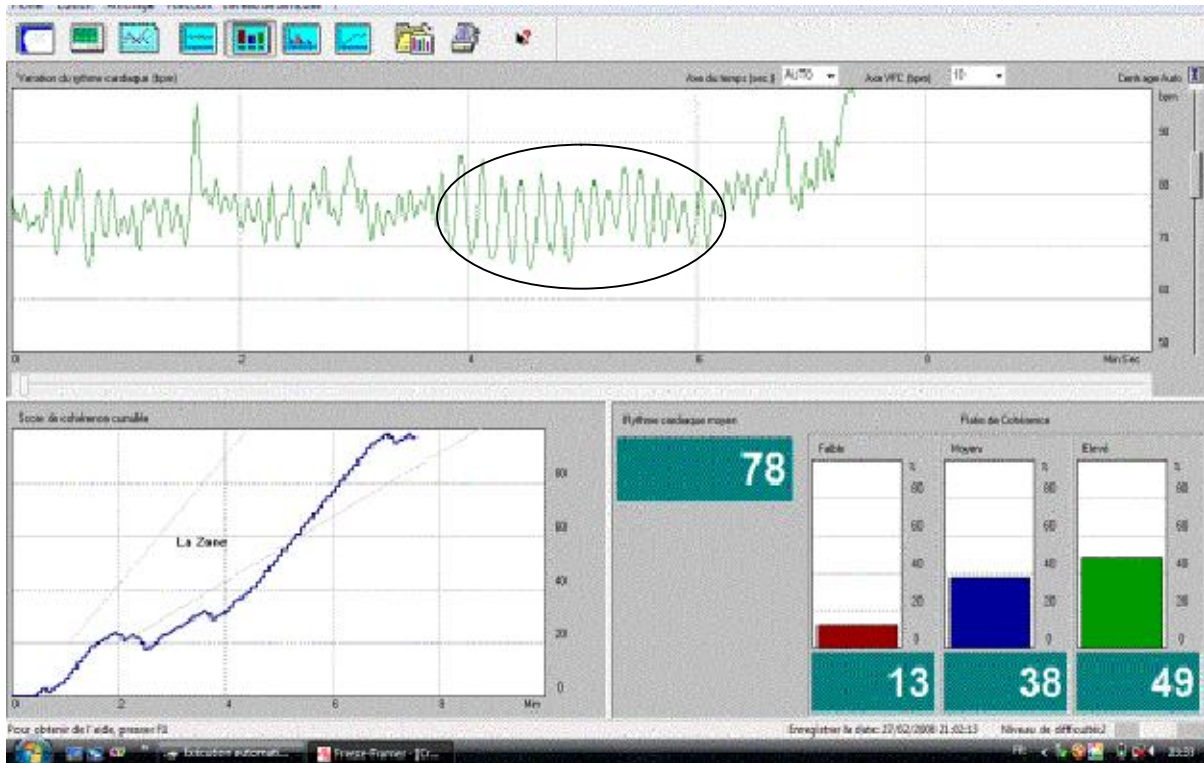
- We can assess which are the most effective stress management techniques for each of us, by looking at the coherence score and variability graphs during the relaxation sessions.
- We become aware of the effects of relaxation and of respiration on our heart rhythms
→ AWARENESS
- It helps me to become aware of moments when I am in coherence, even without biofeedback but due to the biofeedback training
- It develops the awareness of my cardiac variability which in turn induces a better self-management
- We can see objectively and sense the positive effects of the relaxation and this makes the relaxation exercises more attractive
- Better distinguish between moments of coherence and those of chaos, first at the computer, then by myself without any computerized biofeedback
- I can evaluate the progress I make regarding relaxation and coherence
- Biofeedback adds a playful and pleasant context to the relaxation sessions
- I appreciate the scientific and physiologic aspect of HRV biofeedback
- Biofeedback helps me to stay focused on my respiration

The first three advantages in this list are interesting: even a short moment of coherence can be brought into awareness and the specific relaxation technique used at that moment can be outlined. As an example, in the graph below, the HRV pattern of a student who said relaxation was “so and so” for her. When looking at the HRV graph, she realized that the short moment of sine-like waves in the HRV (from minute 4 to 6) corresponds to a respiration technique she really appreciated. The HRV screen enabled her to identify one personal and effective way to enter into coherence.

emWave® PC (formerly Freeze-Framer) screen; in the upper panel, approximately 8 minutes of HRV recorded during a relaxation session associated to biofeedback.

A short moment of coherence is observed from minute 4 to 6.





This example is coherent with the principle of “positive action” in sophrology. By exercising the awareness of simple positive feelings one can develop the capacity of feeling positive.

At the beginning, some of the students can not distinguish by themselves the moments when they are in coherence; they are rather neutral or even “negative” about their feelings during the relaxation. Biofeedback is interesting for such students as it enables them to realize:

- that simple exercises (like respiration) can lead to coherence and
- the benefits associated with it.

Disadvantages of biofeedback:

- My attention to the guided relaxation can be “turned out » by the computer and I can not follow the propositions simultaneously with the HRV screen (this comment concerns the relaxation based on some of the “sophrology” techniques, which make use of visualisations and concentration on the parts of the body)
- At the beginning, one may be destabilized when the heart rhythms accelerate
- The sitting position (in front of the computer) is disadvantageous compared to the laying position when relaxation is employed without biofeedback at the computer
- This technique needs a computer

The most important ideas revealed by this stress management program :

- The importance of respiration and of “inner focus”
- The effects of respiration and of cardiac coherence on my general, physical and mental state
- It is important to create a “relaxation reflex”, which can be trained.
- Try to find what is best for me (respiration, which kind of respiration, visualisation, which kind of visualisation, or other simple relaxation techniques)
- Memo technical means to point out the basic steps to achieve quick relaxation (such as “the three C’s of the coherence: CCC”, in french “Contact, Coeur, Concentration”)

- The effects of respiration and of cardiac coherence
- The awareness of one's body, of oneself.

Conclusion

This study evaluated the effects of a stress management program based on biofeedback and relaxation as well as students satisfaction with the program for the first time at two institutions: "Université Catholique de Louvain" and "Haute Ecole Léonard de Vinci, Institut d'enseignement supérieur Parnasse-Deux Alice".

The stress management program using biofeedback had a positive and significant impact on all the psychometric variables evaluated in this study: stress, negative affectivity and social inhibition. These three variables are significantly lower after the program compared to the values before it.

All the students consider they learned useful stress management techniques (40% answered "very satisfied" and 60% "satisfied").

From the stress management techniques explored in this program, students mostly appreciated the static relaxations associated to the visualisation of their HRV pattern.

The objective of our intervention was to help students overcome their stress by discovering a new method based on biofeedback. Therefore, we can conclude the objective of this stress management program is attained.

Students did not have enough time in 10 sessions to develop in-depth their resources, attain coherence and feel trained to manage stress to a "very satisfied level" (for the majority of students). Nevertheless, more than 70% answered "satisfied" for these three items, which is already a good result. This result is coherent with the objective of our intervention, namely, a first approach, an initiation to stress management, by discovering a new technique based on biofeedback.

The most important advantage of using biofeedback in addition to the sophrology relaxation techniques seems to be the rapid development of the AWARENESS (awareness of effects of respiration, awareness of heart rhythms, awareness of short moments of coherence, of positive state...).

An interesting remark coming from several students was the following: "after the stretching exercises at the beginning of the sessions, I was surprised to see that I was already in coherence, even before the static relaxation". This can emphasize the effectiveness of simple exercises based on movements synchronized with the respiration.

The disadvantage is that using biofeedback at the computer may "turn out" the students' attention from the guided relaxation. This remark is interesting as "inner focus" lays at the basis of all relaxation techniques. For some of the students, following the screen seems to be a problem to inner focusing. Others, on the contrary, said that following the screen keeps their mind focused on the positive sensations induced by the relaxation.

The most interesting ideas discovered during this stress management program are the importance of respiration, and the effects of respiration on one's heart and coherence.

Limitations of the present study

In order to evaluate the effects of biofeedback in a stress management program, a controlled design would have been more appropriate, with two groups of students: "stress management associated to biofeedback" versus "stress management only".

It was not possible to organize such a study mainly because all the students were very interested about biofeedback. This technique seems to attract students, which are already "fun" of informatics and such modern techniques.

The number of the available biofeedback tools relative to the number of students in the groups is another limitation of this study. Each student could not personally train using Freeze-Framer at each session. Nevertheless, this enabled them to compare biofeedback associated relaxation versus relaxation only.

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Appendix :

Paired t-test: STRESS SCORES

Normality Test: Passed(P = 0,240)

Group	N	Missing	Mean	Std Dev	SEM
Stress Before	17	0	34,000	7,898	1,915
Stress After	17	0	31,412	6,965	1,689
Difference	17	0	2,588	4,078	0,989

t = 2,617 with 16 degrees of freedom. (P-value = 0,009 unilateral test)

95 percent confidence interval for difference of means: 0,491 to 4,685

Wilcoxon Signed Rank Test: SOCIAL INHIBITION

Normality Test: Failed (P < 0,050)

Group	N	Missing	Median	25%	75%
Inhibition Before	17	0	12,000	6,750	18,000
Inhibition After	17	0	9,000	5,000	13,000

W= -61,000 T+ = 15,000 T- = -76,000

Z-Statistic (based on positive ranks) = -2,159

P(est.)= 0,034 P(exact)= 0,033

Paired t-test: NEGATIVE AFFECTIVITY

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Normality Test: Passed(P = 0,240)

Group	N	Missing	Mean	Std Dev	SEM
Affectivity before	17	0	12,529	4,033	0,978
Affectivity After	17	0	10,118	4,256	1,032
Difference	17	0	2,412	3,906	0,947

t = 2,546 with 16 degrees of freedom. (P = 0,022)

95 percent confidence interval for difference of means: 0,403 to 4,420