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NEW TECHNOLOGIES AND RELAXATION: AN EXPLORATIVE STUDY ON OBESE PATIENTS WITH EMOTIONAL EATING

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Since stress and negative emotions are critical factors in inducing overeating in obese patients, psychological and behavioural interventions for obesity should include stress management techniques. A three weeks relaxation protocol supported by the use of new technologies, including virtual reality (VR) and portable mp3 players, was developed in order to reduce stress and related emotional eating episodes in obese patients. Sixty female obese inpatients reporting emotional eating were included in the study and divided in three experimental groups (virtual reality-VR, imaginative-IM and waiting list). Psychometric and physiological variables were collected. Results show that relaxation training was effective in improving perceived self efficacy in eating control, as well as in decreasing depressive symptoms, anxiety and physiological arousal both in the VR and IM conditions.

This study suggests that relaxation training for obese patients with emotional eating is effective, even if the lack of differences between the two conditions suggests some important critical considerations.

Introduction

The interest in eating-related issues reflects worldwide statistics showing that approximately 1.6 billion adults (age 15+) are overweight and at least 400 million are obese. The World Health Organization (WHO) further projects that by 2015, approximately 2.3 billion adults will be overweight and more than 700 million will be obese (WHO, 2006). Given that overweight and obesity lead to serious health consequences, developing and implementing effective interventions for substantially reduce weight and the associated risks for health is compelling.

Beside some important and well established aetiological factors such as excessive food intake and lack of physical activity, that are the principal targets in the majority of traditional weight reduction programs based on diet and exercise training, an important variable that must be taken into account for the treatment of obesity regards the way in which food intake relates with bio-psychological stress (Gluck, 2006; Volkow & Wise, 2005). This relationship is well illustrated in the behavioural phenomenon of emotional eating, that is defined as eating in response to one's mood or emotion (Bekker, van de Meerendonk, & Mollerus, 2004), as opposed to eating in response to physiological cues of hunger, eating on a schedule, or eating socially.

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Typically, emotional eaters eat in response to negative emotions (Lindeman & Stark, 2001), as eating in response to positive emotions has not been demonstrated to be as damaging to efforts to maintain a healthy weight. For emotional eaters, the emotion related eating behaviour may be a form of inappropriate coping mechanism for alleviating and dealing with stress and negative emotions (Carver, Scheier, & Weintraub, 1989; Popkess-Vawter, Wendel, Schmoll, & O'Connell, 1998; Solomon, 2001; Timmerman & Acton, 2001; Troop, 1998). A recent study conducted by Ozier and coll. (Ozier et al., 2008) has found that individuals who eat in response to emotions and stress are more likely to be overweight or obese. This finding is in accord with similar data (Blair, Lewis, & Booth, 1990) showing that patients who decreased their emotional eating lost substantially more weight than those who did not. Similarly, other two studies have demonstrated that there is a relationship between emotional eating and binge eating with higher caloric intake (Braet & Van Strien, 1997; Waters, Hill, & Waller, 2001). Furthermore, Geliebter and Aversa (Geliebter & Aversa, 2003) has found that overweight individuals have substantially greater eating ratings, indicating a greater urge to eat in response to negative emotions and situations, than normal weight subjects. These studies support the hypothesis that overweight and obese individuals might lack appropriate strategies to cope with daily stressors and/or that their existing coping mechanisms are ineffective (Crowther, Sanftner, Bonifazi, & Shepherd, 2001), since they lead them to use eating or overeating as a maladaptive way of coping.

If stress and negative emotions are critical factors that may induce eating, overeating and choice of palatable and thus high caloric food, then psychological and behavioural interventions for obese patients with emotional eating should also include stress management and emotion-shifting strategies. Together with the traditional cognitive-behavioural techniques like cognitive restructuring, self-monitoring and social support (Forety & Carlos Poston II, 1998). Ong et al. (Ong, Linden, & Young, 2004) found that one of the most common treatment for stress management is cognitive-behavioral therapy (CBT) associated to relaxation-oriented techniques. However, relaxation is difficult to be achieved in real life situations and the traditional relaxation methods usually take a very long time to be learned. Furthermore, given that all the main relaxation techniques resort to the use of positive mental images to facilitate the induction of the response of psycho-physical calm. The effectiveness of the interventions depends, to a large extent, on the ability of individuals to produce the relaxing images proposed by the therapist or by specific audio-narratives (Vincelli, 1999). Regarding this issue, Freeman et al. (J. Freeman, Lessiter, Keogh, Bond, & Chapman, 2004) explored whether the effects on mood and anxiety of a therapeutic narrative based on standard controlled breathing techniques were enhanced through its presentation within an audio-visual virtual environment. The results show that the presentation of the narrative within the virtual "relaxation island" in a one session experience resulted in significantly greater increase in relaxation compared to presentation of the narrative alone.

In a more recent pilot study Riva et al. (Riva, Manzoni, Villani, Gaggioli, & Molinari, 2008), starting from these promising results, found that a brief relaxation training protocol (2 sessions) performed using relaxing narratives and virtual reality (VR) immersion was more effective than the same protocol provided through a DVD video in reducing anxiety in a sample of obese female inpatients with a history of emotional eating. Riva et al. (Riva, Preziosa, Grassi, & Villani, 2006) also explored the effects on stress of mobile phones playing audio-visual relaxing narratives in a sample of Italian commuters. Once again, they showed that the use of new technologies (a combination of VR environments and mobile phones) was more effective in reducing stress level than commercial relaxing videos. In particular, commuters who experienced the mobile relaxing narratives – virtual audio-visual experiences implemented on UMTS/3G phones – were able to obtain a significant reduction of their stress levels that the other participants did not achieve.

These results, although preliminary, suggest that new technologies, in particular VR and portable devices playing mobile narratives, may be an effective mood induction media, which can play a significant part in dealing with stress and common psychiatric disorders such as anxiety and depression (Waterworth & Waterworth, 2004). Starting from these observations and willing to overcome the above mentioned limits related to the traditional relaxation training methods, we designed an

exploratory study to observe the effect of a three-week relaxation training protocol partially provided through a relaxing VR environment and supported by portable mp3 players on stress and negative emotions in a sample of obese female patients with emotional eating. Furthermore, at the end of the treatment, different virtual environments representing critical situations were developed to expose the patients to the stimuli that usually produce negative emotional reactions, in order to test their ability to put in practice the acquired knowledge about relaxation. The effects of this treatment were compared to an eyes-closed, imaginative, narrative-only condition and with a waiting list condition. In particular, we wanted to investigate if VR and mp3 players can facilitate relaxation training in a sample of obese female patients with emotional eating.

Materials and Method

Participants

Sixty female obese inpatients with emotional eating were consecutively recruited from a reference population admitted for clinical and rehabilitative residential treatment at San Giuseppe Hospital, Istituto Auxologico Italiano, Verbania, Italy, during a seven-months period. Obesity status was ascertained by a Body Mass Index (BMI) ≥ 30 (WHO, 2006). Height was measured before treatment with a stadiometer and weight was assessed with the participant in lightweight clothing with shoes removed, on a balance beam scale.

In order to be included in the study, patients had to meet the following inclusion criteria:

- sex: female
- age: 18-60
- primary diagnosis: obesity, in accord to the WHO criteria.
- presence of recurrent episodes of emotional eating, as assessed through the Emotional Overeating Questionnaire (EOQ) (Masheb & Grilo, 2006).

Diagnostic interviews were conducted by an independent clinical psychologist as part of his clinical work. Patients affected by other psychiatric, psychological or neurological disorders were excluded from the study. No patients dropped-out the study.

Patients who met the inclusion criteria and gave their written informed consent to participate were randomly assigned to 3 conditions: (a) virtual reality (VR) condition; (b) imaginative condition (IM); (c) waiting list condition (WL). The randomization scheme was generated by using the Web site Randomization.com (www. randomization.com).

Detailed epidemiological, clinical and demographic characteristics of the sample are summarized in table 1. No significant differences were found in all these variables between the three groups of patients.

The study received ethical approval by Ethical Committee of the Istituto Auxologico Italiano.

Experimental procedure and clinical protocol

The experimental design consisted of three independent factors (three groups) and multiple repeated measures (pre-post sessions and pre-post treatment measurements).

During the initial diagnostic interview, participants were provided with detailed information about the study and the treatments. The inpatient program (IP) lasted 5 weeks. The additional treatments (VR- and IM-based relaxation training) were administered by two chartered clinical psychologists and one chartered psychotherapist under the supervision of a senior psychotherapist. The three therapists were randomized between the two conditions.

Epidemiological, clinical and demographic characteristics of the sample

Group	VR (n=20)		IM (n=20)		WL (n=20)	
	Mean	SD	Mean	SD	Mean	SD
BMI	41.74	3.94	41.82	4.72	43.21	6.48
Age	42.80	11.44	48.55	7.96	39.65	14.52
	Frequency	%	Frequency	%	Frequency	%
Marital Status						
Single	8	40	4	20	10	50
Married	10	50	14	70	9	45
Divorced	2	10	2	10	1	5
Education						
Less than 5 years	0	0	2	10	2	10
Between 5 and 8 years	7	35	4	20	6	30
Between 8 and 13 years	9	45	11	55	8	40
More than 18 years	4	20	3	15	4	20
Job Activity						
Student	0	0	1	5	3	15
Housewife	6	30	6	30	4	20
Employed	11	55	10	50	11	55
Unemployed	3	15	3	15	2	10

Integrated multimodal medically-managed inpatient program

All patients underwent a 5-week medically-managed, residential program consisting in a moderately low-calorie diet (80% of the basal energy consumption estimated according to the Harris-Benedict equation), physical training, psychological support and participation in nutritional groups. The individual psychological sessions, lasting 45 minutes each, were administered once a week for five weeks and were cognitive-behavioral oriented. Contents were mainly based upon: stimulus-controlling techniques, drawing up a list of activities to dysfunctional eating behavior, problem-solving techniques aimed at coping with interpersonal situations capable of triggering emotional eating episodes, analysis and modification of dysfunctional thinking and cognitive distortions, and self-empowerment.

Relaxation training

The experimental protocol, consisting in 4 sessions per week (12 sessions in total), lasted 3 weeks. It usually started at the beginning of the second week of the inpatient program and ended the week before the last one. The two experimental conditions (VR and IM) differed only in some sessions and the protocol was organized as following:

- Session 1 (VR and IM groups): initial assessment and brief introduction to the rationale and goals of the protocol;
- Sessions 2-4 (VR and IM groups): the patient starts to learn the relaxation techniques guided by a relaxing recorded narrative played by a computer;

- Session 5 (VR and IM groups): each patient discusses with the therapist recent episodes of emotional eating (self-monitoring) and her impressions and comments about the protocol;
- Sessions 6-8 (VR group): the patient is immersed in the Green Valley, a virtual relaxing environment, and is asked to relax herself following the relaxing narrative, after moving around the environment according to the directions suggested by the audio narrative;
- Sessions 6-8 (IM group): the patient is asked to imagine a relaxing environment representing a green valley and to relax herself listening to the audio narrative;
- Sessions 9-11 (VR group): the patient is exposed to a pre-selected virtual environment referring to a real-life situation that usually causes stress and consequently emotional eating episodes (i.e. a kitchen, a restaurant, an office, etc.). Immediately after the virtual exposure to the stressful environment, a relaxing narrative guides the patient through the relaxation process;
- Sessions 9-11 (IM group): the patient is asked to imagine a real-life situation that usually provokes stress and, consequently, emotional eating. After that, a relaxing narrative guides her through the relaxation process;
- Session 12 (VR and IM group): conclusion and final assessment.

Each session lasted about one hour; it usually started with a brief introduction and homework revision, and finished with some comments about the experience (debriefing). Starting form session 2 until the end of the treatment, participants received a portable mp3 player containing the narratives they listened during the sessions (also called mobile narratives). They were asked to use it as many times as they wanted to practice relaxation by their own without the therapist. This task was useful to speed up and boost the learning of the relaxation techniques.

In order to facilitate relaxation, during the treatment sessions patients were seated on a comfortable armchair in a dark room. Participants included in the IM group listened to the narrative with their eyes closed, while those in the VR group wore an head mounted display (HMD) for immersion into the virtual environment.

Psychometric assessment

The following psychometric questionnaires were administered only during the first and the last sessions:

- Beck Depression Inventory – BDI (Beck & Steer, 1993);
- Weight Efficacy Life-Style Questionnaire – WELSQ (Clark, Abrams, Niaura, Eaton, & Rossi, 1991).

In addition, the following psychometric questionnaires were administered before and after each treatment session:

- State Anxiety Inventory–STAI (Spielberger, Gorsuch, & Lushene, 1970);
- Visual Analogue Scales (VAS): a variation of Gross & Levenson's measure (Gross & Levenson, 1995) assessing relaxation (VAS-R).

Psychophysiological assessment

Immediately before and after each treatment session, the Procomp Infiniti Biofeedback system was used to record the heart rate (HR) in order to obtain an objective measure of the internal state of the patients.

The relaxing narratives

The narratives consisted of a combination of different relaxation techniques mainly based on the Progressive Muscular Relaxation (PMR) (Borkovec & Costello, 1993) and the Applied Relaxation (AR) (Ost & Breitholtz, 2000). The PMR directly targets muscular tension and relaxation, while the aim of AR is to demonstrate relaxation as an effective coping strategy for significantly reducing anxiety under many daily-life circumstances. During the second week of treatment, in the VR group the narratives were presented together with the Green Valley in order to create an audio-video experience that enhanced the effect of the relaxing experience (D. Freeman, 2003; J. Freeman et al., 2004).

The virtual environment software

Two different virtual environments included in the open-source software NeuroVR 1.5 were used (Riva, Gaggioli et al., 2007). For the relaxation sessions, the Green Valley, a very relaxing environment showing a mountain landscape around a calm lake, is presented together with a relaxing narrative and soft sounds (birds' songs, water flowing, etc). Participants were asked to walk around the lake, to observe the nature and, after few minutes, to virtually seat on a comfortable deck chair, in order to become easily relaxed.

A screen shot of the Green Valley

A screen shot showing a buffet in a restaurant

For the final part of the protocol, patients were presented with specific virtual stressful environments simulating real-life situations that usually cause stress and emotional eating episodes: a kitchen, a restaurant, a supermarket, an office and so on. Each of these environments could be modified by the therapist with objects and persons depending on patients' personal characteristics and needs.

Technological devices

The VR system is composed by:

- a laptop (Asus G2S; Intel® Core™2 Extreme Processor X7800);
- an Head Mounted Display (HMD), Sony Glasstron PLM S-700, equipped with a visual device for a 3D view of the virtual environment and an audio device (earphones) to listen to the narratives;
- a position tracker, Intersense Intertrax2 256 Hz, that allows the user to modify his/her point of view in the virtual environment according to his/her move ments in the real world;
- a joystick.

Statistical Analysis

Power analysis with alpha=0.05 showed a statistical power of 0.80 and a total sample size of 51 to detect a large difference (f=0.45) between the three groups (VR, IM and WL). Power analyses were made using GPOWER (Faul & Erdfelder, 1992).

Normality of distributions was tested with Kolmogorov-Smirnov test, which showed the violation of the assumption for many variables in all the three groups. As noted by Hogan and Peipert (Hogan & Peipert, 1998), when the variables are not normally distributed, but rather skewed in some direction or kurtosis, as in this case, it is more appropriate to compare the median than the mean. The most common statistic test for doing so is the Mann-Whitney U statistic, which typically requires large samples for powerful group comparisons.

Having a larger sample size (n=60) and expecting to find a large difference between the two experimental groups and the WL condition, we decided to use exact non-parametrical tests with Monte Carlo estimate both for between and within groups comparisons. In statistics, an exact (significance) test is a test where all assumptions upon which the derivation of the distribution of the test statistic is based are met, as opposed to an approximate test, in which the approximation may be made as close as desired by making the sample size big enough. For example, an exact test at significance level 5% will in the long run reject true null hypothesis exactly 5% of the time (Fisher, 1925), avoiding Type I Errors. The Monte Carlo method (Manley, 1991) provides an unbiased estimate of the exact p value, without the requirements of the asymptotic method. From the Mann Whitney U statistic for the pre and post treatment analysis, we calculated Cohen's d, in which a value of 0.20 may be interpreted as a small effect, 0.50 as a medium effect, and 0.80 and greater as a large effect (Cohen, 1988). The Kruskall-Wallis test with post hoc analysis (Siegel & Castellan, 1992) was used for between groups comparisons of independent measures and the Wilcoxon rank-sum test was used for repeated measures. Chi-square test was used for categorical data, with _=0.05, two-tailed. Data were analyzed using SPSS 11.0.

Results

Pre-treatment characteristics of the three groups were compared. As a check of the random assignment to conditions, Kruskal-Wallis test were carried out on all the epidemiological and clinical variables. None of the tests showed significant statistical differences between the three groups.

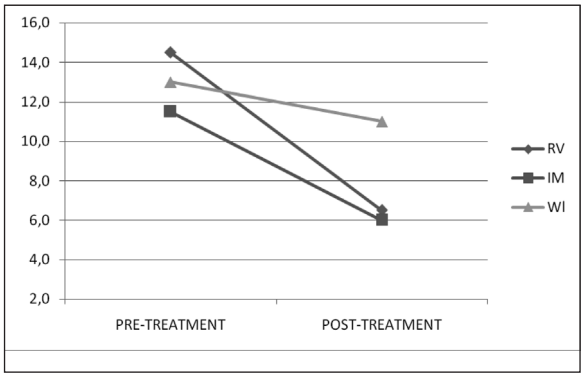
Pre and post treatment analysis

The Wilcoxon Rank-Sum test on the pre vs post treatment scores showed significant changes in the three groups for the WELSQ and the BDI (see table 2).

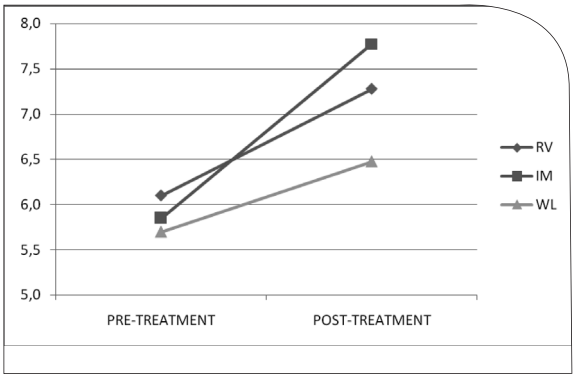
	Group	N	Median (PRE)	chi square[1] (PRE)	P (PRE)	Median (POST)	chi square[1] (POST)	P (POST)
WELSQ	VR	20	6.1	2.13	0.343	7.275**	7.65	0.022
	IM	20	5.85			7.775**		
	WL	20	5.7			6.45**		
BDI	VR	20	14.5	0.97	0.616	6.5***	5.3	0.069
	IM	20	11.5			6**		
	WL	20	13			11**		

Wilcoxon Rank-Sum test on the pre vs post treatment scores.
(Wilcoxon Rank-Sum test between the pre and post scores: *=p<.05; **=p<.01; ***=p<.001)

Between groups, analyses on post-treatment scores showed significant differences between the WL group and the two treatment groups for the WELSQ (VR vs WL: U=125, p<0.05, effect size d=0.81; IM vs WL: U=101.5, p<0.01, effect size d=1.13) and the BDI (VR vs WL: U=127, p<0.05, effects size d=0.78; IM vs WL: U=126, p<0.05, effect size d=0.79), while no significant differences were found between the VR and IM groups (see figures 3 and 4).
With respect to weight data, median weight significantly decreased within the three groups (p<0.01), but no significant difference in weight reduction was found among them.



BDI median scores for the 3 groups before and after treatment



WELSQ median scores in the 3 groups before and after treatment

Pre- and post- sessions analysis

The Wilcxon Rank-Sum test showed a significant decrease of state anxiety (STAI-Y1) and a significant increase of relaxation (VAS-R) before and after each treatment session both in the VR and in the IM groups, while no differences were found between them.

Accordingly to these data, we found significant decreases in heart rate values both in the VR and IM groups after each session.

Discussion

This explorative study evaluates the effectiveness of a relaxation training supported by the use of virtual environments and portable mp3 players in a sample of female obese inpatients with emotional eating. During the first part of the treatment, patients included in the VR group were immersed in a very relaxing virtual environment in which calm images associated to relaxing narratives helped them to reach a good level of relaxation. During the second part of the protocol, the same patients experienced some critical situations related to the maintaining/relapse mechanisms (Kitchen, Supermarket, Pub, Restaurant, etc) and were guided to react to them with the previous acquired relaxation techniques. Patients included in the IM group followed a very similar relaxation training in which virtual environments were replaced by imagination. In both cases, at the beginning of the treatment, participants received an mp3 player and were instructed to listen to the narratives anytime they felt stressed, anxious or sad (or at least once a day). These mobile devices allowed patients to practice relaxation techniques regularly, even when they did not have the possibility to meet the therapist (for example during the week-end days).

The analyses performed on the psychological variables at the beginning and at the end of the treatment indicated that the relaxation training increased the perceived self-efficacy for eating control as measured with the WELSQ and reduced the depression level as shown by the BDI scores in both the experimental groups (VR and IM). We argue that these positive results do not exclusively depend on the residential weight control treatment, since we found them only in the two experimental groups, but not in the WL group. In particular, the effectiveness of relaxation training on the perceived self-efficacy for eating control means that patients improved beliefs about being able to cope functionally with critical situations and supports the hypothesis that obese patients with emotional eating tend to use eating to cope with stressful situations and related negative emotions (Lindeman & Stark, 2001; Ozier et al., 2008; Volkow & Wise, 2005). These results are quite impressive since they have been obtained in only three weeks of relaxation training.

Weight significantly decreased in all the three groups, without difference among them. This result was largely expected because, during the residential treatment, food intake, physical exercise and eating behavior were strictly controlled.

Regarding the within sessions effects, the relaxation training was effective in reducing state anxiety, as measured by the STAY-Y1, and in increasing the relaxation level, as measured by the VAS-R, in the two groups of patients. Similar results have been found in the last three sessions when they were exposed to virtual simulated or imagined stressful situations and asked to relax using the previous acquired techniques. Coherently with the psychological observations, along the entire treatment, we observed a significant decrease in heart rate values indicating an objective reduction of the physiological arousal. Regarding the two different conditions (VR vs IM), they appear to have different effects neither on post-treatment nor on within-sessions outcomes. This result is in contradiction with Freeman's (J. Freeman et al., 2004) and Riva's findings (Riva et al., 2008) that showed that VR is more effective than the narratives alone in facilitating relaxation.

A possible explanation of this apparent lack of effectiveness of VR immersion regards the use of a quite uncomfortable head-mounted display, of a position tracker often characterized by a poor movements accuracy and of a virtual environment not totally feasible in its technical and graphical features. Since in their study Freeman et al. (J. Freeman et al., 2004) provided immersion using a large projection screen instead of an head-mounted display, we hypothesize that the HMD with an embedded position tracker, usually adopted for VR exposure, is not indicated for relaxation purposes. Moreover, the virtual environment we used is graphically less realistic compared to the one used by Freeman (J. Freeman et al., 2004) and Riva (Riva et al., 2008). Furthermore, it is characterized by few moving objects that are not strictly matched with subjects' physical rhythms (i.e. breathing and heart rate). Probably, these critical features negatively moderated the expected enhancing interaction effect of the relaxing narratives and the audio-visual virtual environment. However, this is only a speculation because we did not measure the sense of presence and thus we can say nothing about the subjective quality of experience.

In conclusion, some useful considerations emerge from this exploratory study. First, a brief relaxation training (12 sessions for 3 weeks) provided to obese female inpatients with recurrent emotional eating episodes seems to improve their perceived self-efficacy in eating control and depressive symptoms. We argue that these improvements may have a positive effect on eating behavior (i.e. reduced emotional eating episodes) and on long-term weight loss. However, we need further clinical trials in order to test this hypothesis. Second, even if we did not find any difference between the two conditions (VR and IM), we suppose that VR may play a significant role in providing relaxation when it is well technically and graphically arranged. In his book on "emotioneering" Freeman (D. Freeman, 2003) suggests some possible "recipes" for emotional induction through media, but it is not clear how to manipulate the aspects of form and content of interactive media to induce an emotional response (Riva, Mantovani et al., 2007). From the present experience we conclude that, for relaxation training purposes, providing immersion by an head-mounted display with an embedded tracker device is probably not feasible, that graphical realism is a critical concern and that key moving objects linked to the subjects' physical rhythms (i.e. breathing and heart rate) are necessary.

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