

■ Feasibility of a virtual reality program to treat children with fear of darkness with nonexpert therapists

Mateu Servera¹, Belén Sáez¹, & Joan Miquel Gelabert Mir²

¹Research Institute of Health Science (IUNICS) & University of the Balearic Islands (UIB), Spain

²Psico Smart Apps, SL Company & Quiron Salud Palma Planas Hospital, Spain

Abstract

Fear of darkness is highly prevalent and stable in children and often ends up becoming a specific situational phobia. The aim of this study is to analyze the feasibility of adapting and applying it through a Virtual Reality (VR) tool by nonexpert therapists. A pre-experimental study was carried out with six participants between the ages of 8 and 12 years old using pre- and posttreatment scales for assessing the fear of darkness. Statistically significant differences with large effects were found in all posttreatment measures: EMO (Roshenthal's $r = 0.64$), WCDAN ($r = 0.52$), and Global item of current fear of darkness ($r = 0.59$). Using the Reliable Change Index (RCI) as a measure of clinically significant change, four participants improved satisfactorily, one acceptably, and the other did not improve. The results support the feasibility of using an adapted VR program to treat fear of darkness without being an expert therapist. However, more detailed experimental studies need to be carried out in order to analyze its efficacy.

Keywords: fear of darkness; virtual reality; treatment; childhood phobia; exposure therapy.

Resumen

Viabilidad de un programa de realidad virtual para tratar niños con miedo a la oscuridad con terapeutas no expertos. El miedo a la oscuridad es muy frecuente y estable en los niños y, a menudo, termina convirtiéndose en una fobia situacional específica. El objetivo de este estudio es analizar la viabilidad de adaptarlo y aplicarlo a través de una herramienta de realidad virtual (RV) por terapeutas no expertos. Se ha llevado a cabo un estudio pre-experimental con seis participantes de 8 a 12 años de edad utilizando escalas de pre y postratamiento para evaluar el miedo a la oscuridad. Se han encontrado diferencias estadísticamente significativas con tamaños del efecto grandes en todas las medidas posteriores al tratamiento: EMO (Roshenthal's $r = 0.64$), WCDAN ($r = 0.52$), e ítem global del miedo actual a la oscuridad ($r = 0.59$). Al usar el Índice de Cambio Fiable (ICF) como una medida del cambio clínicamente significativo, cuatro participantes mejoraron satisfactoriamente, uno aceptablemente, y el otro no mejoró. Los resultados apoyan la viabilidad de utilizar un programa de RV adaptado para tratar el miedo a la oscuridad sin necesidad de un terapeuta experto. Sin embargo, se necesitan estudios experimentales más detallados para analizar su eficacia.

Palabras clave: miedo a la oscuridad; realidad virtual; tratamiento; fobia infantil; terapia de exposición.

Fear of darkness is one of the most stable and frequent evolutionary fears in children. In fact, a fear of the dark, or more specifically, a dread of sleeping alone in the dark, is estimated to be one of the 10 most common fears in children between 7 and 13 years of age (Canals, Voltas, Hernández-Martínez, Cosi, & Arija, 2019; Gordon, King, Gullone, Muris, & Ollendick, 2007; Muris, Merckelbach, Ollendick, King, & Bogie, 2001). Some preliminary work indicates that approximately one-third of children are afraid of being left alone in a dark space (Méndez, Orgilés, & Espada, 2004). Although many children overcome this evolutionary fear when they grow up, the phobia of the dark would be prevalent in

2.3% of this population (Fredrikson, Annas, Fischer, & Wik, 1996; Méndez et al., 2004; Muris et al., 2001).

A growing body of research has demonstrated that exposure techniques have a positive effect in psychological treatment for specific phobias (Barlow, 1988; Barlow, Esler, & Vitali, 1998; Barlow, Raffa, & Cohen, 2002; Marks, 1987), although most studies have been conducted on adults. The specific contribution of exposure in children is very similar to treatment in adults. Nonetheless, there are many more variations with the purpose of favoring a greater acceptability of treatment and attenuating the possible aversion as a result of the exposure. Some preliminary and exceedingly innovative work was carried out in

Corresponding author:

Mateu Servera.

University of the Balearic Islands.

Ctra. Valldemossa Km. 7,5, 07122, Palma, Spain.

E.mail: mateus@uib.es

the 1980s by Mikulas and Coffman (Mikulas & Coffman, 1989; Mikulas, Coffman, Dayton, Frayne, & Maier, 1986). Their proposal focused on home-based treatment of children's fear of the dark, based on bibliotherapy and behavioral-based games intervention, where parents could carry out the program with minimal therapeutic guidance. In fact, these authors highlight that until this study, most of behavioral interventions were conducted in research laboratories and on test subjects with moderate fears. One of the strengths of these works was the development of specific measurements used to evaluate the efficacy of the treatments that have been used subsequently.

In a quantitative review of the psychological treatment for the phobia of darkness, Méndez, Orgilés and Rosa (2005) concluded that the multicomponent treatment packages achieved the best results. Although in general the effect size was always very high in all cognitive-behavioral programs, the most effective procedure was Emotive Performances ($d = 2.38$). This program was developed by Méndez and García (1996), and is based on the combination of *in vivo* desensitization through games or dramatizations, participant modeling, and social and material reinforcement of approach responses. The application of the program requires the presence of a highly qualified therapist. However, it has been suggested that current technologies could be an interesting option to improve the cost-efficiency of psychological intervention programs (Bouchard et al., 2017; Segal, Bhatia, & Drapeau, 2011; Turner & Casey, 2014), and in this particular case, the use of technologies as Virtual Reality (VR) could also be a good alternative.

Through VR, it is possible to create virtual worlds and artificial experiences in real time. This technology enables the reproduction of relevant stimulation configurations for mental health intervention, as well as the possibility of manipulating certain variables in order to control and adapt the intervention to the user's characteristics (Aziz, 2018; Ryan, Cornick, Blascovich, & Bailenson, 2019). VR offers numerous advantages, such as being able to place the patient in multiple environments and conditions in a very short period of time and at little cost. Moreover, VR is considered an advantage among various other tools that are available and are based upon empirically validated psychological intervention and assessment protocols (Goodheart, Kazdin, & Sternberg, 2006; Turner & Casey, 2014). Therefore, and despite existing methodological limitations, many clinical trials and review studies have provided evidence of the usefulness and efficacy of virtual reality exposure therapy (VRET) for the treatment of phobias and anxiety disorders in adults (Botella, Fernández-Álvarez, Guillén, García-Palacios, & Baños, 2017; Carl et al., 2019; Powers & Rothbaum, 2019). However, one of the main issues is a lack of studies

in children population (Bouchard et al., 2017; Riva, Baños, Botella, Mantovani, & Gaggioli, 2016). These include studies that have examined school refusal (Gutiérrez-Maldonado, Magallón-Neri, Rus-Calafell, & Peñaloza-Salazar, 2009), social anxiety (Sarver, Beidel, & Spitalnick, 2014) and autism spectrum (Parsons & Cobb, 2011). The aim of this study was to analyze the viability of treating the fear of darkness in children through a VR program based on the Emotive Performances treatment package. The hypothesis was that the treatment would improve the children's fear of darkness and increase their behaviors to deal with the darkness with a large effect size.

Method

Participants

A general dissemination of the project was made among 10 schools on the Island of Mallorca, Spain. A total of 45 families expressed an interest in the study. Inclusion criteria to participate were as follows: (a) children between 8 and 12 years of age at the beginning of treatment, and (b) a total score equal to or higher than 7 on the children *Assessment Scale of Fear of Darkness (EMO, Escala de Evaluación del Miedo a la Oscuridad)* rated by their parents.

Applying these criteria, 37 children were selected. Through interviews, these children were assessed to confirm their fear of darkness (i.e., persistent for at least 6 months), obtain more information about the characteristics of the family and rule out the presence of medical problems (i.e., cardiac problems or those related to vertigo for which the use of VR was not recommended), intellectual disability, autism spectrum disorders, and schizophrenia spectrum and other psychotic disorders. A total of 6 participants were rejected due to the inability of their parents to attend the treatment. Lastly, of the remaining 31 participants, only 10 were randomly selected because we do not have resources to treat more participants. The treatment group consisted of six boys and four girls with a mean age of 9.61 ($SD = 1.41$), and none of them had ever been treated for their fear of the dark. However, after finishing the treatment, only the posttreatment evaluation of six families could be obtained (in all cases the parents informed us of their satisfaction with the treatment, but despite our insistence four families did not return the post-treatment evaluation). The demographic and personal characteristics from the six participants are presented in Table 1.

Table 1. Demographic and personal characteristics

| Participant | P1 | P2 | P3 | P4 | P5 | P6 |
|------------------|--------------|----------|--------------|--------------|--------------|--------------|
| Sex | Girl | Girl | Girl | Boy | Boy | Boy |
| Age | 11.75 | 9.48 | 8.05 | 7.89 | 9.42 | 8.49 |
| Adopted | No | No | No | Yes | No | No |
| Comorbidity | No | No | No | Yes | No | No |
| Divorced parents | Yes | No | No | No | No | Yes |
| WISC-IV | | | | | | |
| Vocabulary | 10 | 10 | 7 | 5 | 15 | 10 |
| Block design | 8 | 9 | 11 | 12 | 14 | 13 |
| CBCL | | | | | | |
| Internalizing | Non-clinical | Clinical | Clinical | Clinical | Non-clinical | Non-clinical |
| Externalizing | Non-clinical | Clinical | Non-clinical | Non-clinical | Non-clinical | Non-clinical |

CBCL: Child Behavior Checklist, parent version.

Measures

A clinical psychologist applied an unstructured interview to parents to determine the inclusion and exclusion criteria. In addition, all participants were assessed with the fourth edition of the *Wechsler Intelligence Scale for Children* (WISC-IV) and the *Child Behavior Checklist* (CBCL) to know their intelligence quotient (IQ) and screening their emotional and behavioral problems. These measures were used only for sociodemographic description of the sample, but we also considered interesting to be able to analyze their influence on the treatment, even if it was from a purely qualitative point of view. The pre-posttest measurements were carried out with three different measures:

Assessment Scale of Fear of Darkness (EMO, Escala de Evaluación del Miedo a la Oscuridad; Méndez et al., 2004; Orgilés et al., 2008). This scale completed by parents consists of 10 items linked to practically all of the diagnostic criteria for specific phobia of the DSM-IV-TR (American Psychiatric Association, 2000) and adapted to the fear of darkness. Each item is rated from 0 to 10, and a global measure of fear of darkness is obtained (maximum of 100 points). We have not found reliability values for this scale, but using our sample the Cronbach's alpha of internal consistency was .79.

What my Child Can Do At Night (WCDAN, Lewis, Amatya, Coffman, & Ollendick, 2015; Mikulas & Coffman, 1989). It consists of 11 items that parent-report measure children's self-efficacy to face situations in the dark. We translated to Spanish with the supervision of a graduated in English philology whose native language was Spanish. The items are rated on a 3-point scale. A total score is obtained, with a maximum of 22 points, where a higher score indicates a greater ability to face situations in the dark. Lewis et al. (2015, p. 106) provided an index of reliability based on the Cronbach's alpha of .89. Our Spanish version showed an index of .68.

An item of current fear of darkness *Ad hoc: Indicate from 0 to 10 the level of fear of darkness experienced by your child (i.e., according to behavior observed last week)*.

Parents completed the measures between 3 and 7 days before starting and after the completion of the treatment.

Procedure

The project was approved by the Research Ethics Committee of the University of the Balearic Islands (UIB), Spain. All parents who participated signed the informed consent. All sessions were held in clinical offices at the UIB. The characteristics of the program and how the sessions were conducted are explained below. The participants did not receive any economic incentive for their participation.

Treatment program

The treatment program was carried out through a VR tool developed by Psious ("Psious", n.d.). This tool provides a specific virtual environment created to deal with fear of darkness. In our case, we used the virtual environment adapted to the Emotive Performances treatment procedure (Méndez et al., 2004; Orgilés, Méndez, & Espada, 2005). Therefore, the VR treatment is presented as a game. The goal of the game is to explore the different rooms of the house and spend as much time as possible in them. Each of the rooms has a predetermined light level graduated from lowest to highest. In addition, the light in the rooms can be reduced (from 100% to 0%) by a sliding bar, depending on the therapeutic needs.

Hence, the child must progressively be able to spend more time in different rooms with lower brightness of light. The last stage of the game consists of going to the child's virtual bedroom, laying down on the bed, and remaining at least two minutes in total darkness. More information about the characteristics of the program, instructions and images can be found in this supplementary material: < <https://bit.ly/2kzWj8I> >.

The treatment was individualized and of short duration (6 to 8 sessions of approximately 40 minutes each). To carry it out, four fourth-year psychology students (girls between 20 to 22 years old) were selected. They had no previous experience as therapists, and were trained during 20 hours in the management of the virtual reality program and the intervention protocol by the authors of the present work. Throughout the intervention, they were able to share their doubts with two supervisors. In the supplementary material cited above are described the activities carried on in each session.

Design and data analysis

We used a pre-experimental design (Thyer, 2012). The design is a series of pre- and posttreatment measures with a single treatment group. The children were assessed by their parents pre- and posttreatment using the three measures previously described.

Due to the reduced number of participants, the comparison between the pre- and posttreatment was evaluated using the non-parametric Wilcoxon test, using SPSS software. Furthermore, the recommended effect size for this test, Rosenthal's r , was used (Fritz, Morris, & Richler, 2012; Rosenthal, 1994). The most usual way of interpreting this effect size is as follows: values greater than 0.1 indicate a small effect, greater than 0.3 a medium effect, and greater than 0.5 a large effect.

Afterwards, the percentage of improvement of each participant on the different scales was calculated. Although there is no established cut-off point for this type of analysis, following Ostelo et al. (2008), a 30% improvement can be considered an acceptable point for most clinical studies. This means an approximate improvement of one-half standard deviation.

Lastly, the Reliable Change Index (RCI) was computed as in their classical formulation of Jacobson and Truax (1991) (i.e., dividing the change score by the standard error of measurement of the differences) for EMO, WCDAN, and the item of current fear of darkness. The RCI scores were used to evaluate significant clinical changes on these measures, following the same procedure applied by Lewis et al. (2015). Therefore, a clinically significant change was defined for each participant that exceeded the cut-off points: a Z-score lower than -1.96 on the EMO, and higher than +1.96 on the WCDAN.

Results

Table 2 shows the comparisons of pre- and posttreatment measurements using the Wilcoxon test. The pre- and posttreatment comparisons were statistically significant (p values < .04) for the EMO and the item of current fear of darkness. In these two measures, the treatment group showed a tendency toward significant improvement (i.e., there was a significant decrease in the fear of darkness scores). However, nonsignificant differences were found for the WCDAN ($p = .07$), although the scores increased, so that in general the children's behaviors facing darkness were also improved. Regardless, the effect sizes of the improvements were large in all three measures (i.e. > 0.5).

Table 2. Pre vs. posttreatment comparisons in the Wilcoxon test

| | Pre-treatment | Post-treatment | Z | p | r |
|-------------|---------------|----------------|-------|-----|------|
| | M (SD) | M (SD) | | | |
| EMO | 74.50 (10.99) | 32.33 (25.55) | -2.20 | .02 | 0.64 |
| WCDAN | 10.17 (3.97) | 15.67 (5.47) | -1.79 | .07 | 0.52 |
| Global Item | 6.67 (1.03) | 2.83 (2.79) | -2.06 | .03 | 0.59 |

EMO = Assessment Scale of Fear of Darkness; WCDAN = What My Child Can Do At Night; Global Item = Item of current fear of darkness (0-10); M = mean; SD = standard deviation; Z = Z-score; p = significance level; r = Rosenthal's r

Table 3 shows the percentages of therapeutic improvement on the EMO (i.e. assessment of fear of darkness) for each participant. All participants showed an expected decrease in the posttreatment scores for fear of darkness. For all participants, except for P6, the decrease was greater than 30%.

Table 3. Percentage of posttreatment improvement on the Assessment Scale of Fear of Darkness (EMO)

| | Pre-treatment | Post-treatment | Change | % Improvement |
|----|---------------|----------------|--------|---------------|
| P1 | 59 | 0 | -59 | -100% |
| P2 | 77 | 13 | -64 | -83% |
| P3 | 86 | 31 | -55 | -64% |
| P4 | 63 | 27 | -36 | -57% |
| P5 | 83 | 54 | -29 | -35% |
| P6 | 79 | 69 | -10 | -13% |

In addition, the results from the RCI on the EMO for each participant are shown in Figure 1. All participants showed a Z-score value lower than -1.96, with the exception of P6. Thus, these results revealed a clinically meaningful effect on the EMO scale (i.e. the reduction of the darkness phobia symptoms) in five out of the six participants.

Figure 1. Reliable Change Index (RCI) on the What My Child Can Do At Night (WCDAN) scale

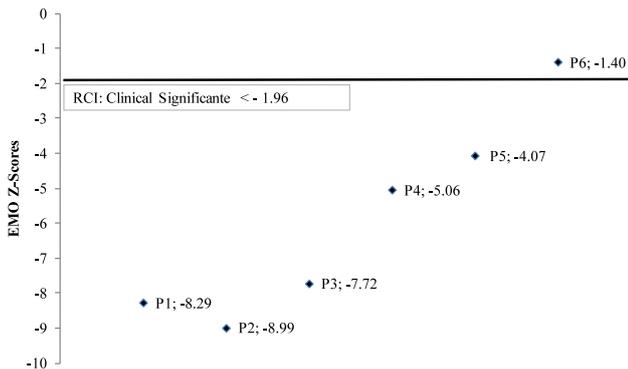


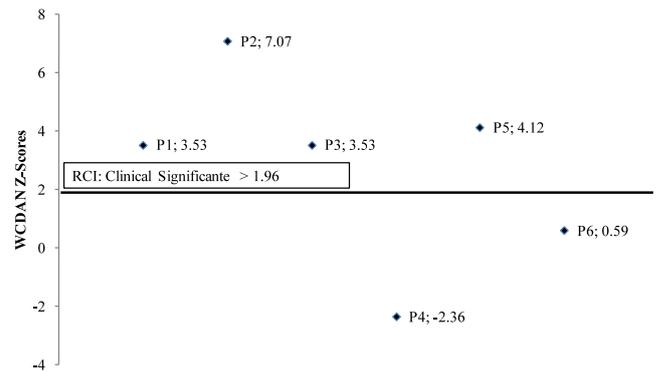
Table 4 shows the percentage of improvement for each participant on the WCDAN. Four participants showed a positive increase (greater than 30%) in behaviors to face situations in darkness. P6 also showed a percentage of improvement, but only by 11%. However, P4 was the only participant whose score worsened (-31%).

Figure 2 presents the results from the RCI on the WCDAN (*What my Child Can Do At Night*). Four participants significantly improved on the WCDAN (i.e. their self-efficacy to face situations in the dark), since their Z-score values were higher than 1.96. Nevertheless, two of the participants showed an RCI value lower than the cut-off point (i.e., they did not improve enough to consider their change clinically significant).

Table 4. Percentage of posttreatment improvement on the "What my Child Can Do At Night" scale (WCDAN)

| | Pre-treatment | Post-treatment | Change | % Improvement |
|----|---------------|----------------|--------|---------------|
| P1 | 14 | 20 | 6 | 43% |
| P2 | 8 | 20 | 12 | 150% |
| P3 | 9 | 15 | 6 | 67% |
| P4 | 13 | 9 | -4 | -31% |
| P5 | 4 | 11 | 7 | 175% |
| P6 | 9 | 10 | 1 | 11% |

Figure 2. Reliable Change Index (RCI) on the Assessment Scale of Fear of Darkness (EMO)



Lastly, Table 5 shows the percentage of decrease after the treatment on the item of current fear of darkness. Four participants showed a progressive decrease in their current fear greater than 30%. For P5, the percentage of decrease was 29%, while P6 did not change his pre-treatment score.

Table 5. Percentage of posttreatment improvement on the global item of current fear of darkness

| | Pre-treatment | Post-treatment | Change | % Improvement |
|----|---------------|----------------|--------|---------------|
| P1 | 5 | 0 | -5 | -100% |
| P2 | 8 | 3 | -5 | -63% |
| P3 | 6 | 0 | -6 | -100% |
| P4 | 7 | 2 | -5 | -71% |
| P5 | 7 | 5 | -2 | -29% |
| P6 | 7 | 7 | 0 | 0% |

Discussion

Although exposure techniques have been shown to be the best option for treating phobias, multicomponent procedures have been developed in children to increase acceptability and attenuate the possible aversive effects of a single and direct exposure to a phobic stimulus. Emotive Performances is one of these procedures and has also shown a particular efficacy for the treatment of fear of darkness in children (Méndez & García, 1996; Méndez et al., 2005).

The current study suggests that an option to improve the cost-efficiency of Emotive Performances would be to adapt this procedure for use through Virtual Reality (VR). In this way, without the need for highly trained therapists, it is possible for users to develop the skills to interact with the stimuli of the environment, face their problem, and then transfer these learnings to the real world, and with a better cost-efficiency than working in real environments (Srivastava, Das, &

Chaudhury, 2014; Turner & Casey, 2014; Wiederhold, Miller, & Wiederhold, 2018).

A pre-experimental pre-post design was carried out using a sample of six children between 8 and 12 years of age. The differences between pre- and posttreatment measures to assess fear of darkness were statistically significant, showing r effect sizes equal or higher than .50. In all previous studies the statistic used to measure the effect size was Cohen's d . In our case we had to use the Rosenthal's r , since the sample is very small and we use non-parametric procedures. From a qualitative point of view, they are comparable since in both cases cut-off points are used to determine the presence of small, medium or large effects. In this sense, our results indicate improvement with moderately large effect sizes, similar to the best effects found in previous studies, where different procedures were applied to treat fear of darkness (Lewis et al., 2015; Méndez et al., 2005; Mikulas & Coffman, 1989).

It is evident that in a pre-experimental study with such a small sample, the analysis of the clinical improvement is more interesting than the statistically significant group differences. Therefore, two procedures to evaluate clinical improvement were proposed: a 30% improvement and a reliable change index (RCI) at 95% at posttreatment measures. The average percentage of improvement was 59% on fear of darkness scale EMO (fear of darkness as a global disposition), 69% on darkness coping behaviors measure (WCDAN), and 61% on current fear of darkness item. Specifically, only some participants on some measure did not improve as expected: P6 on EMO, P6 and P4 on WCDAN, and P6 on current fear of darkness item (P5 was one percentage point below the cutoff criterion, 30%). The improvement on the RCI was very significant for all participants both on EMO (except for P6), and WCDAN (except for P6 and P4).

In fact, our design does not allow us to establish the reasons why the treatment did not work in two children (i.e., P4, and more specifically in P6). This cannot be due to the presence of clinical symptoms, since they were present in P4, but not in P6, and other participants with symptoms improved. However, in the case of P4 there are two characteristics to highlight: P4 was the youngest child and showed lower scores on the vocabulary subtest on WISC-IV (Scaled Index Score = 5). Regarding P6, this participant did not show clinical symptoms and the scores on WISC-IV were normal. A possible explanation for these results might be that P6's parents were divorced and, in addition, did not reach a sufficient level of agreement about bedtime routines and rules. It should be noted that P1's parents were also divorced but had enough agreement between them to be involved in the treatment. Therefore, although the results are extremely preliminary, the hypothesis for future works should consider, on the one hand, to compare the effectiveness of the program with children above and below eight years and, on the other hand, to analyze the influence of the parental relationship, and the child's cognitive level of development.

Lastly, our work has led us to conclude that there is a general trend toward greater improvement in girls than in boys, in contradiction with earlier findings (Méndez et al., 2005). However, given our small sample size, caution must be taken, although this should be considered in future studies. In any case, it should be noted that despite the obvious lack of power, the data have allowed us to find statistically significant differences in two of the three measures used.

In sum, this study supports the feasibility of VR therapy based on Emotive Performances for the treatment of fear of darkness with nonexpert therapists. Its main limitations are obviously those derived from its pre-experimental design: small sample sizes, not randomized, and without a control group. Therefore, in the future, the efficacy of

this type of treatment should be studied using larger samples, randomized controlled trials, follow-up measures, and including mediating and moderating variables.

In our view, although numerous studies have demonstrated the clinical utility of VR in adults (Botella et al., 2017; Mishkind, Norr, Katz, & Reger, 2017; Mohr, Burns, Schueller, Clarke, & Klinkman, 2013; Turner & Casey, 2014; Valmaggia, Latif, Kempton, & Rus-Calafell, 2016), so far very few investigations have used this technology to analyze its viability in children (Bioulac et al., 2018). Therefore, even with some limitations, the findings of the present study are promising for the future, and indicate that it is possible to address specific childhood phobias much more efficiently by adapting widely contrasted psychological procedures to the possibilities offered by VR.

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