

Volume 8, n 3, 2020

**Reports**

**Vlad - Virtual Reality Application for Treatment of Psychosomatic Conditions: A report at final stage of software validation process**

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**Abstract**

Vlad is an innovative serious game that aims to introduce Virtual Reality (VR) in psycho-therapeutical treatment related to emotions. It is a storytelling-based game, where the user is invited to create a tale using a determined series of 20 functions detected by Vladimir Propp studying Russian fairy tales. The game is based on a Game Board where the user can pass from one function to another and create a story with a group of cards, each one representing a possible action/function.

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**Keywords:**

Clinical Psychology; Psychosomatics; Vlad; Virtual reality; Treatment.

**Received:** 11 November 2020

**Accepted:** 30 November 2020

**Published:** 19 December 2020

**Citation:** Pappalardo, S.M. (2020). Vlad - Virtual Reality Application for Treatment of Psychosomatic Conditions: A report at final stage of software validation process. *Mediterranean Journal of Clinical Psychology*, 8(3).

<https://doi.org/10.6092/2282-1619/mjcp-2868>



The present work aims to demonstrate that Virtual Reality (VR) can investigate several pathologies, in this case the treatment of all phenomena which interrupt the relationship between cognition and representation, such as defences in psycho-somatic phenomena.

Perception and representation phenomena present an important difference, from the phenomenological point of view (Jaspers, 1913), that deepen when passing from the first one to the second one and in their role in the psyche.

Images can evoke emotions in many ways and the results of their activity is evident in several mental disorders. Three possible ways are: i. a direct influence on the emotional systems of the CNS, sensitive to sensory signals and therefore in a perceptive order; ii. the overlap between the processes involved in mental imaging and the perception which can lead to responding from

the "*as if*" perspective to actual emotional events triggered by them; iii. the ability of images to come into contact with memory traces due to emotional factors linked to past episodes and thus to become representations subject to unconscious dynamics.

This also occurs with drug addiction, where the sight of an image of the desired drug induces abnormal alterations and manifestations of emotional circuits (Kavanagh et al., 2005). The actions of the images concern correlates that are often explicitly reported by those emotional disorders such as post-traumatic one or social phobia, as reported by Hackmann and Holmes (2004), Hirsch and Holmes (2007) and Holmes et al. (2007).

For this reason, therapists have incorporated the manipulation of mental images during treatment related to emotional concerns.

Vladimir Propp introduced in 1950 a model for the structure of fairy tales. This model has become one of the milestones of semiotic analysis and narratology and its applicability goes beyond Russian fairy tales (Berger, 2002). It can be seen as a common pattern for all folk tales, including non-European and ancient societies.

The Propp's model can be regarded as an archetypal structure for all narratives in the considered areas. It consists of 31 consecutive functions, each one functioning as an isolated element in the tale, concurring to the narrative as a whole. The list has been then reduced to 20 (Greimas, 1983) by later studies.

Our intent is to extend the outcomes of classical psycho-therapeutic approach to new issues of Virtual Reality.

### **Literature and theoretical contest**

Recent research highlighted the need to extend new perspectives to educational paths (Settineri et al., 2019b). The need is based on a lack of knowledge about psychological issues related to physical outcomes, meant as concurring factors providing maladjustment and further issues (Koocher & Hoffman, 2020; Marek et al., 2020; Maloney & Schmidt, 2020; Merlo et al., 2020a, 2020b; Parola, 2020; Settineri et al, 2018; Shahar, 2020).

In order to highlight the above-mentioned advantages, it is necessary to point out some relevant dynamics often not included in previous perspectives, such as narratives and story-telling (Bourlot, 2017, 2018, 2019, 2020; Nurser et al., 2018; Parola & Felaco, 2019; Settineri et al., 2019a; Smorti, 2020; Sperandeo et al., 2019; Veronka, 2019).

The special connections that images have with emotion areas is not a new idea: for example, it is central to the Bio-Informational-Emotional-Imaginary theory by Lang (1979). Images can possibly, other than underlie the symptomatology and subjective phenomenology, also act as

guarantors. In fact, the power of the images and the reactions they cause, in relation to particular clinical situations, generates products analyzable through refined methods with a long tradition. Thus, through phenomenological psychology, image and conscience can express their inextricable co-belonging (Sartre, 1948). Phenomenology makes the moods of the person present and evident (Jaspers, 1912, p. 391) and it distinguishes representation from perception (Jaspers, 1913-1959). Through the psychoanalytic point of view, it becomes possible to consider it as a *representation of thing*, closely linked with the *representation of word*, both endowed with *affective charge*. Therefore, affective representation translates in terms of feeling, processes and modifications of perceptive nature (Freud, 1891).

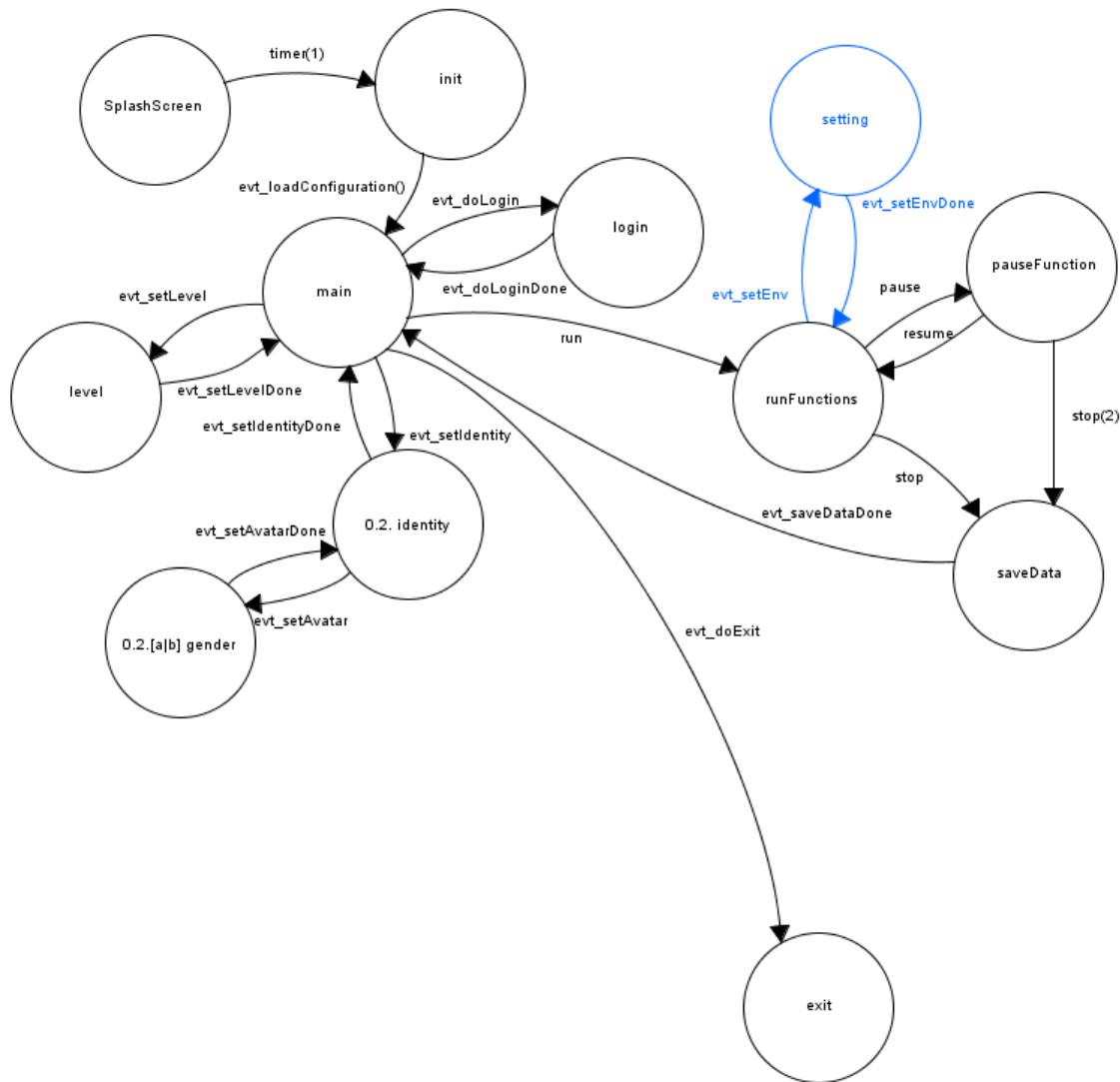
In terms of clinical and hermeneutical analysis, projective methods are instruments or stimuli whose purpose is to elicit verbal or graphic products, which are expressions of the subject's mental activity.

In our case, the manipulation of images in 2-dimensional or 3-dimensional environments aims to improve the generation of those products such as the variation of representations and the related emotional aspects. Activities derives from some initial hypothesis, like: detect the presence of images in relation with specific fields of content that plays a special role within certain psycho-somatic pathologies; collect data referring to the way these contents evolve and what they are composed by; state that scotomization leads to pathologies, that can be detected through the proposed method for psycho-somatic subjects.

### **Architecture**

The Vlad software has an intuitive user-friendly design that helps the player to move inside a 3D semi-immersive space. It generates emotion by images manipulation and recognizes them with qualitative and quantitative monitoring and with recording of storytelling experiences. Storytelling is created by the images, used inside of an endearing context, simplified and partially automated.

Vlad software can be represented by the mathematical model of computation of its *Deterministic Finite State Machine* (DFSM). Starting from a clear initial state, the DFSM moves from one state to another (transition) accordingly to its defined list, in response to external inputs specified as conditions for the transition. The following image represents the DFSM for Vlad.



**Figure 1.** The Adapted DFSM for Vlad

Two modules work together in Vlad serious game in order to build this completely new experience which purpose is to structure the self. The game is deployed in a 3D space where the user is invited to create a story based on the 21-function-cards version of the Propp’s folktale morphology. The two modules are:

- The “Game Board”: a 3D scene within the RunFunction scenario where the user plays a sequence of functions based on Propp’s morphology, having the chance to manipulate objects, actions, roles, settings, etc. The set of cards can be unlimitedly expanded, creating almost infinite combinations of card sequences, so as the set of levels of difficulty.
- The monitoring and measuring system of users’ performance, that consents to acquire qualitative and quantitative parameters by defining any user’s performance, including the audio recording of the storytelling process. The standard and innovative metrics that have to

be monitored are, among others: general latency time and on key moves; execution time for function; average execution time for function normalized by the number of the used cards; total execution time for the session; number of cards on the Game Board and their frequency of use.

The basic element of the serious game is the Card. On the Game Board Scenario the cards are already set and can be placed, even multiple times, on the first region available on the board.

The Vlad application requires the availability of the following components to correctly run:

- A 3D operational environment where the user can navigate while playing Vlad, in this case provided by the Gaming Engine Unity 3D.
- A Hardware set that allows the player to interact with a 3D representation of objects through his/her hands, virtually represented.
- The Vlad VR Software modules and the states previously seen in the DFSM, articulated in 4 main Scenarios:
  - Init, where the game and the goals to reach are presented;
  - Main, where the player chooses the main character, the “hero” of the tale, having several settings for gender, clothes, role, duration of the game and level of difficulty.
  - Login, which allows to trace performance for specific users and store it in the software;
  - RunFunction, where the user is invited to create a story using the sequence of 21 Propp’s functions on the Game Board, passing from one function to the next or previous one if some change is wanted.
  - The Emotion Recognition algorithm and the “Vlad Evaluation Manual” provided in order to explain the totally new approach of this software, based on a mixed (automated and manned) evaluation process. This emotion recognizing approach is a combination of a User Questionnaire, aimed to detect players’ feelings, level of confidence and eventual defence mechanisms; a set of mathematical tools to analyze the audio recording file; an Artificial Intelligence tool that inspect the terms used and their frequency; a Specialist’s Form with the results of the quantitative and qualitative parameters acquired.

## Method

Starting from a complete research about the psychological aspect of representation and perception of images and about the creation of stories theorized by Vladimir Propp, the project has been developed in the following steps:

- Ideation of the serious game and structuring of the DSFM (created on Fizzin).
- Concept of the cards based on the 21 Propp's functions, that will be used during the serious game, and concept of the characters and environments available.
- Development of the graphics of the Splashscreen, of the Main scene and of the Game Board.
- Generation of the 2D Avatars through the website [creaavatar.it](http://creaavatar.it) and manipulation in Photoshop.
- Generation of the 3D Avatar of the King (the only eligible protagonist at the moment) through MakeHuman and manipulation in CharacterCreator and ZBrush.
- Creation of the Virtual Reality experience inside of Unity 3D Engine, to be experienced by Oculus Quest Headset.
- Internal testing of the serious game and improvements.
- Release of the demo.

## Tools (Appendix, description)

Vlad is born as a semi-immersive VR experience in a 3D space accessible by wearing a *Virtual Reality headset*, an innovative head-mounted device (HMD). In order to allow interaction between the player and the software, a dedicated hardware, quite often called *Controller*, must be provided. Controllers help the player to move and interact with the virtual world.

Vlad keeps also the possibility to interact through keyboard and mouse active, quite a good solution to interact with virtual spaces.

The hardware selected for the current version of Vlad software (release 1) is the following:

- Operational Environment: 3D Space by Unity Real-Time Development Platform.
- Visualization: Oculus Quest All-in-one VR Gaming Headset, 128GB.
- Interaction: Touch Controllers (also Keyboard and Mouse).

## **Preliminary Results**

The application development started in mid-2019 and took more than one thousand hours of 2D and 3D graphical models' definition and texturing, Virtual Reality software development and testing.

The process of modelling and texturing took several trials to ensure a fluid and enough detailed graphical experience. The number of polygons per object was tested in order not to affect rendering time and overall application performances.

Based on the results of the likeability questionnaire and of the patient's requirement questionnaire we can state that the general acceptance of Vlad serious game increases with the user experience. The sessions administered are, in fact, part of a unique learning process with the familiarity in using Vlad as an independent variable.

In Vlad software validation we can exceptionally consider the user as a system, whose internal behaviour is not monitored, so we can simply evaluate the trend and changes in system outputs in terms of the following factors:

- existing expectations of the user and matching with new ones rising: this increment represents an improvement of creativity, self-confidence and higher interest in the experience itself;
- eventual discomfort felt and perceived while using Vlad: the weakness tends to decrease as the user familiarizes with the game;
- desire to extend the duration of the experience: the user can tend to keep using Vlad for his/her training activities.

The questionnaires mentioned above have been submitted to the users that tested the game. The outputs of the test positively demonstrated the factors just described. It should be noted that from the results appears a common willingness for sessions with higher frequency and for a substantially longer period.

From the research side, when facing for the first time the software the user is subject to a stressful situation. The initial difficulties in understanding the manipulation of the activities in VR causes slower actions and moves in respect with real conditions, for this reason patients with less ability to recover from stressful conditions can present worse results. This can be accepted in the current analysis if the depreciation is limited to few distress-related values and doesn't affect the trend of remaining items. Nevertheless, the assessment instruments showed an increase of tolerance, acceptance, involvement and likability with the increasing number of sessions.

## Conclusions

As the results demonstrate, the use of Vlad can lead to an increased acceptance of innovative approaches in training and rehabilitation. The users facing Vlad present a higher interest in the experience that they are living, driving the initial discomfort, due to the new approach to Virtual Reality, to the desire to continue this kind of sessions more firmly.

In the next version of the software some improvements are requested:

- continue of the graphical development: at the present time the game cards are displayed by their back side and recognizable just by their name. The graphic definition of each card is, in fact, a time-consuming activity. Some of the graphics were sketched as an example of the final version of Vlad and currently implemented.
- creation of additional choices of protagonists of the story: only the figure of the king has been currently implemented. A selection of different main characters will be available in the future, in order to guarantee the choice to the user. A 3D model of each character will be created and textured, as well as their clothes.

In conclusion, the first version of Vlad's serious game had positive responses in likeability. The results obtained demonstrate the efficacy and usability and encourage rigorously further experimentation in accord with the research design described.

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**DOI:** 10.6092/2282-1619/mjcp-2868