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Virtual Reality in Neuro-Psycho-Physiology

Virtual Reality as Assessment Tool in Psychology

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Abstract. Virtual environments (VEs), offering a new human-computer interaction paradigm, have attracted much attention in clinical psychology, especially in the treatment of phobias. However, a possible new application of VR in psychology is as assessment tool: VEs can be considered as an highly sophisticated form of adaptive testing. This chapter describes the context of current psychological assessment and underlines possible advantages of a VR based assessment tool.
The chapter also details the characteristics of BIVRS, Body Image Virtual Reality Scale, an assessment tool designed to assess cognitive and affective components of body image. It consists of a non-immersive 3D graphical interface through which the patient is able to choose between 9 figures of different size which vary in size from underweight to overweight. The software was developed in two architectures, the first (A) running on a single user desktop computer equipped with a standard virtual reality development software and the second (B) splitted into a server (B1) accessible via Internet and actually running the same virtual ambient as in (A) and a VRML client (B2) so that anyone can access the application.

1. Introduction

Virtual environments (VEs) offer a new human-computer interaction paradigm in which users are no longer simply external observers of images on a computer screen, but are active participants within a computer-generated three-dimensional virtual world. Virtual reality can add, delete, or emphasise details to better help clinicians perform basic functions. These unique features can provide the patient with specialised, safer treatment techniques for problems that previously were expensive or impossible to treat in traditional training and therapy. For these reasons VEs have recently attracted much attention in clinical psychology. One of the main advantages of a virtual environment is that it can be used in a medical facility, thus avoiding the need to venture into public situations. Infact, in many applications VEs are used in order to simulate the real world and to assure the researcher full control of all the parameters implied. Many stimuli for exposure are difficult to arrange or control, and when exposure is conducted outside of the therapist's office, it becomes more expensive in terms of time and money. The ability to conduct exposures of virtual aeroplanes for flying phobics or virtual highways for driving phobics, for example, without leaving the therapist's office, would make better treatment available to more sufferers at a lower cost.

However a promising new use of VEs is in psychological assessment. This chapter will describe the context of current psychological assessment and underline the possible advantages of VR based assessment tools. In the chapter will be also outlined the characteristics of BIVRS, Body Image Virtual Reality Scale, an assessment tool designed to assess cognitive and affective components of body image.

2. VR as assessment tool in psychology

2.1 Assessment in modern psychology

Assessment in the modern era, particularly by clinical, counselling and research psychologists, rests heavily on tools whose origins extend back a half-century or more [1]. For instance, the series of Wechsler scales, the MMPI, and the TAT had their beginnings in the late 1930s. Compared with these venerable instruments, widely accepted behavioral assessment is a relatively new development.

So, the practice of psychological assessment, along with a number of the conceptualisations on which it rests, now differs dramatically from the situation that prevailed when the tenets of the measurement tradition provided the basis for the use of psychological diagnostic instruments.

As Tallent [1] underlines, "Today's psychological assessors are concerned with new and still developing concepts of therapy, with psycho-pharmacology, and with the Diagnostic and Statistical Manuals and their implications for treatment". In this sense, the practice of psychological assessment, must be flexible and open-ended attentive to the opportunities offered by unanticipated or developing situations. The watchword is adaptation—to whatever the situation might be in the ongoing give and take of the assessment process [2].

A key issue in this situation is the distinction between *psychological assessment* and *psychological testing*. Commonly, but erroneously [3], the expressions psychological assessment and psychological testing are used synonymously or interchangeably. Sloves, Docherty, and Schneider [4] make the following distinction between assessment and testing:

> *Psychological testing* is defined as a set of skills, tactics, and strategies subsumed under the heading of psychological methods. In this view, methods represent the technical skills used as a means of carrying out a psychological assessment. *Psychological assessment* is systems and problem oriented, dynamic, and conceptual; whereas psychological testing is methods and measurement oriented, descriptive and technical (Italics added).

The authors then point out the consequence of not attending to this distinction, and suggest a remedy:

> The failure by many practitioners and trainers in professional psychology to distinguish between assessment and testing has led to a tendency for the profession to focus its attention on the mechanistic and technical aspects of test administration and to ignore or slight the conceptual basis of the assessment process.

Bardon and Bennett [5] have proposed as a solution to this problem that practice and training, not just in assessment but in all areas of psychological services, shift away from its current emphasis on knowledge and technical expertise and toward a conceptual approach to professional psychology that trains psychologists to think like psychologists [6].

2.2 Computers and psychological assessment

According to this new paradigm the use of computers and in particular of virtual environments, can offer new powerful tools to psychologists. However, the use of computers in psychological testing it isn't a novelty: it was initiated well over a quarter century ago [7]. Technically, computer testing has its origin in physicalism and psychometrics, and the computer applied to psychological testing may be considered a psychometric machine. [8].The basic thesis is that test scores may be empirically linked to contest behaviors of test takers through the use of algorithms (a partly Greek term honoring the ninth century Arab mathematician al-Khuwarizmi), which are mechanical rules for making decisions. For example, on the basis of empirical correlates, when MMPI Scale 6 is above a T-score of 75, we may expect that the test taker will show disturbed thinking, have delusions of persecution and/or grandeur, ideas of reference, feel mistreated, picked on, be angry and resentful, harbor grudges, and rely heavily on projection as a defense mechanism [1]. On the basis of such established relations between scores and symptom pictures, characteristics that are commonly found with particular score elevations and patterns may be fashioned into statements, stored in a statement library, and called back whenever a test taker registers the scores that have been shown to empirically relate to these statements.

However, in practice, the statements that eventually issue from the computer are not derived entirely by blind adherence to this scheme. The algorithms additionally incorporate the experience of their author, and are not free of theoretical bias, clinical flavoring, intuition, and personally held interpretation. So, early beliefs that the computer would eliminate the need for skilled diagnostic clinicians has not materialized. Errors, inconsistencies, and misleading statements are always a possibility. When computer-derived information is to be employed by a person who does not have sufficient psychological background to use the material responsibly, it falls upon a psychologist to interpret to that person the computer interpretation: there must be a clinician between the computer and the client [9].

2.3 Advantages of VR based assessment tools

The main problem of current computer based assessment *is the transformation of the process of psychological assessment into psychological testing*. As Tallent [1] points out, "the reaching of conclusions through the use of psychometrics often is mislabeled as assessment, as, for example in computer assessment... [Computer tests] do not provide automatic answers to real problem...What test results mean in any given case is a human judgment".

However, the rate of growth of computer testing is remarkable [10]. Computer programs are available for administering, scoring, profiling, interpretation, and report writing for old tests, and for new instruments designed specifically for computer analysis. Creative variations have appeared. In adaptive testing [11], for example, items presented to the test taker are contingent on his or her earlier responses, similar to Binet testing, where tests at a given age-level are administered only if at least one subtest has been passed at the immediately lower year-level.

Virtual reality can be considered as an *highly sophisticated form of adaptive testing*. Infact, the key characteristic of VR is the high level of control of the interaction with the tool without the constrains usually found in computer systems. VR is highly flexible and programmable. It enables one to present a wide variety of controlled stimuli and to measure and monitor a wide variety of responses made by the user. Both the synthetic environment itself and the manner in which this environment is modified by the user's responses can be tailored to the needs of each client and/or therapeutic application [12]. Moreover, VR is highly immersive and can cause the participant to feel "present" in the virtual rather than the real environment. It is also possible for the psychologist to accompany the user into the synthesised world.

More in detail, there are *three* important aspects of virtual reality systems that can offer new possibilities to psychological assessment:

- *How They Are Controlled*: Present alternate computer access systems accept only one or at most two modes of input at a time. The computer can be controlled by single modes such as pressing keys on a keyboard, pointing to an on-screen keyboard with a head pointer, or hitting a switch when the computer presents the desired choice, but present computers do not recognize facial expressions, idiosyncratic gestures, or monitor actions from several body parts at a time. Most computer interfaces accept only precise, discrete input. Thus many communicative acts are ignored and the subtleness and richness of the human communicative gesture are lost. This results in slow, energy-intensive computer interfaces. *Virtual reality systems open the input channel*: the potential is there to monitor movements or actions from any body part or many body parts at the same time. All properties of the movement can be captured, not just contact of a body part with an effector. In the virtual environment these actions or signals can be processed in a number of ways. They can be *translated* into other actions that have more effect on the world being controlled, for example, virtual objects could be pushed by blowing, pulled by sipping, and grasped by jaw closure.
- *Feedback*: Because VR systems display feedback in multiple modes, *feedback and prompts can be translated into alternate senses for users with sensory impairments*. The environment could be reduced in size to get the larger or overall perspective (without the "looking through a straw effect" usually experienced when using screen readers or tactile displays). Sounds could be translated into vibrations or into a register that is easier to pick up. Environmental noises can be selectively filtered out. For the individual multimodal feedback ensures that the visual channel is not overloaded. Vision is the primary feedback channel of present-day computers; frequently the message is further distorted and alienated by representation through text. It is very difficult to represent force, resistance, density, temperature, pitch, etc., through vision alone. *Virtual reality presents information in alternate ways and in more than one way*.
- *What Is Controlled*: The final advantage is what is controlled. Until the last decade computers were used to control numbers and text by entering numbers and text using a keyboard. Recent direct manipulation interfaces have allowed the manipulation of iconic

representations of text files or two dimensional graphic representations of objects through pointing devices such as mice. *The objective of direct manipulation environments was to provide an interface that more directly mimics the manipulation of objects in the real world*. The latest step in that trend, virtual reality systems, allows the manipulation of multisensory representations of entire environments by natural actions and gestures.

In the next paragraph of this chapter will be presented the Body Image Virtual Reality Scale - BIVRS, an assessment tool designed to assess cognitive and affective components of body image. BIVRS, that tries to exploit some of the advantages of VR, is a clear improvement over current drawing-based body image scales; even with some limits, mainly due to current technology, can be considered as the first step towards a new approach to computer testing more oriented to psychological assessment.

3. BIVRS - a VR based assessment tool

3.1 Assessment of body image

The construction of measurement procedures for the assessment of body image has proliferated in the recent years [13]. Generally, researchers and clinicians have focused on two aspects of body image: a perceptual component, commonly referred to as "size perception accuracy", and a subjective component which entails aspects such as body size/weight and physical appearance [14].

There are two broad categories of procedures used for the assessment of size perception accuracy [13]: body-site and whole-image procedures.

Body-site estimation procedures require that subjects match the width of the distance between two points to their own estimation of the width of a specific body site. For instance, Slade and Russell [15] constructed the movable calliper technique (MCT), which consisted of a horizontal bar with two lights mounted onto a track. The subject could adjust the width between the two lights to match her/his estimate of the width of a given body site. The comparison of estimations with actual body widths, measured with body callipers, was used to derive a percentage of over- or under-estimation. For these and other size estimation procedures, an assessment of the subject's actual width (measured with body callipers) is compared with the subject's estimate, and a ratio of over- or under-estimation of size is computed. Generally, the great majority of subjects overestimate all body sites; however, some data suggests that the waist is overestimated to the greatest degree [16]. Because the estimates of the sites are highly correlated, some researchers sum across sites, giving a generic index of overestimation. It may be advisable, given the experimental or clinical purpose of the assessment, however, to evaluate each estimation site individually.

The whole-image adjustment methods constitute a second major category of size estimation procedures. With these procedures, the individual is confronted with a real-life image, presented via videotape, photographic image, or mirror feedback. The experiment is able to modify the representation to make it objectively smaller or larger than reality. The measure of perceptual inaccuracy is the degree of discrepancy between the actual real-life image and the one selected by the subject. The schematic figures or silhouettes of different body sizes are the most widely used measure for the assessment of subjective components of body image disturbance [17, 18, 13]. With this methodology, subjects are asked to choose the figures that they think reflect their current and their ideal body sizes. The discrepancy between these two measures is taken as an indication of level of dissatisfaction. A recent technical improvement of the figural/schematic rating procedure involves the presentation of body schemas on a computer screen [19].

With this method, subjects can adjust the sizes of nine body sites to arrive at the exact image representation that they believe fits their own dimensions. Again, a measure of generic satisfaction with the body can be obtained by asking subjects to create an ideal to compare with their selection of their own current image. A computer based test was also presented by Schlundt & Bell [20]. They have developed a microcomputer program for assessing cognitive and affective components of body image called the Body Image Testing Systems (BITS). The program, that is written in Turbo Pascal language for IBM PC, generates frontal view and side view silhouettes of a human body. Subjects can make the body silhouette image grow smaller or larger for nine independent body regions via the computer control system.

3.2 The Virtual Reality Modeling Language

The *Virtual Reality Modeling Language* (VRML) is a "language for describing multi-participant interactive simulations—virtual worlds networked via the global Internet and hyper linked with the World Wide Web" [21]. All aspects of virtual world display, interaction, and internetworking can be specified using VRML.

The first version of VRML (1.0) allowed for the creation of virtual worlds with limited interactive behavior. These worlds can contain objects that have hyper links to other worlds, HTML documents, or other valid Multimedia Internet Mail Extentions (MIME) types. The second version of VRML (2.0), available now, allow the user for richer behaviors, including animations, motion physics, and real-time multi-user interaction.

The first step in viewing a VRML document is retrieving the document itself. The document request comes from a Web browser—either a VRML browser or an HTML browser. Users send their request to the Web browser, and the Web browser sends the request on to its intended recipient. The Web server that receives the request for a VRML document attempts to fulfill the request with a reply. This reply goes back to the VRML browser [21]. Once the document has been received by the VRML browser, it's read and understood by it creating visible representations of the objects described in the document. Each VRML scene has a "point of view", which is called a *camera:* you see the scene through the eye of the camera. It's also possible to predefine view points. All browsers feature some interface for navigation, so that you can move the scene's camera throughout the world. A VRML world can be *distributed*—that is, it can be spread across the Web in many different places. In the same way that an Internet Web page can be composed of text from one place and images from another, a VRML world can specify that some of its scene comes from *this* place, while other objects come from *that* place.

This means that VRML files often load in stages; first the basic scene description is loaded, and then—if this refers to *nested* (scene within a scene) descriptions—the browser loads these after the basic scene has been loaded. Computer speeds aren't ever quite as fast as we would like, and neither are modems quite as capable as the demands we make upon them. For this reason, there is almost always some delay involved in loading a VRML world—it rarely appears immediately, or all at once.

VRML has the ability to show you where objects will appear before they've been downloaded. Before the object appears, it's shown as an empty box of the correct dimension (called a *bounding box),* which is replaced by the actual object when it has read in. Called *lazy loading,* it allows the VRML browser to take its time—when it has no other choice, that is—loading the scene from several different places while still giving you an accurate indication of what the scene will look like when it's fully loaded [21].

3.3 The research project

The above considerations have led to the design of the following research protocol.

Objectives

The main aim of this research is the development of a virtual reality based body image assessment technique: BIVRS - Body Image Virtual Reality Scale. BIVRS is a software consistent of a non-immersive 3D graphical interface through which the patient is able to choose between 9 figures of different size which vary from underweight to overweight. Subjects are asked to choose the figures that they think reflect their current and their ideal body sizes. The discrepancy between these two measures is an indication of their level of dissatisfaction.

The software was developed in both of two architectures, the first (A) running on a single user desktop computer equipped with a virtual reality development software, such as VREAM or Superscape, and the second (B) splitted into a server (B1) accessible via Internet and actually running the same virtual environment as in (A) and a VRML client (B2) chosen between the ones available for free in many Internet sites, so that anyone can access the application.

The reasons why we propose a Body Image Virtual Reality Scale are various.

1. Even though it is by now possible to choose between a wide range of different tests for the assessment of body image, we are still far from a culture free form, since every research is usually carried out in just one or two institutions, and in perfect isolation from the rest of the world. BIVRS, being designed to both run on any local desktop computer and on the Internet in VRML format, would soon provide a powerful tool to quickly standardize its results, e.g.. by an immediate feedback given on-line right after the assessment session. This way, we could rapidly raise an international multi-cultural database, susceptible of further data splitting, when needed.

2. Virtual reality can add the third dimension to the body size silhouettes presented in the test, so improving its effectiveness. Using 3D it is easier for the subject to perceive the differences between the silhouettes, especially for specific body areas (breasts, stomach, hips and thighs).

3. The extremely low cost of the system, where related to the costs of either a traditional assessment or a computer assisted assessment developed to run on machines other than small personal computers.

Population

Initially BIVRS will be submitted to a sample of Italian normal (200 subjects) and clinical subjects (30 obese, 30 bulimic and 30 anorectic subjects). Other subjects, from different countries will be then added to the original sample. The subject submitted to BIVRS will be also submitted to other body image self-report scales in order to investigate the correlation between them.

System design and implementation

BIVRS was developed using a Pentium based PC (166mhz, 32 mega RAM, graphic engine: Matrox Millenium 4Mb WRam) and a Power PC based Macintosh (PPC 604, 160mhz, 32 mega RAM).

The development system

We developed the two sets of seven silhouettes using the Fractal Design Poser software for Macintosh. Poser is a 3D modeling software through which it is possible to easily build virtual objects, and particularly objects representing human bodies. Its purpose is then to provide, given some basic data about the dimensions of specific body sites, a ready-to-use object to be included in any virtual environment. The two sets of figures, were first developed in wire framed mode to obtain precisely graduated increments between adjacent sizes. Using this mode it was possible to create seven female and seven male schematic figures that range from underweight to overweight. Both the female and the male sets were then rendered and pre-tested. The final sets, composed by more than 10,000 polygons, were then exported as .DXF files and converted in the VRML standard using the WCTV2POV.EXE program. This program is a freeware file converter, developed by Keith Rule for the Windows environment, that converts 3D DXF models in VRML 1.0 files. The final VRML files were then tested using Netscape 3.1 for Windows 95.

Motion input system

We have considered two different input systems, based on the specific module running, the single user station application (A) or the VRML client-server application (B).

Single user station module

The data glove-type motion input device is very common in virtual environments for its ability of sensing many degrees of freedom simultaneously. However, the problem with such devices is that the operator is also frequently confused for the difficulty in correctly using it, especially when there is a time delay contained in the feed-back loop.

To provide a easy way of motion in BIVRS we used an infrared two-button joystick-type input device: pressing the upper button the operator moves forward, pressing the lower button the operator moves backwards. The direction of the movement is given by the rotation of operator's head.

VRML module

As for the VRML module, there is no other choice available than using the habitual keyboard as an input device. The importance to spread *in any available way* the assessment system all over the net to quickly and neatly standardize the results has already been discussed. We believe that as Internet clients grow more and more sophisticated, together with technology becoming more easily available, it should be possible, in a couple of years, to support better input devices on the VRML version too, thus making it not anymore necessary to keep two separated modules.

3.4 Conclusions

The importance of a virtual reality based body image scale relies on the possibility to rapidly test in better and different ways one's perceived body image. It also gives a chance to easily raise a trans-cultural database on body image data.

We have discussed the importance of virtual reality for the possibility of adding the third dimension to the body size silhouettes presented in the test: using 3D can improve the effectiveness of the test because it is easier for the subject to perceive the differences between the silhouettes, especially for specific body areas (breasts, stomach, hips and thighs). We have also noted that such system should become very important for the standardization of body image assessment data, because of the extremely high diffusion of the Internet in several different countries.

We have also set up a stand alone version, which could run on any low cost personal computer. In this system it is possible to provide a better input device, based on an infrared joystick and on a low cost head mounted display. We plan to export this solution to the VRML version too, as soon as such input devices will be supported on the net.

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References

[1] Tallent, N. (1992). The practice of psychological assessment. Englewood Cliffs: Prentice Hall.
[2] Allen, J.G. (1981). The clinical psychologists as a diagnostic consultant. Bullettin of The Menninger Clinic, 45, 247-258.
[3] Wechsler, D. (1958). The measurement and appraisal of adult intelligence (4th ed.). Baltimore: Williams & Wilkins.
4] Sloves, R.E. Docherty, E.M. Jr., & Schneider, K.C. (1979). A scientific problem-solving model of psychological assessment. Professional Psychology, 10, 28-35.
[5] Bardon, J.L., & Bennet, V.D.C. (1967). Preparation for professional psychology: An example from a schhol psychology training program: American Psychologist, 22, 652-656.
[6] Berg, M.R. (1985). The feedback process in diagnostic psychological testing. Bullettin of the Menninger Clinic, 49, 52-69.
[7] Fowler, R.D. (1985). Landmarks in computer-assisted psychological assessment. Journal of Consulting and Clinical Psychology, 53, 748-759.

[8] Tallent, N. (1987). Computer generated psychological reports: A look at the modern psychometric machine. Journal of Personal Assessment, 51, 95-108.
[9] Fowler, R.D., & Butcher, J.N. (1986). Critique of Matarazzo's views on computerized testing: All signs and no meaning. American Psychologist, 41, 94-96.
[10] Butcher, J.N. (1987). Preface. In J.N. Butcher (Ed.), Computerized psychological assessment: a practicioner's guide. New York: Basic Book.
[11] Weiss, D.J. (1985). Adaptive testing by computer. Journal of Consulting and Clinical Psychology, 53, 774-779.
[12] Glantz, K., Durlach, N.I., Barnett, R.C. & Aviles W.A. (1997). Virtual Reality (VR) and Psychotherapy: Opportunities and Challenges. Presence, 6 (1), 87-105.
[13] Thompson, J.K. (1990). Body image distrubance: assessment and treatment. Elmsford, NY: Pergamon Press.
[14] Cash, T.F., Brown, T.A. (1987). Body image in anorexia nervosa and bulimia nervosa: A review of the literature. Behavior Modification, 11, 487-521.
[15] Slade, P.D., Russell, G.F.M. (1973). Awarness of body dimension in anorexia nervosa: Cross-sectional and longitudinal studies. Psychological Medicine, 3, 188-189.
[16] Thompson, J.K., & Spana, R.E. (1988). The adjustable light beam method for the assessment of size estimation accuracy: Description, psychometrics, and normative data. International Journal of Eating Disorders, 7, 521-526.
[17] Fallon, A.E., & Rozin, P. (1985). Sex differences in perceptions of desiderable body shape. Journal of Abnormal Psychology, 94, 102-105.
[18] Thompson, J.K., & Psaltiz, K. (1988). Multiple aspects and correlates of body figure ratings: A replication and extention of Fallon and Rozin (1985). International Journal of Eating Disorders, 7, 813-818.
[19] Dickson-Parnell, B., Jones, M, & Braddy, D. (1987). Assessment of body image perceptions using a computer program. Behavior Research Methods, Instruments, & Computers, 1987, 19, 353-354.
[20] Schlundt, D.G., Bell, C. (1988). BITS: a microcomputer program for assessing cognitive and affective components of body image. Paper presented at the annual meeting of the Association for the Advancement of Behavior Therapy, New York.
[21] Pesce, M. (1995). VRML: browsing and building cyberspace. Indianapolis, In: New Riders Publishing.