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Virtual Reality in Psychological Assessment: The Body Image Virtual Reality Scale

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ABSTRACT

Virtual environments (VEs) are attracting much attention in clinical psychology, especially in the treatment of phobias. However, a possible new application of virtual reality (VR) in psychology is as assessment tool: VEs can be considered as a highly sophisticated form of adaptive testing. In fact, the key characteristic of VEs is the high level of control of the interaction with the tool without the constraints usually found in computer systems. 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. This article describes the context of current psychological assessment and underlines possible advantages of a VR-based assessment tool. It also details the characteristics of the Body Image Virtual Reality Scale, an assessment tool designed to assess cognitive and affective components of body image. It consists of a nonimmersive 3D graphical interface through which the patient is able to choose among seven figures that vary in size from underweight to overweight.

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 3D virtual world. Virtual reality (VR) can add, delete, or emphasize details to better help clinicians perform basic functions. These unique features can provide the patient with specialized, 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 VE is that it can be used in a medical facility, thus avoiding the need to venture into public situations. In fact, in many applications VEs are used in order to simulate the real world and to ensure that the researcher has 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 airplanes 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 article de-

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scribes the context of current psychological assessment and underlines the possible advantages of VR-based assessment tools. Also discussed are the characteristics of the Body Image Virtual Reality Scale (BIVRS), an assessment tool designed to assess cognitive and affective components of body image.

VR AS ASSESSMENT TOOL IN PSYCHOLOGY

Assessment in modern psychology

Assessment in the modern era, particularly by clinical, counseling, 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 Minnesota Multiphasic Personality Inventory (MMPI), and the Thematic Appercetio Test (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 conceptualizations 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] (p. 19) underlined "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] made the following distinction between *assessment* and *testing*:

> *Psychological testing* [italics added] 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* [italics added] is systems and problem oriented, dynamic, and conceptual; whereas psychological testing is methods and measurement oriented, descriptive and technical.

The authors then point out the consequence of not attending to this distinction, and they 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] 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 their current emphasis on knowledge and technical expertise and toward a conceptual approach to professional psychology that trains psychologists to think like psychologists.[6]

Computers and psychological assessment

According to this new paradigm, the use of computers and in particular of VEs, can offer new powerful tools to psychologists. However, the use of computers in psychological testing is not 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 9th-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 relate to these statements empirically.

In practice, however, the statements that eventually issue from the computer are not derived entirely by blind adherence to this scheme. The algorithms also 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 have 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 explain to that person the computer interpretation: There must be a clinician between the computer and the client.[9]

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] (p. 25) pointed 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 problems. . . . 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 subset has been passed at the immediately lower year level.

VR can be considered as a highly sophisticated form of adaptive testing. In fact, the key characteristic of VR is the high level of control of the interaction with the tool without the constraints 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 synthesized world.

In greater detail, there are three important aspects of VR systems that can offer new possibilities to psychological assessment:

1. *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. VR 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 VE, 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.

2. *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, and so on through vision alone. VR presents information in alternate ways and in more than one way.
3. *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 2D 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, VR systems, allows the manipulation of multisensory representations of entire environments by natural actions and gestures.

The focus of this article now shifts to the BIVRS, an assessment tool designed to assess cognitive and affective components of body image. BIVRS, which 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, it can be considered as the first step toward a new approach to computer testing that is more oriented to psychological assessment.

BIVRS: A VR-BASED ASSESSMENT TOOL

Assessment of body image

The construction of measurement procedures for the assessment of body image has proliferated in 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 and weight and physical appearance.[14]

There are two broad categories of procedures used for the assessment of size perception accuracy:[3] 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, which consists of a horizontal bar with two lights mounted onto a track. The subject adjusts the width between the two lights to match her or his estimate of the width of a given body site. The comparison of estimations with actual body widths, measured with body callipers, is used to derive a percentage of over- or underestimation. 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 underestimation of size is computed. Generally, the great majority of subjects overestimate all body sites, and some data suggest 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.[13,17,18] 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 or schematic rating procedure involves the presentation of body schemes 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 first 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 and Bell.[20] They developed a microcomputer program for assessing cognitive and affective components of body image called the Body Image Testing Systems. The program, which 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.

The virtual reality modeling language

The virtual reality modeling language (VRML) is a "language for describing multiparticipant interactive simulations—virtual worlds networked via the global Internet and hyper linked with the World Wide Web." (p. 11) [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 hyperlinks to other worlds, HTML documents, or other valid multimedia internet mail extentions types. The second version of VRML (2.0), available now, allows the user to exhibit richer behaviors, including animations, motion physics, and real-time multiuser 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 VRLM browser, it is 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 is 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 and 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 are never quite as fast as we would like, and modems are not capable of meeting 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 have been downloaded. Before the object appears, it is shown as an empty box of the correct dimension (called a *bounding box*), which is replaced by the actual object once it reads 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 is fully loaded.[21]

The research project

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

Objectives. The main aim of this research is the development of VR-based body image assessment technique: BIVRS. BIVRS is a software program consisting of a nonimmersive 3D graphical interface through which the patient is able to choose among seven figures that vary in size 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 two architectures—the first (a) runs on a single user desktop computer equipped with a VR development software, such as VREAM or Superscape, and the second (b) is split into a server (b1) that is accessible via the Internet and actually runs in the same VE as in (a) and a VRML client (b2) chosen among the ones available for free in many Internet sites, so that anyone can access the application.

The reasons why we propose a BIVRS 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, because 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 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 multicultural database that would be capable of further data splitting when needed.
2. VR can add the third dimension to the body size silhouettes presented in the test, thereby 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. VR is highly immersive, and it improves the effectiveness of the test by focusing the attention of the user to the testing environment only.
4. The extremely low cost of the system is very attractive, especially when compared with the costs of either a traditional assessment or a computer-assisted assessment developed to run on machines other than small PCs.

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 then be added to the original sample. The subject submitted to BIVRS will also be submitted to other body-image self-report scales in order to investigate the correlation among them.

System design and implementation. BIVRS was developed using a Pentium-based PC (166 MHz, 32 mega-RAM, graphic engine: Matrox Millenium 4Mb WRam) and a Power PC-based Macintosh (PPC 604, 160 MHz, 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 build virtual objects easily, 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 VE. The two sets of figures were first developed in a wire-framed mode to obtain precisely graduated increments between adjacent sizes. Using this model, it was possible to create seven female and seven male schematic figures that ranged from underweight to overweight. Both the female and the male sets were then rendered and pretested. The final sets, composed of 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 into 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 and the VRML client-server application.

Single-user station module. The data glove-type motion input device is very commonly used in VEs because of its ability to sense many degrees of freedom simultaneously. The problem with such devices, however, is that the operator is also frequently confused because of the difficulty in correctly using it, especially when there is a time delay contained in the feedback loop.

To provide an 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 backward. The direction of the movement is given by the rotation of the 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 of spreading, in any available way, the assessment system all over the Net to standardize the results quickly and neatly has already been discussed. We believe that as Internet clients grow more and more sophisticated, and as technology becomes 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 unnecessary to keep the two modules separated.

Conclusions

VR can be considered as a highly sophisticated form of adaptive testing. In fact, the key characteristic of VR is the high level of control of the interaction with the tool without the constraints 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 controlled stimuli and to measure and monitor a wide variety of responses made by the user.

A first step in the diffusion of VR-based assessment tools is the development of BIVRS. This scale, which tries to exploit some of the advantages of VR, is a clear improvement over current drawing-based body-image scales. The importance of a VR-based body-image scale relies on the possibility to test rapidly in better and different ways one's perceived body image. It also gives researchers a chance to create a transcultural database on body-image data with ease.

This article has discussed the importance of VR 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). It has also been noted that such a 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.

A stand-alone version has also been set up, which could run on any low-cost PC. 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. This solution can be exported to the VRML version too, as soon as such input devices are supported on the Net.

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