The Virtual Standardized Patient
Simulated Patient-Practitioner Dialogue for Patient Interview Training

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We describe the Virtual Standardized Patient (VSP) application, having a
computerized virtual person who interacts with medical practitioners in much the
same way as actors hired to teach and evaluate patient assessment and interviewing
skills. The VSP integrates technologies from two successful research projects
conducted at Research Triangle Institute (RTI). AVATALK™ provides natural
language processing, emotion and behavior modeling, and composite facial
expression and lip-shape modeling for a natural patient-practitioner dialogue.
Trauma Patient Simulator (TPS) provides case-based patient history and trauma
casualty data, real-time physiological modeling, interactive patient assessment, 3-D
scenario simulation, and instructional record-keeping capabilities. The VSP offers
training benefits that include enhanced adaptability, availability, and assessment.

1. Introduction

Standardized Patients (SP's), sometimes called simulated patients, are actors playing the role of
patients or actual patients coached to present specific illnesses to the medical practitioner. Their
purpose is to teach and evaluate patient assessment and interviewing skills. At least 94 medical
schools in the U.S. and Canada currently employ SP's in their teaching programs, and 26 U.S.
medical schools cooperate in resource-sharing, standard-setting, and other issues relevant to
implementing effective SP programs.

There are limits to how effective SP's can be for training. Given such concerns as actor
training and availability, reproducibility, changing evaluation criteria, and implementation cost,
we have begun development of virtual SP's as an alternative to hiring actors for teaching and
evaluating patient interviewing skills.

Our approach to training is illustrated in Figure 1 (adapted from [1]); the approach holds for
training technical skills such as maintenance and inspection as well as soft skills such as
customer service and interviewing. We have found that for most skills, a combination of learning
environments proves most cost-effective [2]. Specifically, providing students with a virtual
learning environment enables them to become familiarized with materials, acquire and even
practice their skills. This reduces the need for live equipment and on-the-job simulations (which
are often costly, time consuming, and manpower intensive) to validation of skill performance.
Virtual learning environments can take many forms, depending on training requirements. For the present need, the environment demands a responsive, realistic, emotional, intelligent virtual patient with whom the practitioner can converse naturally. The Virtual Standardized Patient (VSP) application with AVA™-enabling meets this need.

2. Design

The VSP integrates technologies from two research programs in advanced learning methodologies conducted at Research Triangle Institute (RTI). The AVA™ program provides natural language processing, emotion and behavior modeling, and composite facial expression and lip-shape modeling for a natural patient-practitioner dialogue. Trauma Patient Simulator (TPS) provides patient history, real-time physiological modeling, interactive patient assessment, 3-D scenario simulation, and record-keeping for realistic physical examination[3].

The AVA™ application has already been used in customer service and survey interviewing training programs. The AVA™ suite of technologies involves:

- Natural language processing which incorporates the ability to recognize natural, unscripted speech and to understand speech based on the content of the discourse [4]. The application is designed to expect relevant, reasonable speech from the trainee, similar to that which occurs during regular conversation. As in regular conversation, expectations mature as conversation progresses.
- Emotion and behavior modeling. AVA™ virtual humans act realistically as if they are angry, depressed, serene, or in pain. Action takes the form of facial expression, lip synching, gesturing, choice of utterances, conversational expectancies, and branching logic within the application.
- Dynamic virtual worlds in which activities occur and contextual cues reside. Conversation does not take place in a vacuum; instead, the environment plays a large role in shaping conversational flow.
TPS has already been used in Emergency Medical Services (EMS) training programs. The TPS suite of technologies involves:

- **Trauma casualty simulation**. The trauma patient simulation occurs in the context of a **trauma scenario** consisting of a scene (or setting), an incident that produces injuries, and one or more patients. The visual presentation is a 3D virtual world that contains patients and other objects. Mechanisms-of-injury currently include falls, gunshot wounds, vehicle collisions, explosions, and blunt injury.

- **Physiological modeling**. The model provides continuous, real-time cardiovascular, respiratory, and pharmacological simulation. The patient exhibits medical signs and symptoms with real-time, true-to-life physiological behavior.

- **Interactive medical care**. The caregiver can also interact physically with the virtual patient, for example, taking a pulse. TPS takes the user through the sequence of trauma-patient assessment, beginning with entering and sizing up the scene, determining level of consciousness, checking the ABCDs, and attending to major life-threatening conditions.

- **Scenario configuration**. Dynamic configurator is the simulation software that combines, schedules, and manages the databases of patients, injuries, scenes, and critical incidents to create static and time-varying scenarios without developing new code.

Integration of these technologies provides for both natural patient-practitioner dialogue and realistic patient assessment in applications of the virtual standardized patient.

### 3. Methods

We are able to demonstrate the VSP using well-established SP scenarios as used in the clinical setting for evaluating patients who have specific illnesses. For this example, we will be using criteria such as that developed for the evaluation of asthmatic patients [5]. The VSP employs a simulation database: (1) to hold patient and scenario data; (2) to define the set of diagnostic testing and interactive care methods available to the practitioner; (3) to provide rules of simulation and interaction; and (4) to characterize responses (verbal, physiological, expressive, and behavioral) made by the virtual patient to the practitioner.

Conversation, where one or more individuals engaging in an interactive dialogue, is similar across disciplines, from patient-practitioner dialogue to conducting surveys. Hence, the AVATALK™ Scripting Engine allows for the rapid creation of interview scripts that readily integrate into the AVATALK™ architecture. An interview template captures questions and responses, branching instructions, emotional feedback to responses, tutorial associated with responses, and other application-specific information. This information is fed into the database structure, from which are generated grammar files for natural language discourse, logic flow files that define behavioral and emotional effects as the conversation progresses, and interface components. The AVATALK™ Role Play Engine interprets all of these files as it runs the interview.

Physical examination is accomplished via the interactive 3-D environment. The patient is a 3D virtual model with realistic attributes that exhibit medical signs and symptoms with real-time, true-to-life physiological behavior. Cardiovascular data, physiological trends, and body sounds (e.g., lung and heart sounds) gives the user insight into the patient’s condition, response to treatment, or failure to take appropriate action. Physiological responses to bleeding, pain, internal trauma, and hypoxia are realistic and can be modified by physical and medical interventions.

We stress that, although the scenarios are pre-defined, the interaction itself is unscripted. The scenario establishes initial conditions, but the trainee’s responses to the virtual patient, as well as
inherent flexibility in how the virtual patient is allowed to react, cause the conversational flow to vary from interview to interview. Add to this versatility the ability to rotate virtual models (e.g., successive patients will differ in age, ethnicity, gender, and personality, as appropriate), and the VSP becomes a realistic learning application wherein the practitioner must learn to handle each patient individually.

4. Results

The VSP is a concept demonstration and as such, no formal assessments presently available. However, assessment is underway on an AVATALK™-enabled survey interview application. We can point to the benefits that we have found from similar training approaches.

The VSP provides a computerized virtual patient who interacts with the medical practitioner in a similar way to the SP, (who is available? The med pract or VSP? and who is available 24/7 for practice). As shown in Table 1, the same roles of trainee, patient, observer, and coach that are required using SP’s are also required using the VSP, but virtual persons obviate the need for a hired actor. In the actor’s place, the virtual patient plays the role of patient while a virtual coach simultaneously observes and records the interaction, providing guidance and feedback when needed or requested. Observation and assessment become more robust and easier to control when these roles are automated.

The VSP has additional benefits in its adaptability, availability, and distribution. Characteristics represented by the virtual patient can easily be modified. For instance, gender, age, and ethnicity can be altered merely by swapping virtual models. Similarly, the virtual patient’s personality, reactivity, expressiveness, and other behavior elements can be determined before use as well as dynamically during the course of training. Patient symptoms are also modifiable; for instance, the patient’s chief complaint may be changed from asthma to cardiovascular problems with the simple replacement of patient interview scripts.

VSP is software is user-friendly and versatile. Its ease of use makes it ideal for both centralized or decentralized training. It is useful for initial training, refresher training, and ongoing assessment of interviewing skills. Because the software was designed to run on a relatively inexpensive laptop computer, it can be used on many home computers as well, with distribution via compact disc or networks.

<table>
<thead>
<tr>
<th>Role</th>
<th>SP Approach</th>
<th>Player</th>
<th>VSP Approach</th>
<th>Player</th>
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</thead>
<tbody>
<tr>
<td>Medical practitioner</td>
<td>Student’s ability to learn dependent on:</td>
<td>Student</td>
<td>Student’s ability to learn enhanced by:</td>
<td>Student</td>
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<tr>
<td>(i.e., trainee)</td>
<td>• relevance of role-play scripts,</td>
<td></td>
<td>• using numerous role-play scripts,</td>
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<tr>
<td></td>
<td>• time available during training to conduct role-plays,</td>
<td></td>
<td>• interacting with different virtual patients,</td>
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<tr>
<td></td>
<td>• acting ability of actor,</td>
<td></td>
<td>• knowing that actions are observed and tracked.</td>
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<td></td>
<td>• observations made by actor and by instructor.</td>
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5. Conclusions

In clinical settings, an effective patient-practitioner dialogue provides the practitioner with full understanding of a patient’s condition, enabling the practitioner to consider medical history, identify root causes of the illness, and implement an optimal course of action. These diagnostic interviewing skills are honed through repeated interactions with “real” or standardized patients.

The VSP provides an opportunity for students to practice numerous case-based scenarios in a reproducible, objective learning environment prior to the challenge of actual patient interaction. (Based on what Steve Downs said yesterday, I wouldn’t include this.

6. References


