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Patient-Provider Communication Training Models for Interactive Speech Devices

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Abstract

Patient-provider communication plays a major role in healthcare with its main goal being to improve the patient's health and build a trustworthy relationship between the patient and the doctor. Provider's efficiency and effectiveness in communication can be improved through training in order to meet the essential elements of communication that are relevant during medical encounters. We surmised that speech-enabled conversational agents could be used as a training tool. In this study, we propose designing an ontology-based interaction model that can direct software agents to train dental and medical students. We transformed sample scenario scripts into a formalized ontology training model that links utterances of the user and the machine that expresses patient-provider communication. We created two instance-based models from the ontology to test the operational execution of the model using a prototype software engine. The assessment revealed that the dialogue engine was able to handle about 62% of the dialogue links. Future direction of this work will focus on further enhancing and capturing the features of patient-provider communication, and eventual deployment for pilot testing.

Keywords

Ontology; Training; Dental education; Patient-provider communication; Conversational agent; Dialogue management

1 Introduction

Good patient-provider communication is an essential aspect of high-quality healthcare. It is a characteristic of clinical expertise that proves to be beneficial to both the provider and the patient. There is evidence that providers and patients do not communicate well and there is always a chance for possible misunderstandings [1]. Several misunderstandings that arise between providers and patients may be solved through a good rapport and communication. Inadequate provider-patient communication has been attributed to one of the root causes of increased violence in workplaces [2]. A rise in the lawsuits against doctors has been seen

over the years and evidence has shown that poor communication between the provider and patient is an attributing factor [3, 4].

A good physician/dentist-patient communication greatly improves a patient's susceptibility to understand and follow the provider's instructions. This results in a reduction in patient anxiety, and an increase in patient satisfaction and adherence to healthy behaviors [5, 6], eventually leading to the desired treatment outcome. In a study done by Hall et al, they analyzed various outcomes of provider communication and found "adherence" to be a predictable outcome from good physician information delivery and more positive discussion [7]. Patient adherence is seen to be significantly related to provider-patient communication and that adherence, can be enhanced when a provider has undergone a training to be a better communicator [6]. The result of the analysis done by Zolnieriek et al, showed that, "patients of physicians who communicate well have 19% higher adherence, and training physicians in communication skills improves patient adherence by 12%" [6]. *Therefore, communication proves to be an essential component of healthcare as shall be seen for both the dental and medical field.*

1.1 Training in Patient-Provider Communication

Effective communication is an essential element of medical care and should be a priority of medical education. According to Hausberg and colleagues, "[c]ommunication can be seen as the main ingredient in medical care" [8]. Professionalism being a fundamental aspect of good medical practice also demands not only knowledge and competence but also effective communication skill [9, 10]. As physicians progress from students to experts, their competence level has to expand as well from conducting generic communication task to successfully handling complex and demanding situations [11, 12] such as interacting with angry patients or families [13].

Medical students focus more on hands-on experiences to ameliorate their clinical skills and pay less attention to their communication skills. There is evidence that students' communication skills depreciate over time especially during their clinical years [14] and teaching these skill is neglected during those years [15]. Communication training is critical and may even be more important in residency training [16]. Medical students communication skills are indispensable when looking into their clinical competence [17], and "[c]ompetence in interpersonal skills should be demonstrated through sustained therapeutic patient relationships and in balancing the biotechnical and inter- personal aspects of care" [13]. Training medical students builds good communication skills during their formative years, and serves as an investment towards making good future practitioners [18]. These skills can be learned during training and perfected over the years.

1.2 Effect of Patient-Provider Communication

Patients need to have a good understanding of their disease, the associated risk and the benefit of consistent treatment in order to have improved healthcare outcomes. It is important to understand the "preferences", "beliefs" and "perspectives" [19] of patient during health evaluations so as to have a positive discussion and good information exchange.

According to Epstein et al, physician-patient communication provides a means to manage the patient's uncertainty, address emotions, decision making [20] all contributing to a better understanding of the prognosis given [21]. Effective communication during patient consultation including history-taking and care planning has been positively correlated with emotional health, symptom management and pain control [22].

When there is a lack or poor communication between a provider and a patient, there is a higher chance of errors. Symptoms affecting patients may be missed or underestimated during consultations [23], which could potentially be attributed to lack of efficient communication between the physician and the patient. Experts estimate that approximately 98,000 people die in any given year from medical errors occurring in hospitals [24]. Before completing their education, physicians should demonstrate an ability to apply the essential skills of communication in a wide range of clinical situations. They should also be able to recognize and repair communication errors quickly [25].

Dental patient's satisfaction relies greatly on the relationship developed with their providers. A large portion of this relationship entails efficient communication and the quality of this communication is closely related to the overall patient satisfaction [26]. According to Bansal et al, quality of care depends on two major concepts which includes patient perspective and satisfaction [27]. Patients do not assess the medical competence of a provider; however, the experience they have during the process of care highlights their perception regarding the quality of the care they receive [28]. For a patient, what counts most in a provider-patient communication process is having a sense of partaking in the treatment process and a feeling of having their needs fully understood by the provider [29]. A good patient-provider communication should be able to give a patient that control they want over their illness [30] and treatment, while receiving comfort and support from the provider [31].

Dental providers differ from each other and patients are faced with a variety of providers to choose from. Every patient has preferences they take into consideration when selecting their ideal dental provider and these preferences are drawn by the dentist ability to "express empathy, manage pain and have good communication skill" [32]. Communication is mandatory in attaining patient satisfaction and has equal importance to a patient as the technical skill of the provider [33].

1.3 Ontology and Intelligent Agent Research

The canonical definition of ontologies is attributed to Gruber's, "an explicit specification of a conceptualization" through the use of binding concepts with expressive relationships for use by agents [34]. According to Feilmayr and Wöß, "[a]n ontology is a formal, explicit specification of a shared conceptualization that is characterized by high semantic expressiveness required for increased complexity" [35]. Ontologies are artifacts that represents domain knowledge using semantic web syntax languages expressed through OWL [36] and RDF [37, 38]. Using the syntax, we can encode high level concepts and logic, and then publish the artifact which can be shared and reused. Devices (i.e., agents) can read these artifacts and be able to conceptualize domain knowledge, thereby being able to perform reasoning capabilities and act upon that domain knowledge.

Some of the capabilities that are yielded through ontologies include facilitating exchange, sharing and standardization of data; providing support for natural language processing tools; represent complex information; and elicit machine reasoning using the “built-in” semantics of the artifacts.

The field of artificial intelligence (AI) research branches out to several categories – *knowledge representation*, *natural language understanding*, *learning*, *search*, *inference*, *planning and problem solving*, and *vision* [39]. Ontologies have wide-ranging impact on a few of the branches, most notably on *knowledge representation*, *inference*, and, within the context of the paper, *planning and problem solving*. *Knowledge representation* involves modeling physical and logical entities (e.g., using semantics and first order logic) and using these models to furnish meaning and understanding for agents. *Inference* involves producing missing or new information from available sources through logical reasoning. The machine reasoning from ontologies is capable of identifying categories of data, and analyzing logical consistency of the knowledge base. Agents that use the machine reasoning from ontologies are able to understand the meaning of concepts from the domain.

Planning and problem solving is another major topic in AI research. This topic involves a computational agent’s use of deliberation to devise a plan for the agent to act on and then devising steps to perform the chosen act. This is accomplished through developing formal computational models for planning and reacting, and then developing technologies that support and implement the models. Overall goals of this area are to equip the computational agent with autonomous or automated behavior to perform intended tasks, and contribute to the ability to interact with a highly variable environment to account for scenarios unanticipated by the designers of the agent.

There exists some potential in utilizing ontologies for automated planning research [40–52]. Within a planning domain there exist *objects* (agents, non-agent things, etc.), *plans* and its *goals*, and the *actions* to enact those plans. As an artifact that represents the concepts in a domain, it can model and reason objects, actions, plans, and goals of a planning domain [40]. With the representational and inferencing ability, ontologies could potentially automate a specific interaction domain space between user and machine.

1.4 Utilizing Technology for Training Medical and Dental Students

In the last decades, there has been an unprecedented increase in the role of technology in healthcare at different levels. There are different aspects of technology that can train a medical student into becoming a well-rounded physician. These new teachings/ training technologies cover the vast spectrum of healthcare. For example; “virtual patient (VP) simulation training to support certain aspects of clinical education” [53], “devices for initial training of combat medics and first responders, devices for training surgical procedures, virtual reality systems for diagnosis and therapy, and team training systems for crisis or incident management” [54] which have been increasingly adopted.

In teaching communication skills in specific to prospective providers, virtual humans are frequently used during training, as they can provide a standardized experience for all

students [55]. In the study done by Wiehagen, he proposed and focused on four categories of medical simulation devices for improving provider training. They included “PC-Based Interactive Systems, Digitally Enhanced Mannequins, Virtual Workbenches, and Total Immersion Virtual Reality” [54]. He further discussed on the limitations of these devices with some of them being the expensive and complex nature of the simulators. The findings in the study done by Yedidia suggest that medical schools that commit to incorporating communications training can expect improved student performance in regards to patient care [56]. Regardless of the prevalent acknowledgment of the importance of improved patient-provider communication, training in communications skills has not been thoroughly incorporated into most medical school curricula [57, 58] nor has it been subjected to evaluation across different schools [59].

Future providers should be able to communicate information, risk involved, and any uncertainty in ways that patients can understand and engage the patients when necessary in decisions taking [1]. Communication is a skill that can be taught in many different ways to future healthcare providers. For example, Stevens et al. developed a virtual standardized patient to teach students on developing their communication skills [60]. Also, actors are presently used to train University of Texas dental students at a cost greater than \$100 per actor [61].

One takeaway based on our scoping review is the cost to deploy technology-based training. Another is the minimal initiative and research for standardizing the technology-based training for medical and dental students. Lastly, using technology to train these students (while not expansively used) has shown some promise in preparing the students for the challenges of patient-provider communication. To address some of these gaps we introduce the use of speech-based conversational agents (computational software that can automate discourse with consumers) that can be utilized to train dental and medical students to experience some aspects of patient-provider communication, and work towards ameliorating the communication skill of healthcare providers thereby building trust and overall satisfaction to both the patient and the provider; and provide a reusable and economical tool for medical training.

Noted earlier, the objectives of automated planning research are to develop computational models to implement self-directed deliberation and develop software and hardware to support the models. This project embarks on creating computational models through the use of ontologies to formalize patient-provider training and execute the models through a software agent engine using the ontology models. The impact of this work could lead us toward the deployment of our model-driven implementation that can improve communication efforts between patient and provider, reduce cost in training, and possibly standardize training to where the models can be shared and reused.

2 Methods and Tools

2.1 Ontology Framework for Health Communication

In our earlier work, we developed an ontology called *Patient Health Information Dialogue Ontology* (PHIDO) [62] that was conceived from data and dialogue flows from a Wizard of OZ study for patient-provider communication of vaccine counseling [63, 64]. The ontology provided a foundation to construct chains of utterances (*Speech Tasks*) and linking those chains to other chains to form network graph conversations. Figure 1 shows an explanation of the structure of the ontology model.

PHIDO's basic structure include a *Communication Goal*, which is a general goal for the machine to communicate. This class concept can be subclassed to specific communication goals for the agent to implement. For example, the Communication Goal can be subclassed to *Communicate Benefits of Yearly Check-ups* to encompass various speech tasks to fulfill the goal of communicating advantages of seeing one's dentist on a year basis.

The *CommunicationGoal* has speech tasks (*SpeechTasks*) connected through an object property of *hasSpeechTasks*. These *SpeechTasks* comprise of several sub-goals to fulfill their communication goal. Some of these tasks could be essential (answering patient questions, pleasantries interaction) or trivial tasks (repeating an utterance, requesting a repeat). Additionally, the *SpeechTasks* are comprised of linked utterances (*Utterance*) that are connected to *hasUtterance*. Each *Utterance* are linked with *utteranceLink* object property, which has sub-object properties of *follow* and *precedes* that are inverses of each other. The important utterances within the dialogue flow of this model are *ParticipantUtterance* (the utterance of the human user) and *SystemUtterance* (the utterance of the agent). Every Utterance is associated with *hasUtteranceString* (string text of what is to be evoked), *hasUtteranceExample* (sample utterances of that type of Utterance), and *hasFocus* (Boolean flag to indicate the position of the dialogue conversation). These links of *Utterances* models the network representation of the dialogue flow that we will discuss in the later sections. Overall, the PHIDO ontology model serves as a domain knowledge base for a specific type of health conversation with a consumer.

2.2 Ontology-Driven Software Engine for Conversational Agents

In a later study, we developed a software engine that uses the PHIDO model to reason and manage the health dialogue strategies [65]. This software engine is named *Conversational Ontology Operator (COO)*. The engine is a software wrapper that is composed of various software libraries – Stanford Core NLP [66], OWL-API [67], rdf4j [68], Hermit reasoner library [69], and some utility libraries. This engine aims to automate the dialogue interaction between a consumer and the agent. The automation of the dialogue is directed by the PHIDO model that maps out the potential sequences of utterances.

Figure 2 shows a brief description of the software engine's process of utilizing the *Utterance* classes and updating the position of the dialogue. The COO, the software engine, in tandem with the PHIDO model begins at an *Utterance* that has *hasFocus* flagged to true. The software engine determines what the next Utterance type is. If the Utterance type is

a *SystemUtterance*, the next Utterance sends the *hasUtterance* data string to the natural language interface, and then updates the *SystemUtterance* as the current *Utterance* by setting the *hasFocus* to true. If it is not, it captures input from the natural language interface and matches the input with two or more possible *ParticipantUtterances*. Once the engine finds the probable *ParticipantUtterance*, it flags the probable *Participant Utterance's hasFocus* to true. This basic process loops through continuously. More detailed treatment of the process is provided in our previous work [65].

Compared to our previous efforts, the software engine initiates and directs the conversation mainly due to the ontology model representing a dialogue interaction as an expert in a health topic and the user as the passive consumer. In this effort, the software engine will be the passive actor in the interaction with the consumer, who is the domain expert (dental student). The system will be reliant on the dental student consumer to initiate and propel the conversation. To do this, we will create our PHIDO model to reflect this interaction, and the software engine will utilize the model to preform interaction decisions for dialogue.

2.3 Modeling Training Dialogue Interaction

In collaboration with the University of Texas Health Science Center's School of Dentistry, we were provided with sample training dialogue scenario scripts based on fictitious personas representing a fictional archetype, essentially eight individual fictitious patients. These eight training dialogue scripts were previously used in an experimental undergraduate project [61]. We drafted flow charts for each individual dialogue script using draw.io [70]. We qualitatively analyzed each of the drafted flow charts and attempted to find some common patterns that were shared in the charts. From our analysis, we derived and drafted a meta-level flow chart that captures the core interaction from the scripts. We also developed a list of *Utterance* types from our review of the script and assigned basic *Utterance* types to the meta-level flow chart. Table 1 shows the complete list of the *Utterances* classes specific to this domain, along with their association to the *ParticipantUtterance* and the *SystemUtterance* classes of PHIDO. Each specific *ParticipantUtterance* inquiries were paired with corresponding *SystemUtterances*. For example, an utterance that was *Oral_cancer_history_inquiry* (e.g., "Do you have a history of oral cancer in your family?") corresponds to an *Oral_cancer_history_information* response (e.g., "My father had oral cancer some years ago before he passed away..").

In Fig. 3, we show the meta-level abstraction that models the basic dialogue interaction from our review of the dialogue scripts and charts. The dialogue interaction initiates with the *Participant Introduction Utterance* ("Hello, we will be completing your dental history today"). If the software engine does not capture the participant input, or if the input does not match any of the next *Utterances*, the PHIDO model will default to *Request Repeat Utterance* to ask for a repeat. Otherwise, the software engine will direct the conversation to the next *Utterance* of *Reciprocal System Introduction* ("Hi Doctor, okay! I am ready") and the *Chief Compliant inquiry*. Depending on the encoded utterance, the dialogue will segue to either the *Persona Appointment Agenda* where there is an utterance that expresses what the purpose of the patient visit is or go directly *Persona health information* that expresses a specific aspect of the patient issue. Afterwards, Fig. 3 outlines the dialogue interaction

where there is a “drill down” inquiry by the student user probing for more information about the patient, and the patient responding with pieces of their personal health information ranging from cancer history, dental aesthetic information, prior appointments, etc.

Using Protégé 5.50 [71], we authored and represented the aforementioned dialogue interaction using the foundations provided through the PHIDO model as a new ontology artifact. Certain *Utterances*, like the *Participant Introduction Utterance*, were provided, but we added the *ParticipantUtterances* and *SystemUtterances* listed from Table 1 which are unique for this project. This ontology serves as a knowledge base to represent the training conversation in the scenarios that could be imported to COO, the aforementioned software engine that automate the dialogue interaction that specifically uses the PHIDO- based models. The ontology models created for the dialogue flow charts resulted in 142 Classes, 27 Object properties, and 6 Data properties.

2.4 Evaluation

To test the operationalization of the model, we developed two test data models based off of the two dialogue scenario scripts, representing two different patients, that had complex discourse. These test data models were published as two separate PHIDO-based ontologies with instance level data as linked utterances. Figure 4 shows the instances for one of the test ontologies.

We imported the test model ontologies into software engine which was executed through Eclipse IDE’s command console. We interacted with the console in the role of dental student using the utterances from the test script and we recorded each successful and unsuccessful transition from one utterance to another on a spreadsheet. Later, we tallied the transition links accounting the number of successful and unsuccessful utterance links, and reviewed the test script models to assess the operational errors.

3 Results

We created two test models from sample dialogues and performed an assessment with the test scripts through the dialogue software engine (that imported the knowledge base) to verify each dialogue chain in the script (235 dialogue chains in total). Figure 5 shows a sample demonstration from the command console prompt.

The total assessment from the two test models revealed that the dialogue engine was able to handle about 62% of the dialogue links (i.e., transition from one utterance to another). Most of the errors encountered were due to the link from *Persona health information* to *Persona health inquiry* (see Fig. 3), originating from the software engine’s algorithm conflicting with a gap in ontology model. We deduced that a possible solution would be to add an utterance between *Persona health information* and *Persona health inquiry* to accommodate the error.

4 Discussion and Future Direction

This work adds to existing research on the utility of ontologies for automated planning and deliberation, specifically in the domain of dialogue management of patient- provider

communication training. In addition, we exhibited possible extensions of our work with the PHIDO model and the COO engine for conversational agents beyond the vaccine education domain, and onto the domain of training dental students on patient-provider communication. Specifically, we demonstrated the flexibility of our previous works' approach by adapting the interaction to where the machine simulates the passive agent, taking on a non-expert role in the dialogue exchange with a human expert user.

In this study, we investigated the development of patient-provider training models to support training of prospective dental students to gain experience communicating with diverse patients. These training models were manifested as ontology artifacts that can be utilized by software and smart devices to automate the interaction of an individual patient from dialogue scripts that represented individual patient visits. We leveraged some of our previous work in an ontology-driven software engine for conversational agents for vaccine counseling but reorienting it to passive dental patient proxies. This arrangement places the conversational responsibility on the prospective dental student to initiate and engage the patient verbally.

While we were able to translate the dialogue scenario scripts to a formal model of dialogue interaction and execute it using our ontology-based method, we intend to refine the model to address the alluded gap which we believe is easily rectifiable through the addition of an *Utterance* concept. However, it may also highlight the rigidity of the dialogue model, and we may encounter unanticipated challenges.

Bearing in mind we were given eight scripts/patients, the model we devised may be limited. In our previous work, we relied on using Wizard of Oz simulations as a way to gain authentic insight of how and what the dialogue interaction is executed. Through these simulations we were able to create the PHIDO-based model that mirror the authentic interactions of the simulation with live users. Our future direction may involve conducting simulations to gain an accurate insight, and also give us an avenue to pursue pilot testing with the automated deployment of the agent.

Another aspect for us to consider are some of the "trivial" social exchanges that sometimes occur between provider and patient. For example, small talk, or similar social emotional exchanges, is not uncommon to occur between the patient and the provider which has been cited to have some benefits in improving the relationship between them [72]. The dialogue scripts did contain minor small talk (e.g., parking issues by the patient), and our model did not include these types of interactions. However, a future research objective is to study social emotional exchanges in health care, and the underlying mechanism for us to represent it computationally.

There were also idiosyncrasies revealed in the different scripts that represented personality types through their utterances or choice words. One of our on-going, current focus involves the exploration of ontologies for personas that could link to the dialogue ontology model. These ontology-based personas could add a layer of interaction and possibly add more heterogeneous and individualized interaction of the agent.

5 Conclusion

Using scenarios provided by collaborators from UTHealth's School of Dentistry, we developed a standard computational model for patient-provider training using ontology-driven tools from our previous endeavors. Using sample utterances from the scenarios, we were able to automate the dialogue that mimics the fictionalized, individual patients from those scenario scripts. Our operational tests revealed some gaps that can be rectified through modification of the dialogue model. Future goals aim to further enhance the realism of the interaction by deploying or simulating the work with potential dental students and adding diverse, individualized dialogue discourse into the model.

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Fig. 1. Structure of Patient Health Information Dialogue Ontology. Dotted ellipses are example sub-classes.

Fig. 2. Activity diagram showing the software engine loop's process of deciding the next steps in the dialogue interaction.

Fig. 3. Meta-level abstraction that represents the dialogue interaction for patient-provider training. Blue nodes are the *ParticipantUtterances* and the red nodes are the *SystemUtterances*.

Fig. 4. Close-up screenshot of instances (utterance data) for one of the test ontology models viewed through Protégé.

```

ddt#u99 : I am sorry can you repeat that
**dialogue location: http://sbmi.uth.edu/ontology/ddt#u99
> Hello we will completing your dental history
[ Hello we will completing your dental history=ddt#u1 ] = 0.8698354363441467
**dialogue location: http://sbmi.uth.edu/ontology/ddt#u1
ddt#u2 : Hi Doctor, okay! I am ready.
**dialogue location: http://sbmi.uth.edu/ontology/ddt#u2
> What brings you in today
[ What brings you in today=ddt#u3 ] = 1.0
**dialogue location: http://sbmi.uth.edu/ontology/ddt#u3
ddt#u4 : I think it's about time I do something about all of these missing and broken teeth.
Honestly, my mouth will probably look like a war zone to you when you see it. And needless to
say, I'm way past due for the usual cleaning.
**dialogue location: http://sbmi.uth.edu/ontology/ddt#u4
> How long since your last visit
[ How long since your last visit=ddt#phia_50 ] = 0.9449111819267273
**dialogue location: http://sbmi.uth.edu/ontology/ddt#phia_50
ddt#phia_50 : It's been at least 5 years, whenever the last time I had a tooth pulled. As you
can tell, I haven't been very good at going to the dentists, only going when I have a
Problem.
**dialogue location: http://sbmi.uth.edu/ontology/ddt#phia_50
>

```

Fig. 5.
Sample execution of the dialogue model through the experimental software engine (COO) in debugging mode.

Table 1.

Classification of the utterance pairs with sample descriptions. The colon(s) indicates depth of the class within the hierarchy.

<i>ParticipantUtterance</i>	<i>SystemUtterance</i>	<i>Explanation/Example from script</i>
Persona_health_inquiry	Persona_health_information	Patient's General care "Please tell me your height and weight", "patient's vital signs"
	:Confirmation_of_persona_health_information	Affirmative response to any inquiry. Applicable to any inquiry "Yes", "Ok"
	:Disconfirmation_of_persona_health_information	Dissenting response to any inquiry. Applicable to any inquiry. "No", "Sorry I don't ..."
:Persona_Dental_Health_inquiry	:Persona_Dental_Health_information	Questions specific to dental health "Tell me more about your toothache."
::Aesthetic_inquiry	::Aesthetic_information	Questions about appearance of teeth "Are you unhappy with the way your smile or how your teeth look or feel?", "Have you had your teeth Whitened before?"
::Anesthetic_inquiry	::Anesthetic_information	Questions about Anesthesia "Problems in past with local anesthetic?"
::Dental_Habit_inquiry	::Dental_Habit_information	Questions about Patient's involuntary dental habits. "Do you habitually clench or grind teeth during the day or night?"
::Oral_cancer_history_inquiry	::Oral_cancer_history_information	Patient's and family history of oral cancer "Do you have a history of oral cancer in your family?"
::Oral_Dental_Appliance_inquiry	::Oral_Dental_Appliance_information	Questions about present or past usage of oral appliance. "Yes, presently I am wearing my orthodontic retainers well...when I remember to wear them."
::Prior_Dental_Visit_inquiry	::Prior_Dental_Visit_information	Questions about past dental visits. "And do you remember what you had done the last time you saw a dentist?"
Persona_General_Health_inquiry	:Persona_General_Health_information	Questions about patient's current status on health "Are you currently under the care of a physician?"
::Allergy_inquiry	::Allergy_information	Questions about patient's allergies. "Do you have any allergies (i.e., medications, foods, latex, cosmetics, and metals)?"
::Cancer_history_inquiry	::Cancer_history_information	Questions about previous or current cancer diagnosis. "What cancer were you diagnosed with?"
::Cardiovascular_inquiry	::Cardiovascular_information	Question relating to the heart "What treatment have you had for CAD (Coronary Artery Disease)?" "Do you have a pace maker?"
	::Dermatological_inquiry	Questions about skin conditions "Have you been diagnosed with any skin conditions?"
::Diabetic_History_inquiry	::Diabetic_History_information	Questions about diabetes "Do you have a first-degree relative with diabetes?"
::Endocrine_question	::Endocrine_information	Questions regarding the Endocrine system (glands) "Have you been diagnosed with any of the following conditions? Frequent thirst, Frequent urination?"
::Family_history_inquiry	::Family_history_information	Questions about diseases that run in patient's family "Do you have any diseases or medical problems that run in your family (i.e., arthritis, diabetes, cancer, cardiovascular disease)?"
::HEENT_inquiry	::HEENT_information	Questions about Head, eyes, ears, nose, throat. "Have you been diagnosed with any of the following conditions? Head injury, Vision problems, Hearing, impairment, Allergic rhinitis, Chronic sinusitis"

<i>ParticipantUtterance</i>	<i>SystemUtterance</i>	<i>Explanation/Example from script</i>
::Hematological_Inquiry	::Hematological_information	Questions relating to blood disorders “Have you been diagnosed with any of the following conditions like Bleeding Disorders?”
::Immunological_inquiry	::Immunological_information	Questions regarding immune system. “Have you been diagnosed with an autoimmune disease?”
::Medication_inquiry	::Medication_information	Regarding patient's current medication status. “Are you currently taking any prescription medications?”
::Medication_dosage_inquiry	::Medication_dosage_information	Questions about dosage of medication patient is currently taking. “Can you tell me the doses for each medication you're taking?”
::Musculoskeletal_inquiry	::Musculoskeletal_information	Question relating to the skeletal system “Have you been diagnosed with any of the following conditions? Arthritis, Osteoporosis, Gout, Other musculoskeletal disorders. . .”
::Neurological_and_Psychiatric_Inquiry	::Neurological_and_Psychiatric_information	Questions regarding to patient's mental state. “What form of depression have you been diagnosed with?”
::Obstetric_and_Gynecological_inquiry	::Obstetric_and_Gynecological_information	Questions regarding child bearing “Are you pregnant or think you might be pregnant?”
::Physical_activity_and_Diet_inquiry	::Physical_activity_and_Diet_information	Question regarding patients physical activity and diet “What's your diet and physical activity like?”
::Previous_surgery_inquiry	::Previous_surgery_information	Past surgeries done. “I've had 3 surgeries for my melanoma, the first in January 1997...”
::Renal_and_Gastrointestinal_inquiry	::Renal_and_Gastrointestinal_information	Questions about kidneys/ relating to stomach and intestines “Have you been diagnosed with any of the following conditions? Renal failure or Insufficiency, Kidney stones/Stomach or duodenal ulcer, Crohn's disease”,
::Respiratory_Inquiry	::Respiratory_information	Questions relating to respiratory system. “Do you presently suffer from any of the following? Chest pain exacerbated by deep breathing, Cough, Difficulty breathing, Sleep apnea/snoring, Wheezing”
::Sexually_transmitted_disease_inquiry	::Sexually_transmitted_disease_information	Questions about infectious diseases (STD) “Have you been diagnosed with any sexually transmitted disease such as Syphilis, HIV, or Herpes?”
::Social_Behavioral_inquiry	::Social_Behavioral_information	Questions regarding patient's leisure activities. “Do you smoke or consume tobacco?”