

PhD Dissertation

UNIVERSITY of BARI
Department of Informatics

PORTIA: A USER-ADAPTED PERSUASION SYSTEM BASED ON “A-RATIONAL” APPROACH

by

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Submitted for the Degree of
Doctor of Philosophy

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February 2009

*I am grateful to Fiorella de Rosis.
She was my mentor not only for her great scientific knowledge, but also
for her human value. She was a dear friend too.*

*Fiorella was the first to trust in me, she introduced me into the world of
research unveiling its charm but also teaching me the scientific rigor as well as
the sacrifice necessary to attain a goal. She used to repeat “Be never content
with mediocrity, but always go further”.*

*Fiorella was a reference point to me: this research would not be as it is
without her encouragement, without our continuous confronting and clashing,
without our differences of opinion which allowed this research to go on, in
spite of difficulties.*

*Fiorella’s high scientific knowledge represented an invaluable heritage
which has proved fundamental for my research. She was an internationally
recognized researcher in several field of Human-Computer Interaction,
especially user modeling and adaptation. She give precious contributions in
intelligent user interfaces, focusing on user-adapted generation of natural
language and multimedia messages, uncertainty in user models, and natural
language dialog generation with Embodied Conversational Agent. She was
also a pioneer in the field of affective computing, and one of the outstanding
figures of the European Human-Machine Interaction Network on Emotion
(HUMAINE).*

*Fiorella died last summer. She will be fondly remembered, and sadly
missed. I am very proud to be her last student.*

To F.

Abstract

Even if sometimes it is marked as negative, persuasion is a relatively new trend in the research community, and persuasion technologies are already part of the everyday technological landscape.

Persuasion is a form of social influence. It involves the Persuader as well as the Receiver, and so, it begins to be a topic of Human-Computer Interaction field.

People tend to treat computers as social actors, and therefore, a persuasion system is as much agreeable as more it is able to interact with the user in a natural way. This skill requires computers with the ability to simulate reasoning forms that are more complex than purely rational ones. Starting from this perspective, I am interested in building *persuasive intelligent interfaces*, that is, intelligent interfaces capable to simulate the persuasion process used by human to persuade someone to perform a given action. According to a typical aspect of the human persuasion, they should also have the capability to combine rational strategies with emotional ones and to adapt them to the context. In particular, they should have the ‘social intelligence’ that enables them to observe the Receiver, so as to reason both on the strength of alternative (rational and emotional) strategies in order to select the most appropriate one, and on the responses to the Receiver’s reactions.

In this Thesis, I propose a computational model of context and user-adapted persuasion, and present a user-adapted persuasion prototype, called PORTIA developed to test the model.

Acknowledgements

The list of people that I would like to thank is so long that few lines are not sufficient. Therefore, I say thank you to everyone I have forgotten to mention.

Berardina Nadja De Carolis for her support and her suggestion during the drawing up of my Thesis. Sebastiano Pizzutilo for his patience. Isabella Poggi and Maria Miceli for their crucial contributions and for being as nice as they are. Floriana Grasso because, although she is far, she has always been present in my moments of difficulties and discouragement: She is a wise woman. Valeria Carofiglio because nobody would be oneself, if there was not his exact opposite in the world...in life this is important, too.

All of the Department of Computer Science of the University of Bari, for giving me the opportunity to live the experience of my PhD. In particular, Nicole, for having patiently shared with me not only the office. Enzo, true friend, for having always “put up with” me, in bad and good times. My fellow countrywoman Francesca for having always reminded me the flavors of “Salento”: her dad’s “cicorielle” drive me mad! Dora, who lived before me all the anxieties of the PhD, for her simple being a friend.

All my family for their love and their support.

All my friends especially those who live in Bari, in Lecce, and in Potenza, for having understood and bear me in these years, above all in my moments of discouragement in recent months. Each of you has been important:

my life would be less rich without you. Special thanks to Felicia and her family for their endless hospitality.

To all of you who will read my Thesis, because, although you do not know now, you will find out to have an immense patience in tolerating all my Italianate.

This work was financed, in part, by HUMAINE, the European Human-Machine Interaction Network on Emotion (EC Contract 507422).

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Chapter 1

Introduction

Persuasion is an ubiquitous part of contemporary life. It is often related to the image of salespeoples and manipulators, while persuasive communications have been used by good people to implement change. For example, social activists used persuasion to change attitudes toward minorities and women, health communicators have launched campaigns to change people's thinking about cigarettes, alcohol, drugs, and unsafe sex. Some of the greatest leaders have been expert persuaders (for example, Martin Luther King, and Barack Obama).

Emotions play an important role into the persuasion process: it is widely acknowledged that persuasion appeals to the information as well as emotional components. The new trend of research concerns the study of emotional model that may strength the persuasion power. Emotional persuasion is often considered as synonymous of irrational persuasion, while it is not necessarily an irrational attempt to influence the mental state of the receiver, because, again, the persuaders performs a process of rational reasoning and planning [96].

There is a growing interest within the research community towards intelligent information technologies, and for better or for worse, persuasive technologies are already part of the everyday technological landscape. Computing systems of many types, from Web sites to mobile applications, are becoming increasingly focused on motivating and influencing the users: Today we can see computers which play the roles of persuaders, including roles of influence that traditionally were filled by teachers, coaches, clergy, therapists, doctors and salespeople, among other. As Fogg said, this is the era of persuasive technology, that is, *interactive computing systems designed to change people's attitudes and behaviors* [51].

Although there is no doubt about the importance of technological aspects related to persuasion (see [51] for a survey), I focus on theories and models beyond the so called *intelligent interfaces* and on their reasoning capabilities on context and user-adapted persuasion. The aim of the present research is to propose a computational model of persuasion that enables user-adapted persuasion system as PORTIA, which is the prototype developed to test the model.

1.1 Research Objectives

Persuasion is a form of social influence. Some of the more implications of the social aspects of Human-Computer Interaction (HCI) come from the media equation research [126] based on the CASA (computers as social actors) perspective. It asserts that “*one can take both theories and methods from social psychology and directly apply them to human-technology interaction*”.

Starting from this perspective, I was interested in build *persuasive intelligent interfaces*, that is, intelligent interfaces capable of simulating the persuasion process used by humans to persuade someone to perform a given

action. I mainly focused on a typical aspect of the human persuasion that is the capability to combine rational elements with emotional ones.

The goals of my work are to propose a computational model of context and user-adapted persuasion, and to test it through a user-adapted persuasion prototype, called PORTIA.

The model is based on a theory of *a-rational* persuasion [96], and then, is defined in term of the Receiver's goals and beliefs from the Persuader's perspective. That is, the Persuader builds an image of the Receiver's mental state (personality, values and beliefs), in order to reason on the most promising strategy to influence the Receiver. Rather than acquiring this information about Receiver through direct questions, the Persuader attempts to implicitly infer it, with some level of uncertainty, from the knowledge of the Receiver's personality traits and living habits. Therefore, a *user model* is built to include both a specific knowledge and a general knowledge component.

The strategies represented in the model are the result of a combination of theoretical and empirical background: On one hand, some reflections on theories of persuasion, and on their integration with the a-rational theory of persuasion; on the other hand, analysis of two corpora of natural persuasion messages and WoZ dialogs. The most promising strategy is the result of more than one persuasion and argumentation strategies.

The model considers how rational and emotional modes of persuasion may be integrated to produce effective strategies in different context. It also considers the role played by *uncertainty* –which is inherent in this form of practical reasoning- to define the strength of alternative persuasion strategies available in a given context.

Finally, the model reflects on the distinction between this *reasoning* phase and the *argumentation* one in which, according to the Natural Language Generation (NLG) theories, the selected strategy is translated into a coherent language plan. The plan may be used to generate a persuasive message (monologic viewpoint) or a possible dialog simulation between the Persuader and the Receiver (dialog viewpoint). In both cases, outcome is rendered with the media available (For example, natural language or Embodied Conversational Agent (ECA)).

Among the various aspects that are considered in the design of persuasion system, I am interested in verbal rather than non verbal communication forms.

1.2 Motivations

People tend to treat computers as social actors, and therefore, a system is as much agreeable as more it is able to interact with the user in a natural way. This skill requires computers with the ability to simulate reasoning forms that are more complex than purely rational one, also in persuasion. Rather, it requires revising the concept of 'rationality' [80] by including, in this term, the role that emotions and affective attitudes play during the human persuasion process.

A growing interest toward not purely cognitive aspects of persuasion characterizes the research scientific community. Emotional elements -or more in general, affective elements- can increase or decrease the strength of a persuasive communication. Among the various aspects related to emotions, three are the main considered by the current research approach: The emotional state of the user (the Receiver), the emotional state expressed by the interface (the Persuader), and the emotional state produce by the interface on the user through persuasive communication applied. So far, most research in this area

has investigated the expression of emotion through affective communication channels, that is, the use of affective words to express empathy or social attitude, the expression of emotion in facial expression, and so on. On the contrary, there are a few researches that consider emotions as integrated part of the persuasion process -as a mode of persuasion- and not only as last step of the NLG process.

Moreover, influencing is not a direct and rough suggestion, but is supported by a careful selection of the target beliefs, values or attitudes and of the methods to activate or strengthen them. Computers may increase the persuasion power by providing tailored information [51]. Persuasive communications matched with the Receiver's motivations will more likely succeed than those engaging no salient desires. Knowledge of what the Receiver wants (preferences, goals, beliefs and significant values) is therefore essential in selecting the aspects on which to focus the persuasion process, that is, the outcomes the suggested behavior would enable.

Therefore, to simulate the persuasion process the intelligent interfaces should have the 'social intelligence' that enables them to observe the Receiver, so as to reason on both the strength of alternative (rational and emotional) strategies in order to select the most appropriate one, and the responses to the Receiver's reactions.

In the scope of my research on a computational model of context and user-adapted persuasion, I work in two main directions that reflect the distinction between reasoning and planning phases: on one hand, formalism to represent strategic reasoning in persuasion, and, on the other one, translation of persuasion strategies into a natural language message or dialog turns. Consider Persuader as intelligent interface and Receiver as user:

- I describe how the Persuader may integrate the hypotheses about the Receiver's characteristics into a consistent model of Receiver's mental state which considers the possible sources of uncertainty, by representing and propagating information -partially known- about the Receiver.
- I define a formalism to represent emotional and non emotional persuasion strategies so as to combine knowledge about the Receiver with knowledge about the available strategies in a given context, and select the most promising one.
- To keep the time complexity of the reasoning process within a reasonable limit, I define a method for assembling dynamically information chunks into a reasoning model in which only the selected candidate strategies and the information supporting their choice are represented.
- I define a formalism to combine Walton's Argumentation Schemes and further revisions, and the Rhetorical Structure Theory (RST) into argumentation plans that represent the arguments expressed in the selected strategy. I study how the concept of enthymeme should be revised and applied in this context.
- I define a method to translate the selected persuasion strategies into a discourse plan: What should be said and in which order, what may or should be omitted, how the discourse plan may be rendered, and so on.
- I define a method in which argumentation plans are logically connected to the information chunks employed in representing the persuasion strategy: Dynamic assembling of these information chunks then comes together with dynamic combination of argumentation plans, until the overall discourse plan is built.

- In the monologic perspective, I define some pruning rules in order to select which elements of the discourse plan may be included in the persuasive text.
- In the dialogic perspective, I define, on one hand, a limited set of Receiver's reactions to the persuasion attempt, and on the other one, a communication language between the two participants to the persuasion dialog, which defines the types of moves that every participant is enabled to perform.
- Finally, a surface generation phase enables either to translate the discourse plan into a natural language persuasive message or a dialog simulation. The former is a Persuader's persuasion attempt to persuade the Receiver, while the second is a possible dialog simulation in which the Persuader replied to the Receiver's reactions.

To summarize, three knowledge sources are used to select and formulate user-adapted persuasion attempts or argue about them: a USER MODEL to reason about the Receiver's presumed characteristics, a PERSUASION KNOWLEDGE BASE to model rational and emotional strategies, and an ARGUMENTATION KNOWLEDGE BASE to translate every strategy into a discourse plan.

The model is based on the distinction between a phase of reasoning and a phase of formulating an argument. In the reasoning module (*REASONER*), the Persuader works on a representation of the Receiver's mental state to select a promising strategy or to repair to its possible failure, given its knowledge of the situation. In the argumentation module (*ARGUER*), the Persuader translates the selected strategy into a discourse plan that may be used to generate a persuasive message or a possible dialog simulation between Persuader and

Receiver. In both cases, outcome is rendered with the media available (for example, natural language or ECA).

1.3 Innovative Aspects

Researchers in natural argumentation and persuasion typically distinguish between cognitive modes of persuasion and emotional ones. Conversely, according to a-rational Theory of persuasion, this work is an attempt to build a computational model in which rational and emotional modes of persuasion may be integrated to produce effective strategies in different contexts. It is worth specifying that, while it is generally considered the role of the emotions expressed by the Receiver and the Persuader in the persuasion process (for example, emotional communication style or emotional facial expression), or the social relations between the two participants in the persuasion process, the model proposed considers emotions as integrated part of the persuasion process: it considers emotions as characterizing a mode of persuasion and takes into account the influence of emotional aroused by the Persuader on the Receiver's mental state, that is, the role of emotional strategies in influencing the attitude of the Receiver.

1.4 Application Domain

Although the model developed is domain-independent, the application domain to which it is applied is the Healthy Eating. This is also the application area I considered in the preliminary experiments.

Eating habits, indeed, are influenced by emotional factors: Persuasion to change wrong habits should therefore act on the central and the peripheral route at the same time, by combining rational and emotional strategies appropriately.

Eating habits are an essential component of wellbeing, which is result of cultural, psychological and educational factors. As such, they consolidate in time and, when wrong, are quite difficult to modify. Information media are masters in employing tricky arguments to persuade the population to consume products of doubtful healthiness. Attempting to contrast this pressure to persuade the population to adopt more appropriate habits by employing only rational and scientific arguments is probably not effective.

This is, therefore, one of the domains in which mingling of rational and emotional strategies are justified if not needed.

Of course, attention should be paid to insure that arguments are relevant and strong: this is a subjective judgment which depends on the Persuader's knowledge about the Recipient and the conditions in which the persuasion is applied [152].

1.5 Thesis outline

Chapter 2 introduces the concepts of persuasion with a brief discussion about ethical aspects, and emotions. Then, it explains the significant roles of emotion in persuasion. Finally, presents the state of the art of the different computational approaches of computer science.

Chapter 3 describes theories and methods behind the persuasion model proposed in the Chapter 5. Theoretical background is divided into two sections according to the distinction between the phases of reasoning and planning: On one hand, an overview of the Persuasion Models studied by Psychologist and Sociologists, focusing on the a-rational theory of persuasion, and on the other one, an overview of the argumentation model and rhetorical theory.

Chapter 4 describes the empirical background on which I also design the model proposed in the next chapter. The section presents the three experimental studies and the results of their analysis. The first study was aimed at collecting a corpus of persuasion messages with the intent to investigate on the basic strategies adopted by humans in producing a persuasive text. The second was an evaluation study aimed at comparing the persuasion strength of some of the strategies identified in the first study. Finally, the third study was aimed at collecting a corpus of WoZ dialogues with the intent to define a restricted set of user's reactions to the persuasive system's suggestion. The three studies proved that a-rational element may be founded both in persuasion strategies as so as in the user's reactions.

Chapter 5 presents the computational model of context and user-adapted persuasion.

Chapter 6 describes PORTIA that is the user-adapted persuasion system built to test the persuasion model proposed in the previous chapter.

Chapter 7 describes an experimental study that should be considered as a first step towards assessing of the effectiveness of Portia. Evaluating the effectiveness of persuasion system is not easy and may require long observations time of the user's behavior in order to exclude from the persuasion process the influence of external factors. Therefore, before planning a general experimental study that considers all the variables involved and their correlation, I performed a pilot experiment to investigate whether a message produce by PORTIA and conveyed through an ECA may be considered more persuasive then the same presented through a simple text. Results of the study will be important in designing the general experiment.

Chapter 8 presents an overview of research discussed in this Thesis and presents some critical questions and possible future developments.

Chapter 2

Persuasion and Emotions

State of the Art

Persuasive communication is a subject of research of multiple disciplines, amongst which are social sciences and philosophy. It has been studied for thousand of years, beginning with the early Greeks. Emotions play an important role in the persuasion: it is widely acknowledged that persuasion appeals to the information as well as emotional components.

There is a growing interest within the research community toward persuasion and for better or for worse, persuasive technologies are already part of the everyday technological landscape.

In this section I start introducing the concept of persuasion, and some persistent ethical aspects; Then, I briefly describe the different schools of thought about emotions and their significant roles in persuasion; Finally, I present the state of the art of the different computational approaches.

2.1 Persuasion

Persuasion is a form of social influence, that is, the broad process in which the behavior of one person alters the thoughts or actions of another. It involves the production of any kind of change of others' beliefs, goals, or behavior, includes a much broader class of phenomena than mere persuasion. Social influence is a topic addressed by many disciplines and approaches: marketing and advertising, law, linguistics and rhetoric, social psychology and communication studies, politics, public relations, human-computer interaction, and captology (that is, the acronym based on the phrase "computing as persuasive technologies [51] and represents the area where computing technology and persuasion overlap). Social influence can occur when receivers act on cues or messages that were not necessarily intended for their consumption. Persuasion occurs within a context of intentional messages that are initiated by a communicator in hopes of influencing the recipient [110]. Therefore, persuasion involves the persuader's awareness the he or she is trying to influence someone else. It also requires that persuadee make a conscious decision to change his mind about something.

Although persuasive communications have been studied for thousand of years, beginning with the early Greeks, not everyone agrees on what the term really means. The followings are some of the major definitions:

- A communication process in which the communicator seek to elicit a desired response from his receiver [3].
- A conscious attempt by one individual to change the attitudes, beliefs, or behavior of another group of individuals through the transmission of some message [8].

- A symbolic activity whose purpose is to effect the internalization or voluntary acceptance of new cognitive states or patterns of overt behavior through the exchange of messages [138].
- A successful intentional effort at influencing another's mental state through communication in a circumstance in which the persuadee has some measure of freedom [101].
- A process in which communicators try to convince other people to change their attitudes or behaviors through the transmission of a message in an atmosphere of free choice [110].

All of these definitions have strengths and agree. A most recent definition of persuasion [96] considers it the process in which communicators directly act upon people's beliefs in order to change their goals (or their importance), and behavior, through communication and without coercion. Therefore, changing others' goals or behaviors without acting upon their beliefs or changing others' beliefs regardless of the latter's impact on their goals and behaviors are kinds of influence very far from persuasion [95].

As said above, persuasion is a strong exemplar of social influence, but not the only force. Even considering only the intentional change of others' attitudes, we can find different forms of intentional influence than mere persuasion. It's important to know the difference between persuasion, coercion, and manipulation, terms that are sometime confused. Coercion implies force; manipulation implies deception; persuasion implies a voluntary change without deceptive stratagems.

To start with, the basic condition that distinguishes persuasion from coercion is self-persuasion [110], that is, persuader wants the persuadee intends to freely do a certain action. One of the great myths of persuasion is that persuaders convince us to do things we really don't want to do. They force us

to give in. Indeed, we are free to change attitudes or behavior [159]. Communicators only provide the arguments, set up the bait. Therefore, orders, threats, and promises are not considered forms of persuasion. Coercion occurs when the communicator delivers a threat of some consequence, attempts to induce the individual to act contrary to her preferences, and deprives the individual of some measure of freedom or autonomy. Persuasion, by contrary, occurs in an atmosphere of free choice, where the individual is autonomous, capable of saying no, and able to change his or her mind about the issue. Moreover, persuasion concerns others' agreement rather than mere compliance, and so, it proves to be far more effective than coercion, especially in the long run. Social influence can be viewed as a continuum, with coercion lying on one end and persuasion at the other. They can overlap, as in situations involving authority, religious cult, and terrorism.

Similarly, persuasion and manipulation may not be confused. Manipulation is a form of influence in which the persuader induces the persuadee to freely conceive intentions or perform actions only to satisfy own interest. Unlike what happens in coercion, however, here persuadee should believe that her beliefs and goals are "freely" changing. Therefore, manipulation is not a form of persuasion. Some authors [14] claim that persuasion should be limited to those cases in which the persuader "acts in good faith", that is, in R's interest, and without any deceptive intent.

Persuasion is often confused with argumentation. Although in both cases the goal of the communication process is to convince somebody, argumentation means inducing to believe while persuasion inducing to do. In the former case, the communicator's goal is to influence an addressee's beliefs, while in the latter the goal is to influence the addressee's intention to perform some action. However, inducing someone to do requires changing his beliefs

[23], and so, there is overlapping between the two communication processes: Argumentation is a resource of persuasion.

A persistent theme in persuasion scholarship –from Plato to the present era- is ethics. Two schools of thought appear to dominate the debate regarding the morality of persuasion. On one extreme are philosophers who argue that persuasion is fundamentally immoral. For example, Plato who was offended by persuasion communication because considered truth as “the only reality in life” [54]. Kant argued that persuasion use people, treating them as a means to the persuader’s end, not as a valued ends in themselves [13]. Similarly, Nilsen [99] argued that persuasion trying to induce someone to do something that is in the communicator’s best interest, but not necessarily in the best of the individual receiving the message. However, some communications are indeed false, designed to manipulate people or are in the interest of the communicator and not the receiver. But others are not. On the other extreme are philosophers who argue that persuasion is fundamentally moral. They believe that people are sufficiently rational to distinguish between truth and falsehood. They say that persuasion is better than coercion, and people are in any event free to accept or reject the communicator’s message. However, to assume that people are capable of maturely rejecting manipulative communicators’ messages naively neglects cases in which trusted but evil people exploit others’ vulnerability.

Some people believe that attempting to change another person’s attitudes or behaviors always is unethical, or at least questionable. Other people view persuasion as fundamentally good. The rub is that persuasive communication can be used with great effectiveness by both moral and immoral persuaders. Persuasion can be used for good or bad purposes, with ethical and unethical intentions. For example, people can use persuasion to induce young teen to smoke, to harm those who are different in race, gender, or belief, but also to change attitudes toward minorities and women, and to

change people's habits in favor of a healthier lifestyle. Aristotle endorses this view. He argued that persuasion could be used by anyone: “by a good person or bad person, by a person seeking worthy and or unworthy ends” [93]. Thus, charisma can be employed by a Hitler or a Martin Luther King, by a Bin Laden or a Gandhi [110].

Therefore, persuasion is not amoral, as is sometime believed. There is ethical and unethical persuasion. Persuasive communications must be judged by the consequences of the act, the intentions of the persuader, the morality of the message, and the context in which persuasion occurs.

2.2 Emotions

It is generally assumed that emotions are a biological device aimed at monitoring the state of reaching or threatening our most important goals [16, 102].

Within the various fields of psychological research, two schools of thought appear to dominate the debate regarding the nature of emotions [130]. The first one assumes that there are several basic defined emotions, while more complex emotions can be defined as a function of them, often classified as primary and secondary emotions. Nature and number of the basic emotions vary according to the theories. Plutchik [116] proposed a system of emotion classification containing eight fundamental emotions. Ekman [48] proposed a system consisting of six fundamental or basic, emotions. Lazarus describes nine negative (Anger, Anxiety, Guilt, Shame, Sadness, Envy, Jealousy, Disgust) and six positive (Joy, Pride, Love, Relief, Hope, Compassion) emotions, with their appraisal patterns [76]. An alternative view, consider emotions as a continuous function of one or more dimensions (for example, the

circumplex model of emotion consider emotions in terms of relative values of what were effectively arousal and valence [135]).

According to the evolutionary theories, emotions were inherited during evolution and are automatically triggered with no cognitive intervention (for example, [48]). On the contrary, cognitive theories of emotions assume that cognition is essential in the triggering of emotion (for example, [106]).

Emotions are often applied in to just modulate facial expressions and lexical choice of conversational agent but they are also powerful motivators. Next paragraph clarifies the powerful impact of emotions on behavior and beliefs.

2.3 Persuasion & Emotions

The importance of appealing to emotions for persuasion has been acknowledged since the ancient Greece. Aristotle identified three main ingredients of persuasion: the nature of the persuader, especially his moral character (*ethos*), the logical and well-reasoned argument (*logos*), and the emotional state of the audience (*pathos*).

From Aristotle to the present era, it is widely acknowledged that persuasion appeals to the information as well as emotional components. In fact, persuasion is aimed at modifying attitudes, which are predispositions to respond in a consistently favorable or unfavorable way to a given object. Attitudes, in their turn, are complex constructs composed of action tendencies, beliefs, and emotional states associated with, or aroused by, the object of the attitude [50]. Therefore, modifying an attitude implies modifying its three components.

Moreover, under certain conditions, emotional responses are characterized by a special strength and immediacy. This may be justified with the strict and manifold relationship with emotions and goals [96]: Emotions *signal* goal pursuit, achievement and failure; they *generate* goals; and they may *translate* into goals [94]. In particular,

- Emotions *signal* the (possible) achievement or thwarting of goals (like in [52, 56]). For example, fear, anxiety, shame, guilt, surprise, joy, and so on, work as signals of the destiny of our goals, thus accomplishing an informative function about our relationship with the environment (like in [36, 72, 76]).
- Emotions *generate* goals, that is, once an emotion has signaled the destiny of some goal, a behavioral response is likely to follow, which implies the generation of some other goal. For instance, once fear has signaled the presence of a possible danger, it produces the goal to avoid it.
- Emotions *become* goals, that is, the anticipation that a certain emotion will (not) be felt may give rise to the goal of (not) feeling it. As a consequence, an action may be performed (or avoid) in order (not) to feel a certain emotion. For example, I may give you a present to feel the joy of making you happy. Therefore, a given action can be performed not only on the grounds of one's expectations about its outcome and evaluations of its costs, but also in order (not) to feel the associated emotions.

In *The place of emotion in argument*, Walton [152] argues that “Two factors combine to enhance the trickiness of arguments that appeal to emotion. One is that an appeal to emotion may not be relevant, meaning that it may not contribute to the goals of dialogue.... The other is that arguments based on

emotional appeals tend to be weak arguments, based on presumptions rather than hard arguments....Such arguments become fallacious when the proponent exploits the impact of the appeal to disguise the weakness and/or irrelevance of the argument". The author examines carefully some classical arguments (argumentum ad populum, ad misericordiam, ad baculum and ad hominem) to prove that emotional appeals are neither right or wrong in themselves, but should be known to both guard oneself against them and to use them appropriately. Therefore, attention should be paid to insure that arguments are relevant and strong: this is a subjective judgment which depends on the persuader's knowledge about the receiver and the conditions in which the message is uttered. In addition, assuming the hearer as a purely logical agent is one of the fallacies of persuasive communication attempts [85] while integrating logical reasoning with consideration of emotional and value factors, enable to achieve some degree of naturalness in the message generated [80].

Other authors argue that affective factors influence argument strength by appealing to the receiver's emotions and highly placed values [137] and may affect, at the same time, the way argument structures are formulated by the proponent [158].

Emotional persuasion is often considered as synonymous of irrational persuasion. However some authors (for example, [80]) claim that the distinction between 'rational' and 'emotional' elaboration is fictitious. Rational thinking implies the correct processing of information, that is, a kind of processing whereby conclusions are derivable from premises. Conversely, irrational thinking goes against the evidence provided, or draws a conclusion which is not derivable from its premises. According to Miceli et al [96], emotional persuasion is not necessarily an irrational attempt to influence the mental state of the receiver, because, again, the persuader performs a process of rational reasoning and planning.

2.4 Computational Aspects

Although theoretical aspects of persuasion have been extensively investigated in the philosophical and marketing studies domains, examples of persuasion prototype systems are few and quite recent. The majority of them concern with the intelligent information presentation and are based on Natural Language Generation (NLG), which is the subfield of AI that focuses on automatic production of understandable texts [127]. Below are listed some major systems or models.

- STOP is one of the first systems for behavior change [128]. It is an NLG system that tries to persuade users to stop smoking. It generates short tailored smoking-cessation letter, based on user's response in a questionnaire. The system is based on the consensus three-stage generation architecture described by Reiter and Dale [129]. Tailored letters are generated through category-specific schema: document planner classified smokers into one of seven categories, and then ran a high-level schema that specified which sections and paragraphs should be included in the letter. STOP was evaluated in a randomized controlled clinical trial and the results prove that it was not effective: That is, tailored letters were no more effective than non-tailored letters. The main responsibilities have to be attributed to the strong domain-dependence, and to the Knowledge acquisition that was primarily based on structured expert-oriented techniques (Knowledge was acquired from health professionals which were knowledgeable about smoking and patient information, but they were not experts on writing tailored smoking-cessation letters.
- ARGUER is a system based on a method that uses argumentation schemata both to detect arguments and to generate candidate arguments

for rebuttal [130]. Argumentation schemata match the deep meaning representation of propositions advanced in a dialog [131]. The dialogs produced by ARGUER are simple exchanges of attack and support moves during the dialogs between the system and the user.

- ASD (Argumentation Scheme Dialogue) is a dialectical system based on Walton's principles of game CB with the aim to explore how traditional dialogue games can be extended to take account of the dialectical nature of argumentation schemes [122]. ASD uses the language of formal dialectics to define systems in terms of *Locution rules* (statements, withdrawals, questions, challenges and critical attacks), *Commitment rules* (effects of locution rules on the two interlocutor's knowledge) and *Dialogue rules* (sequencing of communicative acts).
- Magtalo (Multiagent Argumentation, Logic, and Opinion) is a System for Persuasive Online Interaction [123]. It provides a mechanism enabling users to engage in online debate using naturalistic dialogue supported by argumentation theory. Magtalo uses both monologic argument structures and dialogic argument protocols. It supports flexible intuitive interaction with data in complex debate domains to facilitate understanding, assimilation and structured knowledge elicitation, which enables the expansion of domain resources.

The system described above applied a purely logical reasoning to the domains and the need. Due to the high level of uncertainty in persuasion strategies, other systems or model are based on a probabilistic approach, considering probability theory and belief networks as a method for treating uncertainty.

- NAG (Nice Argument Generator) is a precursor of argumentation systems. It generates *nice* arguments, that is, arguments that are both

normatively correct and persuasive for a target audience. It includes not only a generation component [165], but also a module aimed at interpreting the Receivers' reaction according to the system's knowledge of their presumed set of beliefs [164]. NAG maintains two Belief Network models, one representing a normative set of beliefs, the other the user's beliefs. Although the two components have not yet been integrated into a dialogic argumentation prototype system, they set some of the principles that guide their development.

- Gratton [61] proposes to measure the strength of support in probabilistic terms and to estimate the effect of counterexamples against the argument in terms of this strength.
- Das [37] measures probabilistically the confidence that the inference confers to an argument and proposes a method to semi-automatically aggregate individual arguments into belief networks, which aims at overcoming the well-known difficulty of building this complex kind of knowledge bases.
- Green [62] applies a coding scheme based on a Bayesian Network for describing arguments in medical genetics from a corpus of counseling letters, thus providing evidence that this formalism naturally applies to human argumentation messages.
- Carofiglio [19] proposes a framework in which argumentation schemes are represented through Belief Network. This kind of knowledge base could be used, at the same time, to generate receiver-tailored persuasion messages and to respond to subsequent 'critical questions'.

Computer science recently began, with success, to endow natural language dialogues with emotions, by mainly relying on the OCC theory. Recent

works went beyond this classification, to consider categories of emotions that occur frequently in human-computer communication. Despite this effort, examples of systems that consider the role of emotion in persuasion are very few.

- DAPHNE is a nutrition counseling system [60] that participates in dialogue with users to convince them to adopt a healthy diet. It proposes a formalization of a theory of informal argumentation, focused on techniques to change attitudes of the interlocutor. Arguments generated are based on schemas of the New Rhetoric theory of argumentation [109]. DAPHNE was the first system in which adaptation of arguments to the Receiver's values was considered: It considers values and opinions of the addressee to select and justify arguments. Values, in particular, are related to topic and perspective, that is, the attribution of a value (Good/Bad/Indifferent) to a topic (for example, Cancer) has to be made via a perspective (for example, Health): For example, Cancer is Bad from the Health perspective.
- Carofiglio and de Rosis [20] proposed a model of emotional activation in which emotions are central for affective message generation. The implemented model is a platform for simulating simple emotional "reactions". This model of emotional activation is inserted in an argumentation framework.
- PROMOTER is a system for generate persuasive multimodal messages [65]. It is based on taxonomy of persuasive strategies and on a meta-reasoning module that works on this taxonomy [67]: The meta-reasoning module generates an abstract description of the message which is composed of several persuasive strategies that is used for multimodal message generation. The message is generated and tailored (to maximize its impact) according to the cognitive state of the receiver, his/her social

relations, his/her emotional state, the context in which the interaction takes place. It is designed for monological message both tailored to an individual or to a homogeneous group.

Chapter 3

Theories and Methods

Persuasion is a form of social influence and reasoning is the first step of any production of persuasion attempt. The persuader builds a model of the receiver's mental state (based on his theory of mind and personality) and reasons on it to predict the possible emotional and non emotional consequences of a given communication. Therefore, the kind of reasoning is presumptive and plausible. Once a strategy has been selected, the persuader has to translate it into a good persuasive text. That is, the strategy must be instantiated into a discourse plan in which the items to mention, their presentation order and the rhetorical relations among them have to be carefully established. The plan has then to be translated into a natural coherent message, implying a phase of surface generation.

The current chapter describes theories and methods behind the persuasion model and the system presented in this Thesis. In particular, theoretical background is divided into two sections according to the distinction between the phase of reasoning and that of planning: An overview of the Persuasion Models studied by Psychologist and Sociologists, focusing on the a-

rational theory of persuasion, and an overview of the argumentation model and rhetorical theory.

3.1 Persuasion Model

Since the times of Greece, two different mechanisms of persuasion are identified: On one hand, Plato's ideal thinkers epitomized systematic, deep processing of persuasive messages; on the other hand, some of the Sophist writers embodied the colorful, stylistic appeals typical of a not deep processing of persuasive messages. Contemporary models agree that there are two ways to persuasion: One thoughtful, focusing on the main arguments in the message, and the other superficial and short circuited, characterized by an attempt to make a quick choice, an easy fix.

Two models currently dominate the field. The Elaboration Likelihood Model (ELM) and the Heuristic-Systematic Model (HSM) of persuasion, building on the Yale attitude change [71] and cognitive response [63] approaches, offer insights about how people process messages in many situations. Both are process-based models of persuasion that is, they emphasize on the importance of understanding the underlying processes by which messages influence attitudes to understand their communicative effects. Both are dual-process models in that they claim that there are two different mechanisms by which communications affect attitudes. Both assume that the two mechanisms are mutually exclusive (or almost mutually exclusive). A most recent model of persuasion is the Emotional-Non Emotional Persuasion model which presents connections with, as well as differences from, such dual-process theories of persuasion. It also identifies two general classes of persuasion strategies but, unlike ELM and HSM, a qualifying feature of the model is the theory of *a-rational* persuasion, that is, an attempt to integrate emotional and non emotional persuasion: The 'a-rational' persuasion concerns

kinds of persuasion strategies in which 'purely rational' arguments are combined (in various ways) with 'emotional' ones. The model assumes that the two mechanisms of persuasion are not mutually exclusive.

While the first two sub-paragraphs are an overview of ELM and HSM, the third one deals in depth with the Emotional-Non Emotional model because it is the start point of the persuasion system described in this Thesis.

3.1.1 The ELM Model

The Elaboration Likelihood Model (ELM) of persuasion [114] was introduced by Richard E. Petty and John T. Cacioppo during the 1980s. The basic idea of Petty and Cacioppo's theory is that the efficacy of persuasion depends on "the likelihood that an issue or argument will be elaborated upon (thought about)" [113]. In other words, under different conditions, receivers will vary in the degree to which they are likely to engage in elaboration of information relevant to the persuasive issue. By "elaboration" is meant engaging in issue-relevant thinking. Sometimes receivers will engage in extensive issue-relevant thinking: For examples, they will pay attention to a presented message, carefully examine the arguments it contains, think on other issue-relevant considerations (for example, other arguments recall from memory), and so on. But sometimes receivers will not take on so much issue-relevant thinking and display relatively little elaboration. To bring out the differences in these persuasion processes, the ELM distinguishes between two routes to persuasion: a *central* and a *peripheral* route.

The central route represents the persuasion processes involved when elaboration is relatively high. It is characterized by considerable cognitive elaboration: Persuasion achieved through the central route commonly occurs through extensive issue-relevant thinking. It comes about when individuals

focus in depth on the central features of the issue, person, or message. When people process information centrally, they carefully examine the information contained in the message, closely scrutinize the message's arguments, ponder implications of the communicator's idea, and relate information to their own knowledge and values. This is the thinking person's route to persuasion.

The peripheral route represents the persuasion processes involved when elaboration is relatively low. It is characterized by relatively little thought about issue-relevant information: Persuasion achieved through the peripheral route commonly occurs through non-relevant arguments (the attractiveness of the source, the credibility of the source, social role, etc.) about the topic under consideration. It comes about when individuals employ some simple decision rule to evaluate the advocated position. When people process information peripherally, they do not examine the pros and cons of the message's arguments, but rather they rely on various peripheral cues and simple association processes or the use of various mental shortcuts and heuristics. The ELM suggests that there are other peripheral route processes in addition to heuristic principle, specially, "simple affective processes" [114].

Two factors influence the degree of elaboration that a receiver will likely undertake in any given circumstance: One concerns the receiver's *motivation* for engaging in elaboration, the other the receiver's *ability* to engage in such elaboration. High elaboration will not occur if the receiver is motivated to undertake issue-relevant thinking but is unable to do so, nor will it occur if receiver is able to engage in elaboration but is unmotivated to do so. In other words, if the receiver of the message is interested in the issue and is cognitively able to process the persuasive message, that person will process centrally. On the other hand, if the receiver is not motivated by the arguments of the message and/or does not possess the ability to process the message, that person will process peripherally.

While has been convenient to break processes of persuasion into two distinction routes, the degree to which receivers engage in issue-relevant thinking forms a continuum, from cases of extremely high elaboration to cases of little or no elaboration. The central and peripheral routes represent prototypical extremes on the high-to-low elaboration continuum. The ELM suggests that persuasion occurs along the *elaboration likelihood continuum* (Figure 3.1). The continuum stretches from processes requiring no thinking, to processes requiring some effort, to processes requiring careful consideration. “Along much of the continuum, both peripheral and central process takes place” [112]. The ELM assumes that as motivation, ability for argument scrutiny, or both increase, peripheral mechanisms become less important determinants of attitude change.

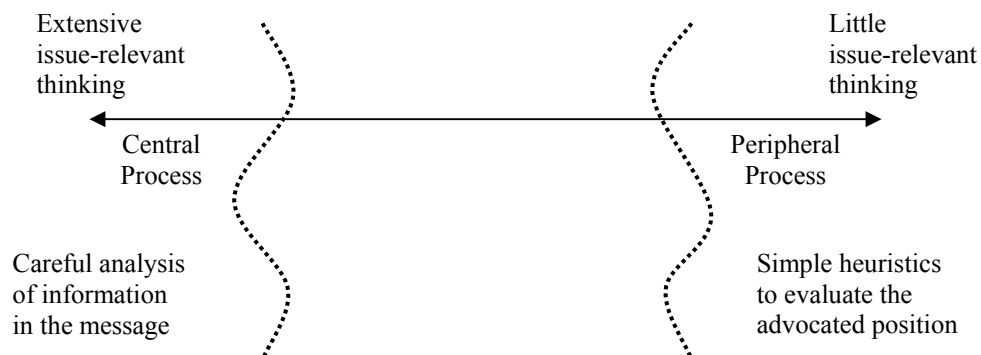


Figure 3.1: Elaboration likelihood continuum

Although persuasion can be accomplished at any point along the elaboration continuum, this does not mean that the nature of the persuasive effects obtained will be identical. The ELM suggests that with variations in the amount of elaboration, there are corresponding variations in the character of the persuasive outcomes effected. Specially, the ELM suggests that attitudes shaped under conditions of high elaboration will display greater temporal persistence than those shaped under conditions of low elaboration. While the mechanism by which these outcomes arise is not interlay understood [115],

there is good reason for persuader to presume that persuasion accomplished through high elaboration is likely to be more enduring and to be more directive of behavior than is persuasion accomplished through low elaboration. In addition, the two routes to persuasion are mutually exclusive, that is, they cannot be followed at the same time (Figure 3.2).

Lastly, the ELM suggests the impact of mood on information processing. Positive mood seems to reduce central processing whereas negative mood enhances it, and positive feelings lead to more positive information evaluation whereas the opposite seems to hold for negative feelings. That is, processing a message extensively often results in feeling aversion for the task. Indeed, Receivers in positive mood are then motivated to avoid such through processing in order to maintain their positive mood. Again, when Receiver's are very motivated to process information, people in positive mood will recall more pleasant material and will make more positive evaluations (chained activation of positive concepts, with encoding and/o retrieval of affect-consistent ideas) [113].

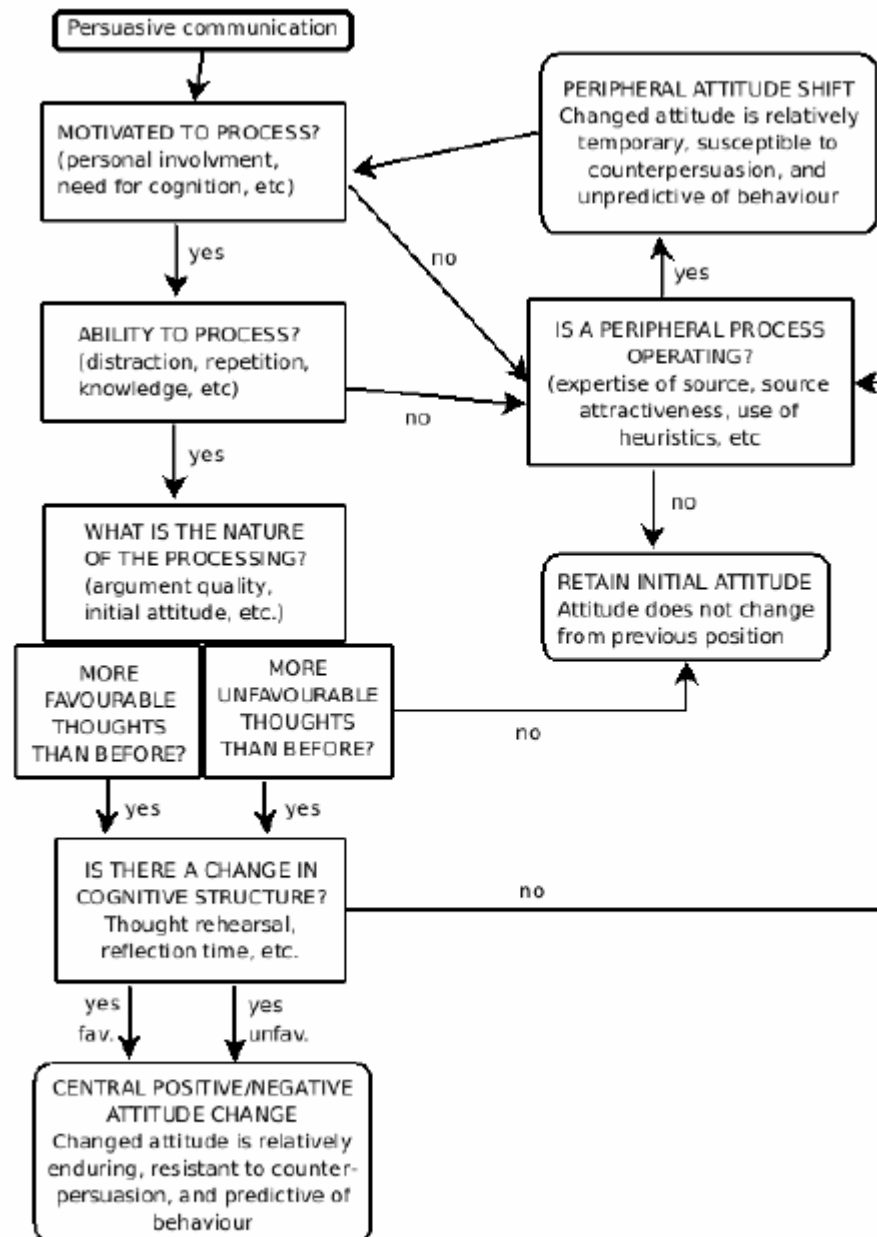


Figure 3.2: The elaboration likelihood model of persuasion (from [114])

3.1.2 The HSM Model

The Heuristic-Systematic Model (HSM) of persuasion [26] was introduced by Chaiken, Liberman and Eagly also during the 1980s. The HSM model delineates two basic modes by which perceivers may determine their attitudes and other social judgments: the *systematic* and the *heuristic* processing.

The systematic processing involves a comprehensive treatment of judgment-relevant information. Judgments formed on the basis of systematic processing are thus responsive to the actual content of this information. Given its nature, systematic processing requires both cognitive ability and capacity.

The heuristic processing involves the activation and application of judgmental rules or “heuristics” that, like other knowledge structures, are presumed to be learned and stored in memory. Judgments formed on the basis of heuristic processing reflect easily processed judgment-relevant cues, rather than individualistic or particularistic judgment-relevant information. People invoke heuristics or simple rules or thumb that enables them to evaluate message arguments without much cognitive effort.

Motivation and *ability* have an important role in determining the processing strategy. The HSM emphasizes that people can be motivated by need to hold accurate attitudes, defensive needs to maintain attitudes that bear on the self-concept, or desire to make a positive impression on other [27].

A key point in the HSM is the *sufficiency principle* based on the least-effort notions. Indeed, it assumes that perceivers are guided in part by a “principle of least effort” that is, heuristic processing often predominates over relatively more effortful systematic processing. The sufficiency principle proposes a continuum of judgmental confidence, along which two critical

points lie: One indicating their level of *actual confidence*, and the other indicating their level of *desired confidence*, or *sufficiency threshold*. This continuum implies that varying degrees of heuristic and systematic processing may occur, corresponding to variations in the width of the confidence gap. Perceivers will use cognitive effort until their level of actual confidence reaches their sufficiency threshold, thereby closing the gap between actual and desired levels of confidence. When low-effort heuristic processing fails to confer sufficient judgmental confidence, perceivers are likely to engage in systemic processing in an attempt to close the confidence gap. In other words, HSM suggests that simple decision rules or heuristics play an important role in attitude change. People are viewed as “minimalist information processors” who are unwilling to devote much effort to processing persuasive arguments. They like their shortcuts and they use them frequently in everyday life. Even so, there are some conditions under which people will gravitate to a systematic processing mode, and individuals seek a balance between relying on shortcuts and carefully processing a message.

Lastly, the HSM interestingly emphasizes that heuristic and systematic processing are not mutually exclusive. Instead, it says that, under certain circumstances, people can rely on heuristics and systematically process a message [46]. Although either processing mode may occur alone, the HSM explicitly assumes that its two modes may co-occur. And that both heuristic and systematic processing can have an impact on judgment when motivation and ability for argument scrutiny are high.

3.1.3 The Emotional-Non Emotional Persuasion Model

The Emotional-Non Emotional Persuasion Model [96] was recently introduced by Miceli M., de Rosis F. and Poggi I. They have presented a model of persuasion in term of goals and beliefs from the Persuader’s perspective:

The model focuses on Persuader's theory of the Receiver's mind and on Persuader's planning strategies for influencing the Receiver, that is, for changing his mental state so as to induce in the receiver the intention to do a certain action or plan. Rather than focusing the analysis on how information is actually processed by the Receiver, the authors have addressed how the Persuader consciously plans to communicate so as to induce the Receiver to process the conveyed information.

The basic idea is to proceed for general classes of strategies, which concern the mental mechanisms and processes implied, rather than focusing on the specific content of persuasive messages, the kinds of goal to "hook", or the positive vs. negative valence of the goal. As seen in the previous sections, representative examples of general classes of strategies are the dual-process theories of persuasion: the Elaboration Likelihood Model and the Heuristic-Systematic Model. Miceli et al. propose two general classes of persuasion strategies: *emotional* and *non emotional*. The two classes present connections with, as well as differences from, such dual-process theories of persuasion. A qualifying feature of their model is the theory of *a-rational* persuasion, that is, an attempt to integrate emotional and non emotional persuasion. Indeed, according to the ELM, the two routes to persuasion are mutually exclusive, that is, they cannot be followed at the same time. However, the HSM assumes that, under certain condition, they can co-occur. Emotional-Non Emotional model views the mingling and intertwining of emotional and non-emotional strategies in the same persuasive attempt as possible, and even likely. These strategies are called *a-rational* and are persuasion strategies in which rational arguments are combined with emotional ones.

In Miceli et al.'s viewpoint, emotional persuasion is seen as a sub-case of their definition of general persuasion: That is, a *persuasive intention which appeals to Receiver's emotions*. This may happen through the medium of the

Receiver's emotions in a twofold sense: both through the actual elicitation of some emotion in the Receiver (*persuasion through arousal of emotions*) or by appealing to Receiver's expected emotions, that is, to Receiver's beliefs and goals *about* her emotions (*persuasion through appeal to expected emotions*) [101].

However, the Persuasion's knowledge of the basic components of emotions and their interrelations, as well as of the Receiver's dispositions and personality, are crucial requirements for the applicability of these persuasion strategies.

Henceforth, P will denote the Persuader and R the Receiver, which is the addressee of P's persuasive message.

Before proceeding to the Miceli et al.'s definitions of persuasion (in term of goal and belief) it is important to outline some basic notions and criteria behind their theory.

To start, a notion of goal and intention is necessary. A *goal* is a regulatory state of a system, that is, a representation that the system tries (through its actions) to liken the world to. Regulatory state is actually a complex family, including wishes, needs and intentions. Not any goal is chosen for being pursued [6, 23, 68]: The choice depends on a variety of criteria, including the perceived importance of the goals, their feasibility, and the amount of resources required to accomplish them. An *intention* is a special kind of goal, which mediates the relationship between mental attitudes and behavior [2]. It is a goal with some properties: it is conscious; consistent with both the agents' beliefs about its possible achievement and their other intentions; chosen, i. e., implying a decision to pursue it; and planned for. So, an intention is always about some action or plan. The decision to pursue the goal implies the agent's commitment to it [29]. However, also an intention is

not necessarily pursued. If a goal is chosen for pursuit, and some planning is being done for it, this goal is already an intention. Other important concepts are the notion of activated and generated goal. A goal is *active* when it is included in the agent's "goal balance" [22], that is, when the agent starts to assess its importance and/or feasibility through comparison with other candidate goals, in view of its possible translation into an intention. An active goal is not yet an intention; it may become so if that goal is finally chosen for pursuit. An inactive goal of R (that is, a goal currently not included in her goal balance) can be activated by P when, in various possible ways, P makes the goal enter into R's goal balance. By contrast, a *generated* goal is a new goal. Goals are generated by means of pre-existing goals [31] on the condition that this goal is active in R's mind. The means-end relationship between a generated goal and a pre-existing one may be either internally represented (that is, planned by R) or external to R's mind.

Persuading somebody commonly implies succeeding in influencing that person. Nevertheless, the theory at issue is interested in P's planning aimed at persuasion, and does not view its actual success as a necessary requirement for its being a persuasive planned intention. Indeed, a persuasive strategy may happen to be effective or ineffective depending on a variety of factors, including contextual or accidental causes. While P may accidentally influence R to do something (that R would not have done without P intervention), for a persuasive attempt to occur, P should have the intention that R intends to do something as a result of some attitude change (physically forcing, for instance, is outside). P may intentionally change R's attitudes in many different ways, but a change in R's attitudes pursued through communication, is more likely a case of persuasive intention. P may use communication to change R's attitudes in a coercive way but this is not considered a case of persuasion. More precisely, a minimal condition for a persuasive strategy to apply is that P wants that R intends to do the required action (at least) not only because P wants so

[117]. Therefore, to define a process as persuasion is not necessary that R is in fact finally persuaded. Rather, it is a P's intentionally persuasive attempt to induce an intention in R, through communication, and in a non-coercive way.

3.1.3.1 General persuasion

General definition of persuasion: An agent P's intention to modify, through communication, R's beliefs or their strength, as a means for P's super-goal to have R freely generate, activate or increase the strength of a certain goal q and, as a consequence, to generate an intention p instrumental to q, and possibly to have R pursue p; but the minimal condition is that R has that intention [94, 96]. For instance, P's saying to R "Your cholesterol level is high; maybe you are overweight" is meant to activate R's goal q of "being in good health", while suggesting the intention p of "to lose weight" as a means for q. Figure 3.3 Represent P's persuasive plan to influence R, but not necessarily its effect on R's mind.

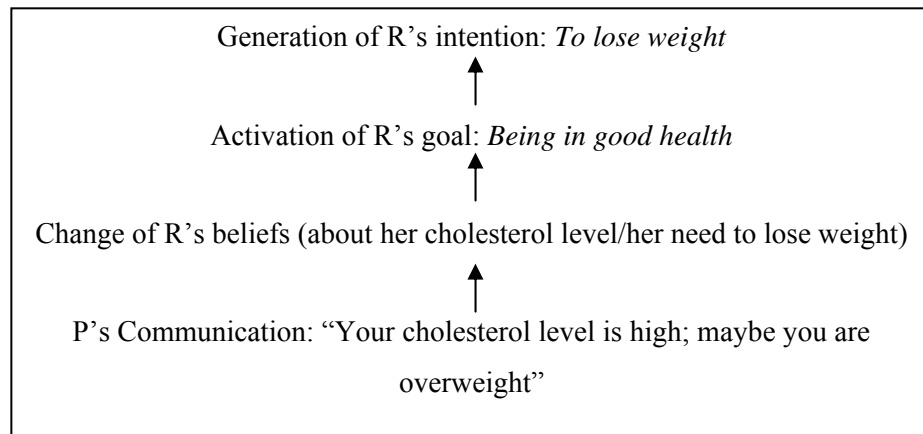


Figure 3.3: An example of P's planning of persuasion attempt

3.1.3.2 Emotional persuasion

As its non emotional counterpart, emotional persuasion is aimed at generating, activating or increasing the strength of R's goals, so as to induce in R some intention instrumental to such goals. The specificity of emotional persuasion lies in the means used for accomplishing this task. That is, when using an 'emotional' strategy, P tries to generate, activate, (etc...) R's goals through the medium of either R's emotions or R's beliefs and goals about her emotions.

Appealing to emotion is functional to persuasion and the relationships between emotions and goals are basic for the emotional persuasion strategies. As said in the previous chapter, emotions monitor and signal goal pursuit, achievement and failure; they generate goals, and may translate into goals [96]. Specially, once an emotion has signaled the (possible or actual) destiny of some goal, a behavioral response is likely to follow, which implies the generation of some other goal. This generative relationship between emotions and goals is at the foundation of what Miceli et al. have called *persuasion through arousal of emotions*. In addition, as said by decision theorist, the role played by the anticipation of future emotions in decision making and behavior seem to be that of predictors of intentional behavior [132, 162]. The anticipation that a certain emotion will (not) be felt may give rise to the goal of (not) feeling it. As a consequence, agents may perform (or avoid performing) an action in order (not) to feel a certain emotion: This kind of relationship between emotions and goals is at the foundation of what the authors have called *persuasion through appeal to expected emotions*.

Persuasion through appeal to expected emotions. P's intention to modify R's beliefs or their strength is a means for P's super-goal to activate, or increase the strength of, R's goal of (not) feeling a certain emotion, and to induce in R an intention instrumental to this goal. For instance (Figure 3.4) P's

saying to R “If you are kind to John, you will not feel guilty” is meant to activate R’s goal q of “not feeling guilty”, while suggesting the intention p of “being kind to John” as a means for q.

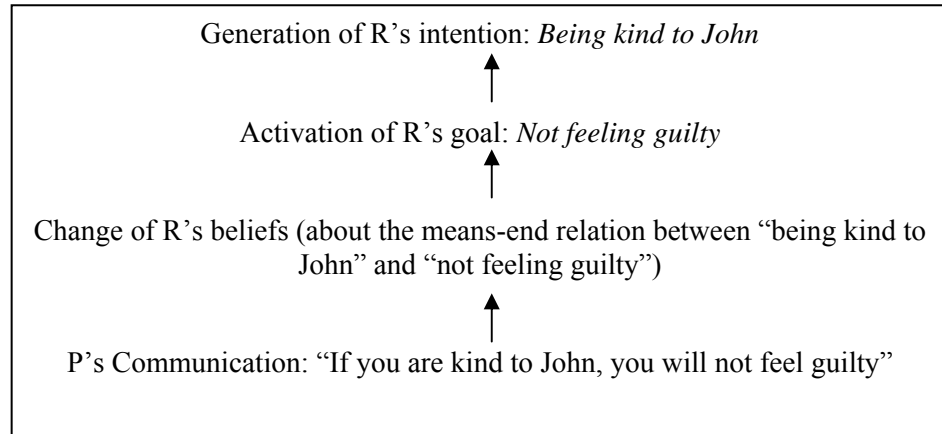


Figure 3.4: An examples of P’s planning of persuasion through appeal to expected emotions

An appeal to expected emotions is structurally indistinguishable from any other “argument from consequences” or, “intention generation by goal activation” [96]. The only difference resides in the content of the activated goal: In the appeal to expected emotions, this content is that of “feeling” a certain emotion rather than having a certain state of the world true. Actually, there is no structural difference between “If you are kind to John, you will not feel guilty”, and, for instance, “If you are kind to John, you will obtain an advancement at work”. In fact, persuasion through appeal to expected emotions is a form of rational and argumentative persuasion (that is, it applies typical rules of reasoning about means ends relationships) with the sole specification that the “ends” considered concern a special class of goals: the goals to feel (or not to feel) certain emotions.

However, P’s knowledge of the basic components of emotions and their interrelations, as well as of R’s dispositions and personality, are crucial requirements for the applicability of this strategy.

Persuasion through arousal of emotions: P’s intention to modify R’s beliefs or their strength is a means for P’s super-goal to arouse an emotion in R, which in turn is a means for P’s further super-goal to generate a goal in R, and then an intention instrumental to it. For instance (Figure 3.5), P’s saying to R “John is very smart, much smarter than you” is meant to provoke R’s envy, this aroused feeling should generate (according to P’s planning) R’s goal that John suffers some harm and induce, as a means for it, her intention to deny John a favor.

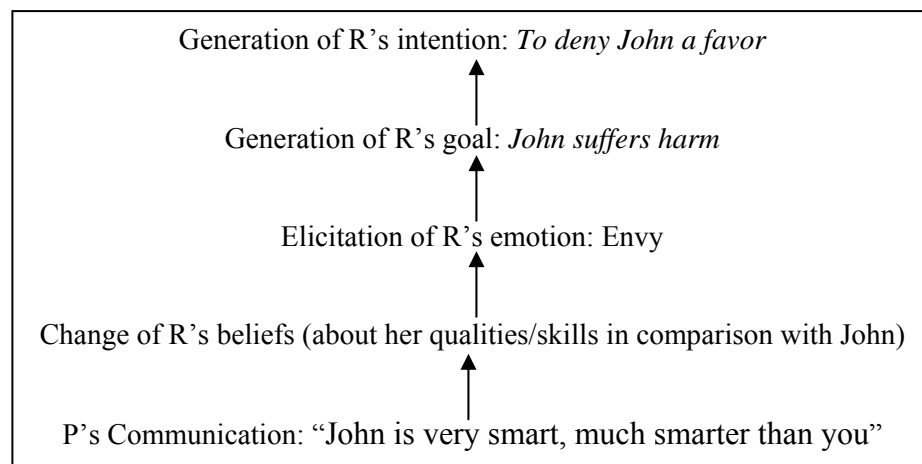


Figure 3.5: An examples of P’s planning of persuasion through arousal of emotions

There is a difference between inducing goals through mere beliefs and inducing goal through emotion-arousing belief. A belief cannot generate goals by themselves alone, but can only active a pre-existing goal. The latter, in interaction with the belief, can generate a sub-goal. By contrast, if a belief arouses an emotion, the latter can directly generate a goal, independent of any planning and reasoning, i.e., independent of any represented means-end relation between the generated goal and some other pre-existing goal.

Persuasion through arousal of emotions is no doubt a form of non argumentative persuasion (that is, it applies processes which are extraneous to reasoning about means ends relationships and independent of its rules) as long as the emotion aroused directly produces a certain goal independently of any

reasoning. However, in this context ‘non argumentative’ should be made equal to ‘a-rational’, rather than ‘irrational’ (as long as ‘irrational’ implies going *against* the dictates of reason). Moreover, it should be stressed that the direct production of a goal through arousal emotional is just one step which is generally included in a more complex persuasion strategy expecting a very ‘rational’ planning and behavior on R’s part. That is, once a certain goal is emotionally produced, R’s reasoning and planning can be called into play in view of its achievement.

However, the strategy has a number of possible drawbacks. Emotion, when unpleasant, may favor some form of resistance, as shown by the research on fear appeals [71]: the experience of a negative emotion may foster emotion control processes which, in the case of fear, are very likely when R has low self-esteem, lacks coping skills, and is very anxious [133]. Yet, persuasion through arousal of emotions may be perceived as particularly unfair by R, if he detects or suspects that P is playing with her emotions. In case R suspects that P is trying to influence through emotional arousal, R perceives a very serious threat to freedom, because P is “using” R’s spontaneous and hardly controllable feelings in view of some strategic end. Further, persuasion through emotional arousal is a risky strategy because often there is no one-to-one relationship between emotions and goals. That is, an emotion may arouse more than one kind of goal. Finally, it is often hard to identify the differences between “germane” emotions (for example, anger vs. indignation; envy vs. emulation). This bears important consequences in persuasion through emotional arousal: A persuasive message aimed to arouse emulation may happen to arouse envy.

Such considerations point to the crucial role played in persuasion through emotional arousal by P’s knowledge of the basic components of emotions and their interrelations, as well as of R’s dispositions and personality.

3.1.3.3 Persuasion strategies

The basic ingredients of reasoning by any persuading agent P include: P's second-order beliefs about R's beliefs, value, activity and state of achievement of goals, intentions and possible actions; and first-order beliefs about the opportunity, for P, to achieve a given own goal.

Let p be a variable denoting an action or plan and $\text{CanDo}(R, p)$, $\text{Do}(R, p)$ be formulae denoting (respectively) that R is able to perform p and that R performs p . Let $q_1, q_2, \dots, q_i, \dots$ and w be formulae denoting states of the world that may include agents such as R or P and $e_1, e_2, \dots, e_j, \dots$ be formulae denoting, in particular, an emotional state of R. Let $\langle \rangle q_i$ be states of the world, and $\langle \rangle e_j$ be emotional states of R which will hold in a more or less near future. Let Bel , Int , A-Goal , V-Goal and Feel be modal operators to denote the various *aspects of the mental state of agent R* which are relevant in persuasion processes, that is (respectively) beliefs, intentions, active-goals, valued-goals and feelings. The first term of these operators is an agent name (R), the second is a formula. Lastly, the symbol $\rightarrow?$ denotes an uncertain implication.

Miceli et al. [96] assume that P believes that: (i) *if R intends to perform p, R will do it* and that (ii) *if R performs p, P will achieve his own goal w*. P's plan is aimed at inducing, in R, the intention to perform p . P may apply various strategies to get this: he may *generate intentions* or *activate goals*. In both cases, P may evoke either rational or emotional factors, or an appropriate mixture of them.

Generate intentions. In this case, P assumes that a domain state or an emotional state of R is already active, and therefore, P tries to show the reasons why R should intend the action to perform as a means for achieving R's own states. P may induce intention by acting either on rational goals or on the goal (not) to feel a certain emotion. In both cases, the hypothesis may be formalized

in terms of a conditional rule, which defines the relations among the components of R's mental state that should be verified, for an intentional state to hold.

Generating intention by acting on 'rational' goals. Action may be performed in order to achieve a certain goal q_i . In particular, to induce intention about p in R , P believes that a goal q_i should exist with a sufficiently high value to R and should be active; R should believe that performing p implies achieving q_i and conditions (internal and external) exist to perform p . The rational generation of intention may be represented as follows:

$$[(V\text{-Goal } R \ q_i) \wedge (A\text{-Goal } R \ q_i) \wedge (Bel \ R \ (Do(R,p) \rightarrow \langle \rangle q_i)) \wedge (Bel \ R \ CanDo(R,p))] \rightarrow ? (Int \ R \ Do(R,p))$$

Generating intention by acting on the goal (not) feel a certain emotion. Action may be performed (or avoided) also in order to feel (or avoid feel) a given emotion. That is, an intention may be generated by the goal of feeling (or avoid feeling) an emotion which is associated with it. As in the previous strategy, the emotional generation of intentions may be represented as follows:

$$[(V\text{-Goal } R \ e_j) \wedge (A\text{-Goal } R \ e_j) \wedge (Bel \ R \ (Do(R,p) \rightarrow \langle \rangle e_j)) \wedge (Bel \ R \ CanDo(R,p))] \rightarrow ? (Int \ R \ Do(R,p))$$

It is worth specifying that *appeal to expected emotions* is a persuasion strategy which exploits this opportunity. Again, expected emotions may be positive (for example, to feel happy) but also negative (for example, to feel aggressive): in the last case, the negative emotional state e_j in the condition rules is considered in the negative form, that is, $\neg e_j$.

Active goals. In this case, P assumes that a domain state or an emotional state of R is *not* active, and therefore, P tries to activate it so as to satisfy this basic condition for allowing consideration of a means-end relation between the action to perform and R 's own states. P may active a goal either through a

cognitive activation or an emotional one. In both cases, the hypothesis may be formalized in terms of conditional rules.

Cognitive activation of goals. This strategy is based on the concept that a belief cannot by itself generate a goal but it can only activate a goal which is already represented in the subject's mind. Suppose that R's belief q_k activates R's goal q_h . Once R's goal q_h has been activated, if R believes that goal q_i is useful to achieve q_h , this will generate, in turn, q_i as a sub-goal. Being generated by an active goal, also q_i will be active. Therefore, P should give the 'activating' information about q_k so as to induce R to intend q_i . Cognitive activation of goals may be represented as follows:

$$\begin{aligned} &(\text{Bel } R \ q_k) \rightarrow? (\text{A-Goal } R \ q_h) \\ &[(\text{A-Goal } R \ q_h) \rightarrow? (\text{Bel } R \ (q_i \rightarrow? \diamond q_h))] \rightarrow? (\text{A-Goal } R \ q_i) \end{aligned}$$

Notice that, the activated goal q_h may be either a non emotional goal (for example, to be in good health) or a goal to feel an emotion (for example, to be cheerful).

Emotional activation of goals. This strategy is based on the concept that emotions signal the achievement or frustration of goal. They also generate other goals which are instrumental to increasing the probability of achieving the monitored goals or avoiding their thwarting, or to limiting the damages implied. Suppose that R's belief q_j arouses R's emotional state e_j , which in turn generates and activates R's goal q_h . Once R's goal q_h has been activated, if R believes that goal q_i is useful to achieve q_h , this will generate, in turn, q_i as a sub-goal. Therefore, P should give the 'activating' information about q_j so as to trigger the whole process. Emotional activation of goals may be represented as follows:

$$\begin{aligned}
&(\text{Bel } R \ q_i) \rightarrow? (\text{A-Goal } R \ e_j)) \\
&(\text{Bel } R \ e_j) \rightarrow? (\text{A-Goal } R \ q_h)) \\
&[(\text{A-Goal } R \ q_h) \rightarrow? (\text{Bel } R \ (q_i \rightarrow? \diamond q_h))] \rightarrow? (\text{A-Goal } R \ q_i)
\end{aligned}$$

It is worth to specifying that the generated goal, being produced by an aroused emotion, is also active in the subject's mind. This is an *a-rational* process, as no planning link is represented between the activating conditions (the monitored goal) and the generated goal.

As already said, P's persuasive strategies to influence R represent P's persuasive plans, but not necessarily their effect on R's mind. Therefore, may happen that a P's message produces different effect in different address: A communicative act may produce, in different address, either a cognitive or an emotional activation of a goal; and a given belief may arouse, in different contexts, different emotions which, in turn, may generate and activate different goal. For example, the sentence "*You are disgustingly fat*" can either rationally active the goal to lose weight or generate it through the emotion of fear. Yet, the same sentence may arouse shame, anger or a mixture of the two emotions. Thus, these effects of P's message on R depend on the context in which the message is delivered, including the specific R of the message [118].

Combining strategies. As just said, emotional persuasion is partially based on R's planning ability, and very 'rational' strategies may appeal to the R's emotions. Therefore, the distinction between emotional and non emotional persuasion is, in real life, unclear. In addition, persuasive strategies are not necessarily alternative: if needed, they may be combined to strengthen the persuasive effect. Of course, the strength of a combined strategy depends on the hypotheses P can make about the R's personality. R's personality may influence the value she assigns to goals [102, 118, 105], her 'propensity to feel emotions' and how she believes in her own capacities. Thus, different forms of

persuasion may be unified to simulate how rational and a-rational forms may be combined to produce an argumentation strategy suited to a particular context: That is, to a R with a given set of beliefs, goal values and personality traits.

3.2 Argumentation and rhetoric

As said in the previous chapter, argumentation is a subset of persuasion: While argumentation means inducing to belief, persuasion means inducing to do. Therefore, inducing someone to do requires changing his beliefs. The art of argumentation, long prized in communication in the past, had fallen on hard times and the term “argument” had a negative connotation, calling to mind obstinate, unpleasant, even aggressive individuals [110]. Only recently, a growing interest in this ancient art starts up, also in Computer science researches. The first interests have been given to the analysis of argumentation, especially in the optic of informal logic. Lately more interest has been given in natural language processing to the automatic analysis of the argument structure.

“Argumentation is the use of arguments” [12]. An argument is a set of one or more premises along with the conclusion. More in detail, an argument is a form of reasoning whereby one gives a reason or reasons in support of some claim. The reasons are called premises and the claim one tries to support with them is called the conclusion. Unlike to the concept of inference, the term argument stresses that premises are reasons given for the *credibility* of the conclusion. Premises aim at persuading someone of the truthfulness of the conclusion, or otherwise, to accept it: The term argument involves a reference to an interlocutor, and that is not present in the concept of inference. More in general, in daily argumentation, we are not interested to know if an argumentation, or reasoning, is a valid deductive inference, or a strong

inductive inference. Instead, we are interested to know whether or not we have to believe a certain conclusion, or adopt a certain decision. Of course, this process involves extra logical item, like the skills of an individual of understanding and evaluating an argument, of examining the source and the context, and so on.

The Toulmin's model of argumentation [142] (Figure 3.6) was one of the first works to highlight the inadequacy of logical structure in analyzing the arguments expressed in natural language. In his book, "The uses of Argument", Toulmin stresses the need of a more complex model of argumentation rather than the traditional model premises-conclusion of the formal logic. Toulmin presents an argument as premises (*Data*) that lead to a conclusion (*Claim*) through a rule (*Warrant*), that in turn has a support (*Backing*), and sometime balanced by a refutation (*Rebuttal*). Lastly, words or phrases expressing the speaker's degree of force or certainty concerning the claim (such as, "possible," "probably," "impossible," "presumably," "as far as the evidence goes," and so on).

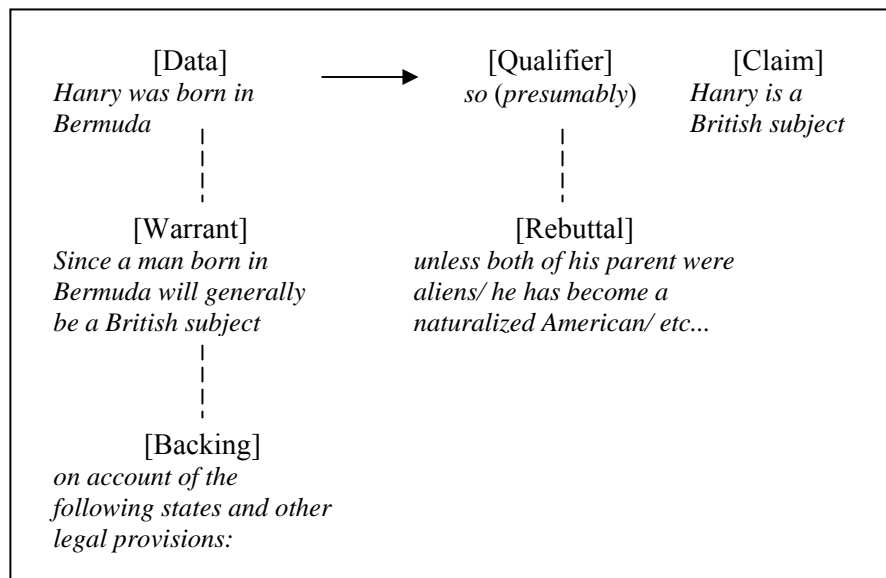


Figure 3.6: Toulmin's model of argumentation (from [142]).

The model presents the first signs of breaking away from formal logic: the *qualifier* according to which the validity of an argument depends on the context in which it happens, and the *rebuttal* that is exception in the argumentation that make defeasible the conclusion.

In “The New Rhetoric: A Treatise on Argumentation”, C. Perelman and L. Olbrechts-Tyteca [109] stress that argumentation is not just the task of using force in discourse. It is the act of presenting facts to an audience and so, an argument is valid if it is persuasive for a certain audience. Perelman and Olbrechts-Tyteca believe that processes like persuasion and argumentation may not necessarily comply with the logical structures, and however, they should not be relegated in the domain of irrationality. Again, while logic has a universal validity (that is, regardless of the persons to whom the evidence is presented), argumentation and rhetoric aim at persuading a certain audience to accept arguments pro or against the thesis. Perelman and Olbrechts-Tyteca identified and defined many distinctive kind of arguments used to convince a respondent on a provisional basis.

One influent informal logic based approach to argumentation is given by Walton. He proposed a new dialectic [144], designed to be used to normatively evaluate any argument used in any case. The new dialectic concerns with the most common kind of arguments used in everyday conversations, which are based on presumptive reasoning, rather than deductive or inductive logic. Such arguments are extremely common, and are often called *plausible* or *presumptive*, meaning that they are only tentatively or provisionally acceptable, even when they are correct. Presumptive reasoning works by making a guess and its presumptive inference gives an arguer a reasons for accepting a conclusion, even though the conclusion may later have be withdrawn if critical questions are asked in the dialogue. The form of inference does have a logical structure: if you accept the premises, and the

form of argument is structurally correct, and you do not ask critical questions, then you must accept the conclusion [145]. Such forms of inference, called *argumentation schemes*, represent the logical structure of this type of argument. Recent work on argumentation theory [74, 155] influenced considerably research about application of IA techniques to the simulation of argumentative dialogue games.

There are explicit relationships among the items of an argument (see Toulmin's model of argumentation in Figure 3.6), but also, among the arguments in a more complex argument structure (for examples, chaining of argumentation schemes) that have to be defined and considered in the presentation. That is, when there is more than one element in an argument, some decision have to be taken about their order of presentation, how to expose the relationship among them, and so on. One method is to employ the Rhetorical Structure Theory (RST) [83] that was developed mainly for text analysis and text generation. RST maintains that, in most coherent discourse, consecutive discourse elements are related by a small set of rhetorical relation that is defined by the theory. Many natural-language generation systems rely on the rhetorical relations defined in RST.

3.2.1 Walton's Argumentation Schemes

Walton's argumentation schemes [153] were introduced by Douglas Walton during the 1990s. They are forms of argument that represent inferential structures of arguments used in everyday discourse, especially in contexts like scientific argumentation, legal argumentation, and especially in artificial intelligent (AI). As said before, some of the most common argumentation schemes are neither deductive nor inductive, but defeasible and presumptive [156].

Argumentation schemes have recently attracting increasing interest in several fields. They give an important contribute to fallacy theory: As said by Walton, arguments which fit into traditional categories of fallacies seem, under right circumstances to be appropriate, acceptable and persuasive. Yet, schemes offer a way of handling a variety of problems in artificial intelligent, in particular in AI domains typically characterized by a deductive basis for communication, such as communication between intelligent agents. Focusing on reasoning skills, an agent must handle uncertainty and incompleteness: Not only will an agent not know everything, it cannot even be sure of the things that it does know [125]. Recent work [154, 124] has shown that argumentation offers a powerful means of tackling these problems by moving away from purely deductive, monotonic approaches to reasoning, towards presumptive, defeasible techniques. In addition, reasoning systems interact not only with the world, but also with humans: Therefore, they not only must reason, but they must present the result of the reasoning in a form that is appropriate for human. Once again, argumentation schemes are a useful means in domain such as natural language generation [59].

A list of twenty–five argumentation presumptive schemes identified by Walton [153] is not complete, and the analysis of each scheme is still in rough form. But this list identifies many most common forms of defeasible argumentation. The treatment of these schemes follows Hastings' style, especially in having with a set of critical questions matching each form. Therefore, matching each argumentation scheme, a set of critical questions is given. The two things together, the argumentation scheme and the matching critical questions, are used to evaluate a given argument in a particular case, in relation to a context in which the argument occurred. If all the premises are supported by some weight of evidence, then that weight of acceptability is shifted towards the conclusion, subject to rebuttal by the asking of appropriate critical questions.

Among the presumptive argumentation schemes presented and analyzed in [153] are such familiar types of argumentation as argument from example, argument from evidence, argument from commitment, argument from position to know, argument from expert opinion, argument from popular opinion and argument from consequences.

Below, an example of what argumentation scheme is and how it works. It is called argument from position to know and it is a type of argument based on the presumption by a proponent that a respondent is a source that is privy to some information that can be extracted from him (she, it) by questioning. The classic example [125] is the dialogue in which someone lost in a foreign city asks a stranger where the Central Station is. The questioner presumes, perhaps wrongly, that the person queried is familiar with the town [153].

Argument from Position to Know

PREMISE: Source a is in a position to know about things in a certain subject domain S containing proposition A .

PREMISE: a asserts that A (in Domain S) is true (false).

CONCLUSION: A is true (false)

Matching the argument from position to know, as indicated in [153], are the following three critical questions:

CQ1: Is a in a position to know whether A is true (false)?

CQ2: Is a an honest (trustworthy, reliable) source?

CQ3: Did a assert that A is true (false)?

As said above, argument from position to know is taken shifts a probative weight from the premises to the conclusion, thus tilting the balance of considerations in a dialogue more towards one side. But this outcome is only tentative, depending on what happens next in the dialogue. If an appropriate

critical question is posed by the respondent, the probative weight shifts the balance of considerations to the other side. Only if the question is answered satisfactorily is the probative weight shifted back again [125].

The followings figures are some of the most common used argumentation schemes.

Argument from Expert Opinion

PREMISE: E is an expert in domain D
PREMISE: E asserts that A is known to be true
PREMISE: A is within D
CONCLUSION: A may (plausibly) be taken to be true.
CQ1: Is E a genuine expert in D?
CQ2: Did E really assert that A is known to be true?
CQ3: Is the expert's pronouncement directly quoted? If not, is a reference to the original source given? Can it be checked?
CQ4: If the expert advice is not quoted, does it look like important information or qualifications may have been left out?
CQ5: If more than one expert source has been cited, is each authority quoted separately? Could there be disagreements among the cited authorities?
CQ6: Is what the authority said clear? Are there technical terms used that are not explained clearly? If the advice is in layman's terms, could this be an indication that it has been translated from some other form of expression given by the expert?
CQ7: Is A relevant to domain D?
CQ8: Is A consistent with what other experts in D say?
CQ9: Is A consistent with known evidence in D?

Figure 3.7: Walton's argumentation scheme: Argument from Expert Opinion

Argument from Popular Opinion

PREMISE: If a large majority (everyone, nearly everyone, etc.) accept A as true, then there exists a (defeasible) presumption in favor of A
PREMISE: a large majority accept A as true
CONCLUSION: There exists a presumption in favor of A.
CQ1: What evidence, such as a poll or an appeal to common knowledge, supports the claim that A is generally accepted as true?
CQ2: Even if A is generally accepted as true, are there any good reasons for doubting it is true?

Figure 3.8: Walton's argumentation scheme: Argument from Popular Opinion

Argument from Example

PREMISE: In this case, the individual a has property F and also property G

PREMISE: a is typical of things that have F and may or may not have G

CONCLUSION: Generally, if x has property F then (usually, probably, typically) x also has property G

CQ1: Is it actually the case that a has F and G?

CQ2: Does the example of a actually support the general claim: is it really an instance of the generalization?

CQ3: Is a actually typical of the kinds of cases that the generalization ranges over?

CQ4: How strong, how widely applicable is the generalization?

CQ5: Are there special circumstances pertaining to a that impair its generalisability?

Figure 3.9: Walton's argumentation scheme: Argument from Example

Argument from Evidence to a Hypothesis

PREMISE: If hypothesis A is true, then a proposition B, reporting an event, will be observed to be true.

PREMISE: B has been observed to be true in a given instance

CONCLUSION: A is true

CQ1: Is it the case that if A is true, then B is true?

CQ2: Has B been observed to be true (false)?

CQ3: Could there be some other reason why B is true, other than its being because of A being true?

Figure 3.10: Walton's argumentation scheme: Argument from Evidence to Hypothesis

Argument from Consequences

PREMISE: If A is brought about, then good (bad) consequences will (may plausibly) occur

CONCLUSION: A should (not) be brought about

CQ1: How strong is the likelihood that these cited consequences will (may, must, etc.) occur if A is brought about?

CQ2: Are these consequences really good (bad) for the receiver?

CQ3: Do conditions exist to bring about A?

CQ4: Are there consequences of the opposite value that should be taken into account?

Figure 3.11: Walton's argumentation scheme: Argument from Consequences

Argument from Commitment

PREMISE: R is committed to proposition A

CONCLUSION: In this case, R should support A

CQ1: Is R really committed to A, and if so, what evidence supports the claim that she is so committed?

CQ2: If the evidence for commitment is indirect or weak, could there also be contrary evidence, or at least room for the rebuttal that this case is an exception?

CQ3: Is the proposition A cited in the premise identical to the proposition A cited in the conclusion? If not, what exactly is the relationship between the two propositions?

Figure 3.12: Walton's argumentation scheme: Argument from Commitment

Argument from Waste

PREMISE: If a stops trying to realize A now, all R's previous efforts to realize A will be wasted

PREMISE: If all R's previous attempts to realize A are wasted, that would be a bad thing

CONCLUSION: R ought to continue trying to realize A

CQ1: Are R's attempts to realize A really a negative value to be taken into account in any practical decision on what to do now, or are they simply past events that can no longer be changed?

CQ2: Is there sufficient reason to think that if R continues, A will be realized? In other words, is A possible?

CQ3: Is there good reason to think that, from this point, the value of realizing A is greater than the disvalue (cost) of continuing the process of attempting to realize A?

Figure 3.13: Walton's argumentation scheme: Argument from Waste

3.2.1.1 Further revisions

As usually happens in science, there is now a growing interest towards validating whether this theory applies successfully to formalizing argumentation of various sorts and in various application domains.

With some exceptions, Walton's schemes are adopt rational arguments, such as pointing out the positive or negative consequences of (respectively) performing or omitting the suggested action. Other authors suggested an

extension of these schemes, to enable formalizing, as well, a-rational aspects of persuasion. Some variants of Walton's argumentation schemes are being proposed, for instance to represent 'values' in practical reasoning [4]. Others authors found much more difficulty in translating into a chaining of Walton's schemes the texts in which emotional strategies were applied [96, 89]. In particular, they propose a revision of some of Walton's schemes which enables representing these strategies: Appeal to Cognitive Dissonance, Appeal to a Friend's Personal Experience and Appeal to the goal to feel a Particular Emotion.

Appeal to Cognitive Dissonance. Cognitive inconsistency is seen, by several psychologists, as an uncomfortable state and evoking the dissonance may produce a motivation to induce the person to reduce it. Therefore, the persuasion power of a strategy may be strengthened by making specific reference to the inconsistency between the referents' beliefs and goals and their behavior. Let consider the following example:

Ex1.: *"I'm surprised Mary! You spend hours in front of the mirror, you buy the latest innovations of cosmetics, you have a mania for fitness,...and then I discover that you don't eat fruit and vegetables... Come on!"*

In this text, P lists some evidence proving that R is committed to 'being in shape' (the proposition A): R should therefore support A. P then implicitly claims that 'eating fruit and vegetables' is a way to achieve A, and that R should therefore support it as well. This kind of argumentation strategy might be represented by combining Walton's scheme of Argument from Commitment with some other scheme (for example, Argument from Evidence). Alternatively, the strategy might be represented with a revised instance of Walton's Argument from Waste. In the first case, the scheme would emphasize consistency of behavior; in the second one, saving of efforts. The authors believe that the first alternative seems to better suit the goal of evoking

cognitive dissonance, and therefore a possible revision of Walton's scheme is the following new scheme:

Argument from Consistent Commitment

PREMISE: consistency is a value to R

PREMISE: A1, A2, ... An are all signs of R's commitment to G

PREMISE: R knows that An+1 is an important mean to achieve G

PREMISE: R does not make An+1

CONCLUSION: R should feel uneasy about not making An+1

CQ1: is consistency really a value to R?

CQ2: Is G really important to R?

CQ3: Is R really committed to A1, A2,...An?

CQ4: Is R committed to A1, A2,...An because of G, or for other reasons?

CQ5: Is An+1 really important to achieve G or does it contribute minimally to this goal?

CQ6: Is the proposition An+1 cited in the premise identical to the proposition An+1 cited in the conclusion? If not, what exactly is the relationship between the two propositions?

Appeal to a friend's personal experience. The hypothesis of friendly relationship with the receiver may be taken as a key factor in formulating a particular kind of 'appeal from position to know'. Let consider the following example:

Ex. 2: *"I tested on my skin the benefits of these simple and health foods"*.

This may be seen as an *Argument from position to know*, in Walton's theory, in which the person a is, in particular, the persuader. However, the authors believe that the strategy applied in the previous example adds some 'emotional strength' to persuasion, due to the friendship relationship between the person who is 'in the position to know' and the receiver. If combined with conditions about honesty of the source, this relationship increases its believability. A possible revision of Walton's scheme is the following new scheme:

Argument from Friendly Personal Experience

PREMISE: Q (who may be also P) is in a position to know whether A is true (false)

PREMISE: Q is a friend of R (or is in some other type of 'empathic' social relationship with R)

PREMISE: Q asserts that A is true (false)

CONCLUSION: A is true (false)

CQ1: Is Q in a position to know whether A is true (false)?

CQ2: Is Q really a friend of R (or does really R feel empathy to Q?)

CQ3: Is Q an honest (trustworthy, reliable) source?

CQ4: Did Q assert that A is true (false)?

Appeal to the goal to feel a particular emotion. Let consider the following example:

Ex. 3: *“A correct diet, rich in vitamins, minerals and calcium, combined with a regular physical exercise, is ideal to be in shape”.*

This is an example of ‘purely rational’ persuasion, which may be formalized with Walton’s argument from consequences:

This scheme enables introducing in practical reasoning emotional strategies of ‘fear appeal’ or ‘hope appeal’. Let, however, consider the following text:

Ex. 4: *“I would be delighted to meet you and discuss pleasantly with you!”.*

In this case, the goal the receiver is induced to achieve is ‘to feel an emotion’ (in the example, ‘pleasure’, or ‘feeling attractive’) rather than a rational goal like ‘being in shape’. The authors claim that, to represent the goal to feel (or to avoid feeling) a broader range of emotions than fear or hope, an extension of Walton’s scheme is needed. A possible revision is the following new scheme:

Argument from Emotional Consequences

PREMISE: If A is brought about by R, then the positive (negative) emotional consequence E will (may plausibly) occur

PREMISE: R is sensitive to feeling (avoid to feel) E

CONCLUSION: A should (not) be brought about by R

CQ1: How strong is the likelihood that the cited emotional consequences will (may, must, etc.) occur if A is brought about, for a receiver with the given characteristics?

CQ2: Is the receiver really sensitive to feeling/not feeling these emotional consequences?

CQ3: Do conditions exist to bring about A?

CQ4: Are there consequences of the opposite value that should be taken into account?

Lastly, Miceli et al. [96] stress that the majority of Walton’s schemes are focused on ‘persuading to believe’ (like Argument from Evidence, Argument from Expert Opinion, and Argument from Position to Know). Among the few of them which are aimed at ‘persuading to do’, the most

commonly applied are the Argument from Consequences and the Practical Reasoning.

Nevertheless, a remarkable body of results about modeling of persuasion and argumentation in AI comes from Walton's theory of argumentation schemes

3.2.2 Rhetorical Structure theory

The Rhetoric structure Theory (RST) [83] was introduced by Mann and Thompson during the 1980s. It is a “*descriptive theory of a major aspect of organization of natural text*” [82].

This theory has enjoyed continuous attention since its origins: It has been applied in a number of areas in discourse analysis, theoretical linguistics, psycholinguistics, and computational linguistic. With reference to the last areas, the most frequent use has been in Natural Language Generation where it is often used to plan coherent text and to parse the structure of texts (see [141] for a survey). Text generation includes not only monologic discourse type like instruction manuals [134, 79], user documentation [69], descriptions of tourist sights [75], and descriptions of concepts [163], but also interactive dialogue like advisory dialogues [98], and dialogue interaction with a database [103, 104]. Some of the work in text parsing has led to further applications, among them text summarization, like parsing algorithm to summarize text [85, 32]. Yet, another active area of research has been hypertext generation, like generation of hypertext descriptions of museum objects [35, 104], generation of dialogue for a multimedia database of Italian 14th century frescoes [18], generation of hypertext-based instructions on how to perform tasks [38], but also, rules for identifying rhetorical relations between speech and gesture in an embodied conversational agent [39]. Lastly, RST can be used to describe,

analyze, and generate argumentative discourse, like strategies for generating evaluative arguments in an automatic personal assistant (such as advisors or sales assistants) [17], and for generating arguments tailored to the user's beliefs [58, 59].

As said above, RST is a descriptive linguistic approach that addresses text organization by means of relations holding between segments of a text. It justifies text coherence by defining hierarchical, connected structure of texts, in which every part of a text has a role. Therefore, the relations have also been called *coherence relations*, or *discourse relations*. The theory is based on four kind of defined object: relations, schemas, schema applications, and structures.

Relations are defined to hold between two text units: the central unit, called *nucleus* (N), and the supporting unit, called *satellite* (S). The first is more central to the text than the second. For example, satellite can be an elaboration, a preparation or a justification for the nucleus. Rhetorical relations are described in terms of Schemas, i.e. the way in which one or more satellites (or nuclei) are related to the current nucleus. It is also assumed that a relation that holds between two text spans also holds between the nuclei of those text spans (multinuclear relations). RST recognizes five type of schema, represented by five diagrams, as in Figure 3.14: While the last four are schemas for multinuclear relation, first of them is an example of mononuclear relations, that is a single relation with nucleus and satellite. All the mononuclear relations of RST have the same schema of circumstance but named with the corresponding relation. The application of a particular schema (schema applications) to a couple of text units is restricted by a number of constraints: constraints on the Nucleus, constraints on the Satellite, constraints on the combination of Nucleus and Satellite. Finally, the notion of structures of an entire text is defined in terms of composition of schema applications. Diagrams representing RST structures are a tree structures.

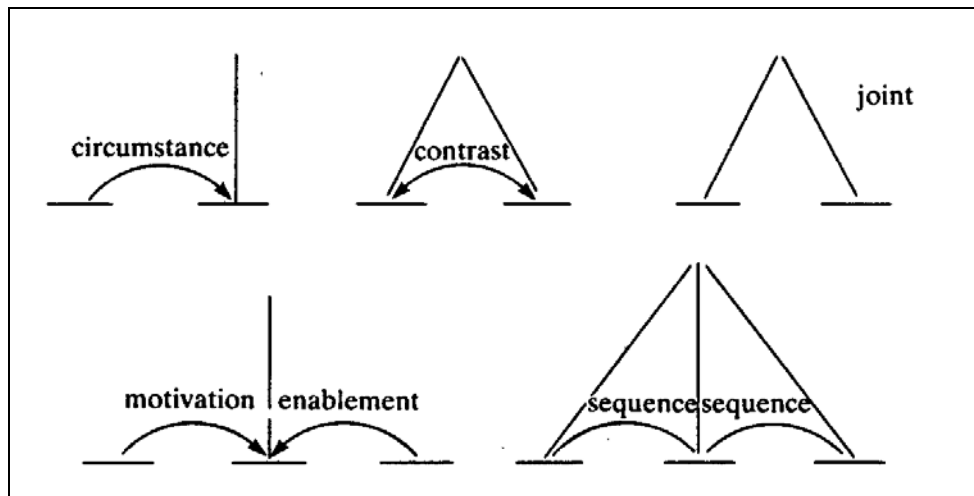


Figure 3.14: Examples of the five schemas types (from [82])

Below, are reported two defined rhetorical relations by name, and their application schema.

The first of the two is the *Evidence* relation: The purpose of the Evidence satellite is to increase the reader's belief in the nucleus.

Relation name: Evidence

Constraints on N: The reader might not believe N to a degree satisfactory to the writer

Constraints on S: The reader believes S or will find it credible

Constraints on N+S combination: The reader's comprehending S increases the reader's belief on N

The effect: The reader's belief of N is increased.

The following Figure 3.15 shows unit 2-3 in an evidence relation with unit 1.

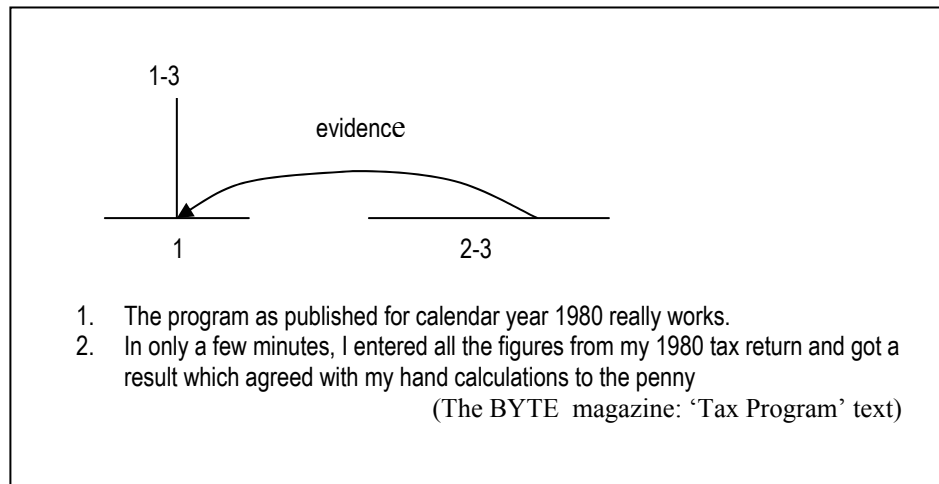


Figure 3.15: An application of the Evidence schema (from [82])

The second example is the *Justify* relation: The purpose of the Justify satellite is to increase the reader's readiness to accept the writer's right to present the nucleus.

Relation name: **Justify**

Constraints on N: none

Constraints on S: none

Constraints on N+S combination: The reader's comprehending S increases the reader's readiness to accept the writer's right to present N

The effect: The reader's readiness to accept the writer's right to present N is increased.

The following Figure 3.16 shows unit 2-3 in a justify relation with unit 1.

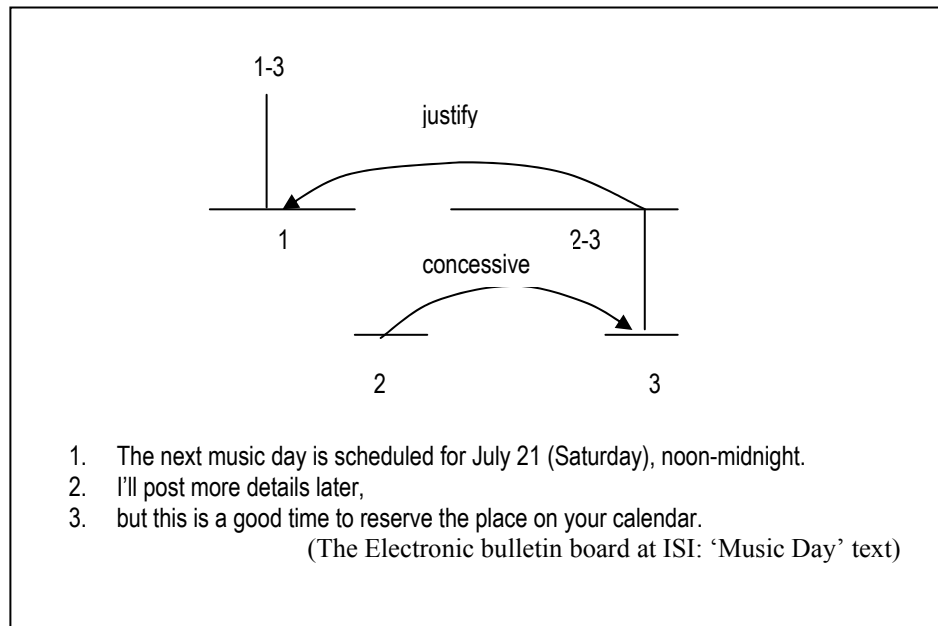


Figure 3.16: An application of the Justify schema (from [82])

The followings figures represent some of the most common used relation definition. It is worth specifying that Schema called Joint has no corresponding relation: the Schema is multinuclear, and no relation is claimed to hold between the nuclei.

<i>Relation name:</i>	Solutionhood
<i>Constraints on N:</i>	none
<i>Constraints on S:</i>	present a problem
<i>Constraints on N+S combination:</i>	The situation presented in N is a solution to the problem stated in S
<i>The effect:</i>	The reader's recognizes the situation presented in N as a solution to the problem presented in S

Figure 3.17: The definition of Solutionhood relation

<p><i>Relation name:</i> Enablement</p> <p><i>Constraints on N:</i> presents the reader action (including accepting an offer), unrealized with respect to the context of N</p> <p><i>Constraints on S:</i> none</p> <p><i>Constraints on N+S combination:</i> The reader comprehending S increase the reader's potential ability to perform the action presented in N</p> <p><i>The effect:</i> The reader's potential ability to perform the action presented in N is increased</p>

Figure 3.18: The definition of Enablement relation

<p><i>Relation name:</i> Motivation</p> <p><i>Constraints on N:</i> presents an action in with the reader is the actor (including accepting an offer), unrealized with respect to the context of N</p> <p><i>Constraints on S:</i> none</p> <p><i>Constraints on N+S combination:</i> comprehending S increase the reader's desire to perform action presented in N</p> <p><i>The effect:</i> The reader's desire to perform action presented in N is increased</p>
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Figure 3.19: The definition of Motivation relation

<p><i>Relation name:</i> Contrast</p> <p><i>Constraints on N:</i> multi-nuclear</p> <p><i>Constraints on S:</i> none</p> <p><i>Constraints on the combination of nuclei:</i> no more than two nuclei; the situation presented in this two nuclei are (a) comprehended as the same in many respects (b) comprehended as differing in few respects and (c) compared with respect to one or more of these differences</p> <p><i>The effect:</i> The reader recognizes the comparability and the difference(s) yielded by comparison being made</p>
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Figure 3.20: The definition of Contrast relation

Lastly, following the diagram of a text structures defined in terms of composition of schema applications. The example is in [83].

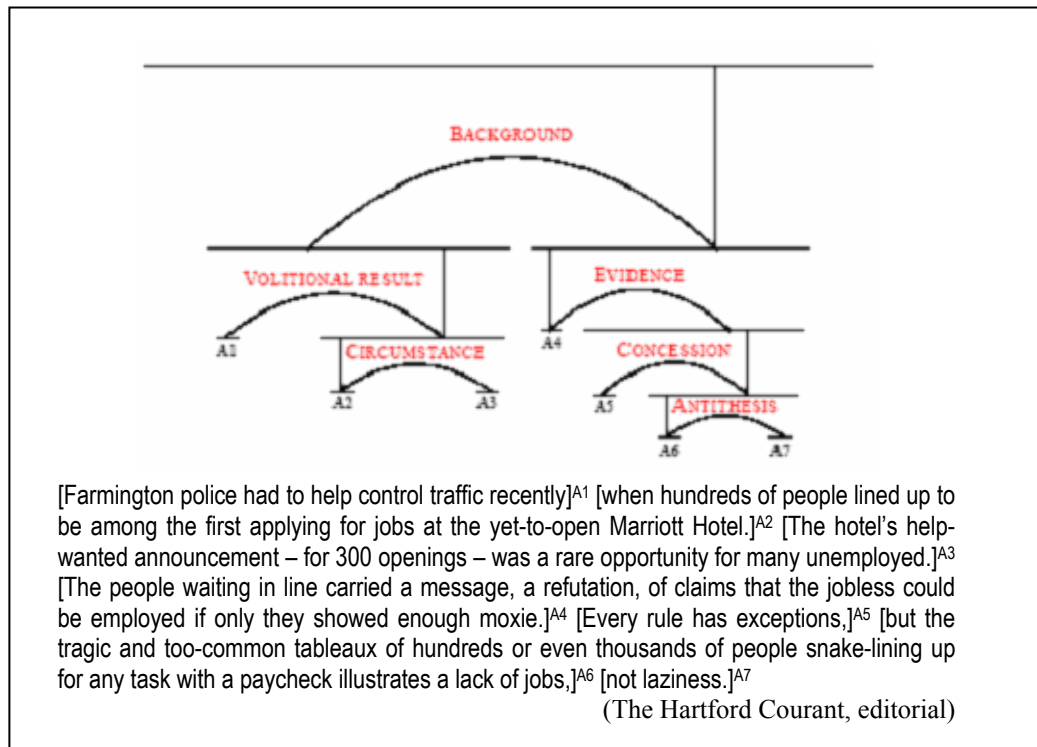


Figure 3.21: An RST analysis of a text (from [82])

Finally, it is worth to explain the position of RST in the text generation. The RST definitions have underlined that relations are one way for writers to express their intentions. Then justify why many generation systems use RST to plan their output. Reiter and Dale [127] have proposed a consensus three-stage generation architecture where modules are connected in a pipeline: document planning, micro-planning, and realization. The output from the first module is a document plan, the output from the second module is a text specification, and the output from the third is the generated text (Figure 3.22). According to them, most systems using RST first specify the relations in the macro-planning stage, and postpone the ordering of text segments and the realization of any discourse markers until the micro-planning stage.

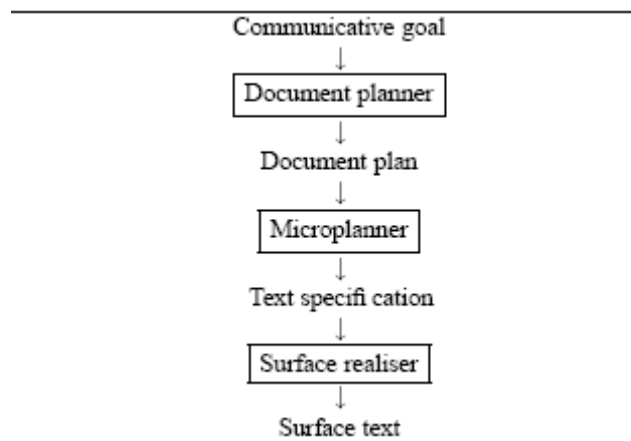


Figure 3.22: Modules, input and output in the consensus generation architecture (from [127]).

Although this architecture is explanatory for many systems, some authors [107, 15] showed that it is not representative for all systems. Indeed, there are applied systems where the borders between the three modules were not that clear, and that the tasks were actually performed in more than one module and not always in a particular order. In particular, for systems with input from a database or knowledge base, rhetorical structuring was mostly done in the first stage, but could also be performed in the micro-planning stage.

Chapter 4

Empirical Background

Besides the theories about argumentation and persuasion seen in Chapter 3, the computational model of context and user-adapted persuasion described in this thesis is also grounded on the results of three experimental studies. The goal of the model is to apply natural argumentation techniques to persuade users to improve their behavior in a given domain. ‘Natural’ argumentation means integrating rational arguments with the common sense, friendly style and emotional ingredients that are used in human-human communication. Therefore, the three studies are based on two corpora: a corpus of ‘natural’ persuasion examples collected from subjects with various backgrounds and a corpus of human-ECA dialogues with user’s reactions to persuasion attempts, collected with a Wizard of Oz (WoZ) study. All the studies are in the Healthy Eating domain.

The current chapter describes the three studies. In particular, the first paragraph describes how the corpus of persuasion messages has been collected and analyzed and what are the basic strategies adopted by our subjects in producing a persuasive text. The second paragraph describes an evaluation study in which the persuasion strength of some of the strategies identified in

the first study is compared. Finally, the third paragraph describes how the corpus of WoZ dialogues has been collected and analyzed to define a restricted set of user's reaction to the persuasive system's suggest.

The three studies proved that a-rational element may be founded both in persuasion strategies as so as in the user's reactions: While purely rational strategies were employed infrequently by human 'persuaders', emotional elements could be found in various forms also in the reactions expressed by the user that go beyond the formalization of critical questions proposed by Walton (see Chapter 2).

All studies are designed in collaboration with two experienced psycholinguistics: Maria Miceli of CNR-ISTC Rome and Isabella Poggi of University of Roma Tre.

4.1 Corpus collection of Persuasion Messages

The starting point is the idea to integrate persuasion theories with observation of how humans behave when they wish to persuade someone to adopt a given behavior in the domain of healthy eating. With this intent, I performed a web-based experimental study aimed at collecting a corpus of 'natural' data by people with no particular competence on Healthy Eating education. The website was developed in PHP languages, a widely-used scripting language especially suited for Web development that can be embedded into HTML. It is still available at www.di.uniba.it/intint/H-persuasion-bi.html.

4.1.1 Method

4.1.1.1 Participants

The experiment was conducted through a public accessible website. Therefore, any person could participate in the study. Some participants were recruited through an e-mail in which was asked them to divulgate the web address of the study. Thirty-two participant were involved in the study: They were Italian subject with various backgrounds (psychologists, philosophers, computer scientists, epidemiologists, and health care providers), aged between 23 and 63, and of both genders.

4.1.1.2 Design

As suggested by Walton [152], attention should be paid to insure that arguments are relevant (that is, they contribute to the goals of the dialogue that the participants in the argument are supposed to be engaged in) and strong (that is, they are based on evidence rather than only on presumption). The extent to which an argument is relevant or strong depends on the characteristics of the message receiver. This is even truer when artifices are employed in the persuasion process. Hence, adaptation of the message to the presumed characteristics of the receiver is a means to increase its persuasion strength.

In the web-based experiment, a scenario was presented to describe the ‘situation’ in which the subjects involved (taking the role of Persuaders) should imagine to be. The scenario was formulated so as to raise the subject’s attention on ‘rational’ persuasion arguments (positive or negative effects of a diet respectively rich or poor of vegetables). It included the following hypotheses: friendship between Persuader and Receiver, Receiver’s personality and goal, his living habits, his ability to make the action possible, relationship between desired action (eat vegetables) and likelihood to achieve the

Receiver's goal. Two versions of the scenario were presented randomly to the subjects: one of them was formulated as a 'positive framing' (positive consequences of a diet rich in vegetables), the other one as a 'negative framing' (negative consequences of a diet poor in vegetables) [78]. For more details about this study, see [89]. One of the two scenarios is the following:

“Mary, one of your best friends, is a 25 year old girl who follows a wrong diet. She does not eat much fruits and vegetables while tends to overeat meat, sweets and pasta. Try to persuade her to eat more fruits and vegetables and, in doing so, don't forget that Mary is famous for her obstinacy!

You know the following facts: eating fruits and vegetables is good for health. They are good sources of vitamin A and C, which are important for growth and repair of body tissues, to cleanse the blood and give resistance against colds. Moreover, various epidemiological studies proved that a diet rich in vitamin A and C decreases the risk of coronary heart diseases and stomach cancer.

In addition, consider that health is very important for Mary: she likes sports, undergoes periodical check ups and looks at TV programs about health care. Mary would have enough free time to cook vegetables and delicious fruit dishes.

Please, use this information to write a text (from 5 to 10 lines) to argue about your thesis.”

Cognitive dissonance was implicitly assumed in the Receiver's mind. The hypothesis was that, in conditions of cognitive coherence, the intention to perform some action should be a consequence of a set of beliefs, goals and conditions which make the action possible. In the scenario, on the contrary, premises were presumed to be true while the consequence was not. This case of cognitive dissonance was similar to the smoking example originally formulated by Festinger [49].

4.1.1.3 Procedure

After receiving a short explanation of the purpose of the experiment, all participants filled out a pre-test questionnaire (Appendix A) aimed at assessing their level of knowledge, habits and interest for healthy eating, in addition to their cultural background. This took no longer than five minutes to complete. Finally, they wrote a short persuasive message according to the scenario displayed in the same web page.

4.1.2 Results

The persuasive messages collected were overall thirty-two. Each of them was factored into ‘discourse segments’, by defining segment boundaries according to the intentional structure [64]: a segment could include one or more utterances with a given communicative goal. The corpus was analyzed in the light of the a-rational persuasion theory explained in the Chapter 3.

4.1.2.1 Quantitative analysis

First result is that the average number of discourse segments per message (5.5) did not differ in the messages originating from positive and negative framing scenarios (Table 4.1).

	Scenario	
	Negative framing	Positive framing
N. of messages	17	15
N. of segments	91	84
Av n. of segment per message	5.4	5.6

Table 4.1: Average number of discourse segment per message

To test whether the framing affected the valence of arguments employed, every discourse segment was categorized as using ‘negative’ or

‘positive’ arguments [78]. The segment was tagged as ‘neutral’ when no negative or positive risk, attribute or goal framing was employed. Table 4.2 describes the proportion of negative, positive and neutral arguments in the messages produced from subjects who initially were displayed a negatively or positively framed scenario. Irrespectively of how the scenario was formulated, *the subjects tended to combine negative with positive arguments but preferred positive arguments to negative ones*: a large proportion of positive arguments (46 %) was employed also in the negatively framed scenario, while a lower proportion of negative arguments (26 %) was included in the positive framing case.

	Scenario	
	Negative framing	Positive framing
Discourse segments using negative arguments	30	22 (26%)
Discourse segments using positive arguments	42 (46%)	42
Discourse segments using neutral arguments	19	20
Total	91	84

Table 4.2: Proportion of negative, positive and neutral arguments per message

The scenario was formulated so as to raise the subject’s attention on ‘rational’ persuasion arguments. One could therefore expect a prevalence of this form of argumentation in the messages produced. Therefore, to test whether the ‘rational’ formulation of the scenario resulted in using rational arguments in the messages, every discourse segment was classified as ‘emotional’ when it included one of the techniques mentioned in [96]:

- Appeal to the goal to feel an emotion. For example: “You will enjoy by preparing delicious fruit recipes”
- Emotional activation of a goal. For example: “*You are a so clever cook!*”

- Expression of emotion in the language style. For example: *“delicious dishes”, “a crispy salad”, “a tasty and colored salad”,* and so on.
- Display of some form of empathy. For example: *“I would be delighted to meet you and discuss pleasantly, in a good dinner, what means to feed healthily”*

Contrary to our hypothesis, very few of the messages were formulated according to a ‘rational’ scheme: *Rational and emotional arguments* were usually combined, with a *prevalence of emotional arguments* (56 %) both in the negative and in the positive framing conditions (Table 4.3).

	Scenario	
	Negative framing	Positive framing
Discourse segments with emotional content	52 (57%)	47 (56%)
Discourse segments without any emotional content	39	37
Total	91	84

Table 4.3: Proportion of emotional and non-emotional arguments per message

4.1.2.2 Qualitative analysis

The hypothesis is that, in conditions of cognitive coherence, the following implication holds: *if a given goal is of high value to R and is active in her mind, and R believes that doing a given action implies achieving the goal, and believes that conditions hold to do the action, then R has the intention to do that action.*

The main goal (the claim) of a persuasion message is to *recommend the activity* by strengthening the intention to perform it. This goal may be achieved by combining various techniques which take, as their target, different items in the previous implication:

- 1) attempt to *increase the desirability of the outcome*;
- 2) attempt to *remind information about activity-outcome relationship*;
- 3) attempt to *prove that conditions exist for performing the activity*.

In addition, as said before, *being aware of a cognitive dissonance* between own beliefs and intentions may produce a motivation that results in genuine cognitive changes [49]: Therefore, specific reference to inconsistency between the referents' beliefs and goals and their behaviour can also be made to strengthen the persuasion power of a message. In attempting to produce a motivation based on *evoking the cognitive dissonance*, the target is the inconsistency between the receivers' beliefs and goals and their behaviour.

Every text in the corpus was analyzed by trying to find out whether and how each of these strategies was implemented. Table 4.4 shows an example message from the corpus.

DS1	<i>Mary, I believe you should eat more fruit and vegetables.</i> Aim: recommend the activity.
DS2	<i>By making sport, you should know that fruit and vegetables are good for health! They strengthen muscles and bones because they are rich in minerals.</i> Aim: remind information about activity-outcome relationship. The rational strategy adopted is enriched by exploiting evidence about the referent which prove her believing in the relationship (' <i>by making sport, you should know...</i> ').
DS3	<i>Especially making sport, a good quantity of fresh season fruit tonifies and rehydrates the body after the big toil!</i> Same aim and target as in DS2. Emotional items are introduced in the style (' <i>fresh season fruit</i> ', ' <i>awful sweat</i> ': ' <i>faticaccia</i> ', in <i>Italian</i>)
DS4	<i>Without counting the benefits of vitamins A and C for skin and hair!</i> Same aim and target as in DS2.
DS5	<i>Maybe you might get rid of some portion of meat or sweets, to leave more space to fruits and vegetables!</i> Aim: to suggest a plan to implement the activity.

Table 4.4: Example of message from the corpus

This text is very simple¹: it is a nearly purely rational message that was taken as a basic schema in the analysis. However, very few of the messages in the corpus were formulated according to the basic schema. This occurred primarily when the subject's background was scientific (computer science in particular); on the contrary, the majority of subjects with a humanistic background added other emotional items to the previous schema. For example:

- *Increase the desirability of the goal* was often given by through arousal of emotion. For instance, by saying:

"... you pretend you care for your health! ..."

"... a person like you, who cares considerably for her health!"

"... you, who care so much for your shape and health!"

the subject aimed at arousing in Mary the emotion of shame in order to produce the goal to save face and therefore to care more for her health as a means to this super-goal.

- *Prove that conditions exist for making the activity* was given, sometimes, in emotional form. For instance:

"...you, who have time and may enjoy in preparing food..."

"...as you have time at your disposal"

"...you may find some excellent vegetables and fresh fruits!"

- *Evoke the cognitive dissonance*: For instance, in attempt to persuade through arousal of emotions was frequently based on evoking explicitly the *cognitive dissonance* mentioned in the scenario, with the intention to arouse the emotion of shame (and therefore, the goal of saving face) in a Receiver

¹ All examples are translated from Italian.

who is (presumably) sensitive to the value of consistency. See the previous examples, and also

"...And you, who care so much for being well, you don't think to that?"

"... I'm surprised Mary! You spend hours in front of the mirror, you buy the last inventions of cosmetics and then ..."

- *Emotional activation of goal*: For instance, by saying

"... you pretend you care for your health!"

"...a person likes you, who care so much for her health!"

the subject aimed at arousing in Mary the emotion of shame in order to produce the goal to save face and therefore to care more for her health as a means to this super-goal.

- *Appeal to the goal to feel an emotion*: For instance, by saying:

"...try to think, Mary, how much more beautiful you might appear and be!"

the subject aimed at appealing to Mary's emotional goal to feel attractive.

- *Introduce higher-order goals* like 'to live in a natural way', 'to satisfy gluttony', 'to enjoy', 'to make friends'. For instance:

"...you would contribute to the life of biological peasants"

"...you may always enjoy in preparing gorgeous vegetable meals."

- More or less explicit *appeal to emotions* was made in some cases:

"here is the sagacity of experienced women: you have the creative intelligence on your side..." or *"...here is the sagacity of experienced women: you have a creative intelligence on your side..."* (*Pride*)

"...I would be delighted to meet you and discuss pleasantly with you..."
(*Attraction*)

"...if you insist in not eating more fruits and vegetables, you demonstrate that you don't love yourself..." (Self-estimate)

"...you don't want to become enormous, do you!" or "...I myself will not want to look at you any more." (Fear)

"... Vitamin C helps to get tanned: look at how tanned I am!" (Envy).

Lastly, a comment on the claim of the persuasive message is necessary. The *recommendation* of the behavior to follow was usually *introduced at the beginning of texts* which were prevalently rational, while it was introduced *only subsequently in more emotional ones*, after preparing the subject to receive the suggestion. In some cases, the role of this section became so minor, that it was not mentioned explicitly but was substituted with the description of some tempting consequences of the activity. This recommendation was supported with a *combination of different strategies*: by attempting to increase the desirability of the outcome, by reminding information about activity-outcome relationship or by proving that conditions hold to make the activity. For instance: *"A meal based on vegetables can be tasty: with just a little imagination you can prepare a first-rate dinner for your friends!"*. Other segments were aimed specifically at evoking the *cognitive dissonance* in the receiver's mind. An example: *"I'm surprised at you Mary! You... and then...."*.

4.1.3 Conclusion

Two important results come from the analysis of the corpus collection. On one hand, quantitative analysis have proved that the subjects involved in this experimental study tried to persuade a friend to eat in a healthier way by employing preferably *positive* and *a-rational* arguments even when the scenario was framed rationally and negatively. On the other hand, qualitative analysis underlines that the subjects adopt various sorts of persuasion strategies in their message: This is a proof that they did not consider each of them

sufficiently strong per se, and that they attempted to increase the overall effectiveness of the message by combining them appropriately. This is, in my view, evidence in favor of the theory of a-rational persuasion.

4.2 Comparative Evaluation of Strategies

The study was aimed at verifying whether the persuasion strategies proposed by subjects in the previous experiment should be considered as a mere exercise of ‘artifice production’ or whether they could be seen as plausible and effective means to persuade. With this intent, I performed a web-based evaluation study aimed at assessing the effectiveness of some ‘typical’ strategies employed in the corpus. In particular, the study was a 2x2 (negative vs. positive framing and rational vs. emotional arguments) subject design. Having to control the number of factors considered in the study, I selected a limited set of strategies to compare. The website was also developed in PHP languages and it is still available at www.di.uniba.it/intint/H-evaluation.html.

4.2.1 Method

4.2.1.1 Participants

As in the previous experiment, evaluation study was conducted through a public accessible website. Participants were recruited through online tam-tam: Some participants were invited through an e-mail in which was asked them to divulgate the web address of the study. Overall, thirty-nine participants from various countries were involved in the study: There were subjects with backgrounds in Humanities and Computer science, aged between 20 and 50, and of both genders.

4.2.1.2 Design

As said in Chapter 1, although the goal of my work was to define a user-updated persuasion model, the final intention was to endow a conversational agent with the ability to simulate user-adapted persuasion

strategies. The natural way to identify the most effective persuasion strategy was to evaluate a monologue. Previous experiences [7, 41] have shown that the evaluation of embodied agent's monologues is strongly influenced by the character's expressiveness and naturalness. Hence, rather than focusing the scenario evaluation on the human-character interaction (as in previous experiment), it was shifted toward a character-character interaction: The subjects involved in the study have to evaluate the persuasiveness of the message from the viewpoint of the character personifying the Receiver. Among all methods defined to this aim, the evaluation study was based on 'in his shoes imagining' one. As said by Goldie [55], there is a difference between 'centrally imagining' and 'imagining oneself in the shoes of other'. The former implies *"imagining oneself in the place of another person by retrieving certain aspects of our own characterization as well as certain aspects of the other's characterization"* (for example, questions like: "what do you think John feels or believes?"). This suggests that a deep knowledge of the other person as well as some degree of similarity is necessary. The second implies that *"one brings about his knowledge of the other, although tending to retain several aspects of own characterization"*. While 'centrally imagining' suggests a deep knowledge of the other person as well as some degree of similarity, 'imagining oneself in the shoes of other' seems to better satisfy the intent of the evaluation study.

From my view, this new scenario should limit the influence of the character's expressiveness on the evaluation. Therefore, rather than asking to the subjects to evaluate a text-based message, they were asked to "witness" a virtual dialogue in English between two embodied agents: A female and a male young characters that respectively took the role of the persuader and the persuadee. Four videos were prepared in which a character (Alice) tried to persuade another character (her friend John) to adopt a diet including a good proportion of vegetables (Figure 4.1). A third character (Mary), known to both John and

Alice, was introduced in the story as the person from which the dieting suggestion was formulated.

The videos were prepared through a pre-existing tool to simulate affected pre-compiled dialogs between two ECAs with various personalities and expressive capabilities. The tool was previously implemented by the Research Group on Intelligent Interfaces of the University of Bari. It is a Visual Basic 6.0 application that includes two Agents made using PeoplePutty (distributed by Haptik) for the body, and Microsoft TTS as English text-to-speech synthesizer. Input moves are tagged strings in the APML language [40].

The videos were presented randomly to the subjects. They had to be short enough to enable the study to be performed in a reasonable time (less than 10 minutes). The dialogs therefore included a few turns. The four videos varied in the persuasion strategy adopted, by combining positive vs. negative framing (P/N) with emotional vs. rational (E/R) arguments:

- In the *positive* cases, positive consequence of eating vegetables were described;
- In the *negative* cases, negative consequences of not eating vegetables were described;
- In the *rational* cases, Mary was presented as a dietician;
- In the *emotional* cases, Mary was presented as a girl interested to John.

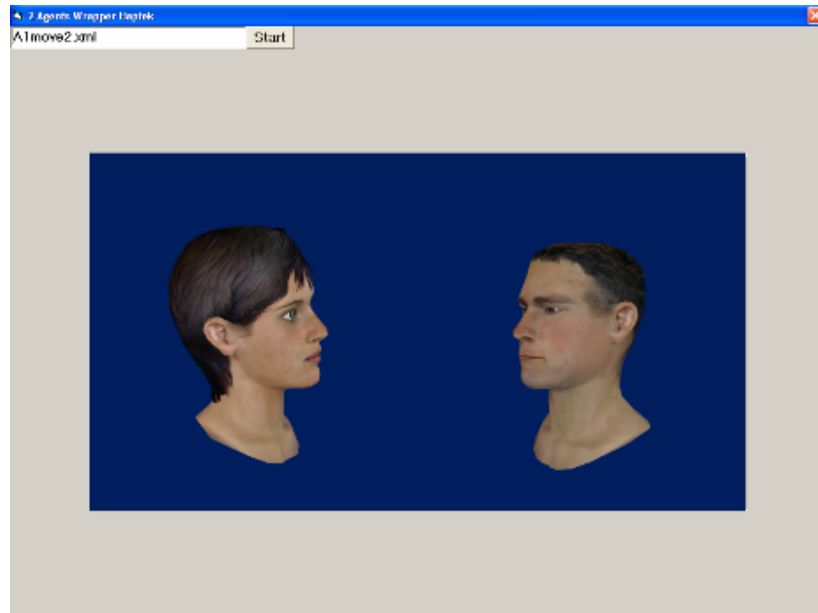


Figure 4.1: The two agents employed in the evaluation study

The following was the *emotional&positive* dialog:

Alice1: *Hi John, do you remember Mary? The beautiful girl we met a couple of weeks ago in a pub! You were talking with her all the time!*

John1: *Oh Mary, of course I remember her!! (SMILE)*

Alice2: *Well, I met her yesterday and she immediately asked about you: she looked quite interested ...*

John2: *Really? And what did she tell you?*

Alice3: *She told me that she had spent a fantastic time with you. And that you are a pleasant and interesting guy! (SMILE)*

John3: *Really? So did I make a hit with her?*

Alice4: *Good gracious! I would say yes! She also finds you pretty handsome. (SMILE) Did you by any chance talk about diets and eating?*

John4: *Yes, but why?*

Alice5: *Because she said she appreciates that you are on a diet. She liked that you are trying to reduce fats and eat more vegetables! (SMILE)*

John5: *Really?*

Alice6: *Well, I believe that you should continue this way. If she meets you in a week, she will be surprised by the perfect shape you will have taken by then!!*

John6: Ok, thanks for your suggestions!

The **emotional&negative** dialog differed in the last four turns, which were the following:

Alice3: *She said that you look quite out of shape, and your aspect suffers from this. Are you sure you are OK? Is there anything going wrong?*

John3: Maybe I'm a bit down, but what then?

Alice4: *But you can't go on this way ! I am sorry to tell it, but you look heavier, your color is dull, your face is swollen* (SAD)

John4: And then, what should I do?

Alice5: *You could do a lot, in my view. You are eating badly!* (SAD)

John5: Why? What's wrong with my eating?

Alice6: *Your diet abounds in fats, meat and carbohydrates, while you eat almost no vegetables and fruits! You seem to disregard the basic rules of a healthy eating. If you go on this way, you will make your harm!! Think of it!* (SAD)

John6: Ok, thanks for your suggestions!

The following was the **rational&negative** dialog:

Alice1: *Hi John, do you remember Mary? The beautiful girl we met a couple of weeks ago in a pub! You were talking with her all the time!*

John1: Oh Mary, of course I remember her!! (SMILE)

Alice2: *Well, I met her yesterday and I found out... you know what her job is? She is a dietician.*

John2: Really? And what did she tell you?

Alice3: *She told me about her studies in food science. She has just been working in an important research study about food and health.*

John3: Really? So did she tell you about results?

Alice4: Oh yes! They once again demonstrated how not eating fruit and vegetables is bad for health and beauty and makes you get old earlier (SAD)

John4: So, what should one do?

Alice5: You could do a lot in my view. You should not go on by eating no fruit and vegetables. (SAD)

John5: Why so much of fruit and vegetables?

Alice6: Because if you eat no or little fruit and vegetables, blood cleaning and tissue regeneration are slower, and this has bad consequences on your skin and hair, your look, and your general health. (SAD)

John6: Ok, thanks for your suggestions!

The **rational&positive** dialog differed in the last three turns, which were the following:

Alice4: Oh yes, quite interesting! They once again demonstrated how eating fruit and vegetables is good for health and beauty and helps you stay young (SMILE)

John4: Yes, but why?

Alice5: Because eating two portions of fruit and vegetables per meal favors blood cleaning and tissue regeneration. (SMILE)

John5: Really?

Alice6: Well, I believe that you also should eat more vegetables and fruit. Your skin and your general health would improve a lot.

John6: Ok, thanks for your suggestions!

In order not to influence the subjects' opinion, the four dialogs included the same number of moves and were of the same duration. Emotional agents' expressions (SMILE and SAD in the two previous examples) were introduced so as to equally balance them in the four cases.

A final questionnaire asked the subjects to evaluate separately, with a Likert scale from 1 to 4, the agent’s expression (*How much did you like the agent’s performance?*) and the dialog content (*If you were in John’s shoes, would you be persuaded by Alice’s words?*). Two open questions enabled them to justify their evaluations.

4.2.1.3 Procedure

All participants first received a short explanation describing the purpose of the experiment. Then they watched a video of the virtual dialogue between two embodied agents. At last, they filled out the post-test questionnaire (Appendix B) that took no longer than five minutes to complete.

4.2.2 Results

The post-test questionnaires collected were, overall, thirty-nine (equally distributed among the four modalities). The following are the main results of this study (Table 4.5):

- *The ‘emotional and positive’ version of the dialogue was considered as the most persuasive on the average (2.4), the other three versions being equivalent (1.9 for the ‘emotional and negative’ version, 2.0 for the two rational versions). Notice that a rating equal to 2 corresponds to answering ‘little’ to the question: “If you were in John’s shoes, would you be persuaded by Alice’s words?”: and, in fact, very few subjects answered ‘much’ to this question, in the EN, RP, RN modalities. On the contrary, a rating equal to 2.4 shows that subjects were divided between answering ‘little’ and ‘much’ or even ‘very much’ to that question. The main critiques to the rational versions of the dialogue were that they were “too much technical”, that “Alice used only a medical approach”, that “people don’t talk like that, unless they are lecturing”, that “reasons employed were not*

enough strong” or similar. The only critique to the ‘emotional and positive’ strategy was that it was *‘too obvious’*, that “*Alice was too patently trying to convince John*”.

- The ‘*emotional and negative*’ version of the dialogue raised quite negative comments: the scenery presented was seen as *‘terrible’*, the persuader (Alice) was seen as *‘violent’*, etc. The expected result was that the Receiver (John) would become *‘angry and defensive’*, and would stop listening.
- Many subjects claimed that suggestions should be “*more tailored to the persuadee, less straightforward, more cautious*”, that the persuader (Alice) should have “*engaged the receiver in the discussion*”.

Although the efforts to limit the influence of the character’s expressivity on the evaluation, this received, on the average, a higher rating than the dialog content. The main limit being found in the lack of expressivity of John: This was a feature we had introduced on purpose, to avoid the risk that John’s answers and facial expressions might influence the subject’s evaluation of the message.

	Average rating	
	Characters’ expressivity	Dialog content
Emotional & positive dialog (EP)	2.8	2.4
Emotional & negative dialog (EN)	2.1	1.9
Rational & positive dialog (RP)	2.5	2.0
Rational & negative dialog (RN)	2.8	2.0
Total	2.5	2.1

Table 4.5: Main results of the evaluation study

4.2.3 Conclusion

Overall, in spite of the limited size of the study, the evaluation study confirmed the preference of non specialists in health promotion for a positive rather than a negative framing approach to persuasion. Consistently with the corpus analysis, it showed, as well, that purely rational argumentation was not seen as an effective method to persuade subjects in the domain of healthy eating, and that incorporating emotional issues was considered to be a more promising strategy. Again, this is evidence in favor of the theory of a-rational persuasion. In all cases, adaptation of the message to the user characteristics was seen as a necessity.

4.3 Corpus of WoZ Dialogues

Although the goal of my work was to define a user-updated persuasion model, the final intention was to endow a conversational agent with the ability to simulate user-adapted persuasion strategies. Of course, if the dialogue is natural in its developing, users tend to not accept a-critically the System's suggestions. With the intent to investigate the kinds of users' reactions to System's suggestion received, I collaborated with others my colleagues of the Research Group on Intelligent Interfaces of the University of Bari to collect two human-ECA dialogues corpora: One corpus was collected through a text-based interaction mode and the other through a speech-based interaction mode. The two studies were performed through a pre-existing tool to design and manage WoZ studies with ECAs [24]. The tool was previously implemented by the Research Group on Intelligent Interfaces of the University of Bari. It is a Visual Basic 6.0 client-server application that includes an Agents made using PeoplePutty (distributed by Haptek) for the body, and Microsoft TTS and Loquendo TTS respectively as English and Italian text-to-speech synthesizers. Input moves are tagged strings in the APML language [40].

4.3.1 Method

4.3.1.1 Participants

The two studies involved overall fifty-four subjects (thirty for the first study and fourteen for the second one) aged between 23 and 30, of both gender and background (humanities or computer science). All participants were volunteer Italian subjects.

4.3.1.2 Design

As in all WOZ studies, subjects believed that an automated system was generating the ECA's answers, while these were selected by a human confederate ("wizard") from a set of precompiled moves [34]. To insure the uniformity of the experimental conditions throughout the two studies, the wizard followed some rules: After every subject move, the wizard selected the next move according to a well-defined dialog plan and to insure, at the same time, the internal coherence in every dialog. This was achieved by a careful preliminary training of the wizard and by employing the same wizard with all the subjects. The moves available to the wizard included a set of sentences responding to several communicative goals: to Assess the situation and collect information about the subject, to Provide suggestions about healthy eating, to Persuade the subject to follow these suggestions in case of doubt, and others. A female young character (called Valentina) took the role of persuader. Subjects involved in the dialogue could respond to the agent by typing in the text field (Figure 4.2) in the first study or by speaking in a microphone in the second one. They were left totally free in answering to the ECA's dialogue move: They could just answer the agent questions or take the initiative in the dialog by making comments and asking questions.

Two type of evaluations was possible: subjective and 'natural' (icon-based) evaluation of individual agent moves (not compulsory) and final, 'subjective' and compulsory evaluation of the dialog and the agent (a questionnaire with a Likert scale from 1 to 4 displayed on the same monitor or touch-screen). The last enabled collection of the subject's evaluation about several features of the message and the agent: For instance, how credible, plausible, clear, useful and persuasive was the message and how sincere, likable, natural, intelligent and competent was the agent. Dialogs were stored in a log at the end of the interaction for subsequent analysis.

A log of all dialogues was collected. It was employed to investigate two main aspects of the users' responses: That is, their social attitude towards the ECA and their reactions to the suggestion received.

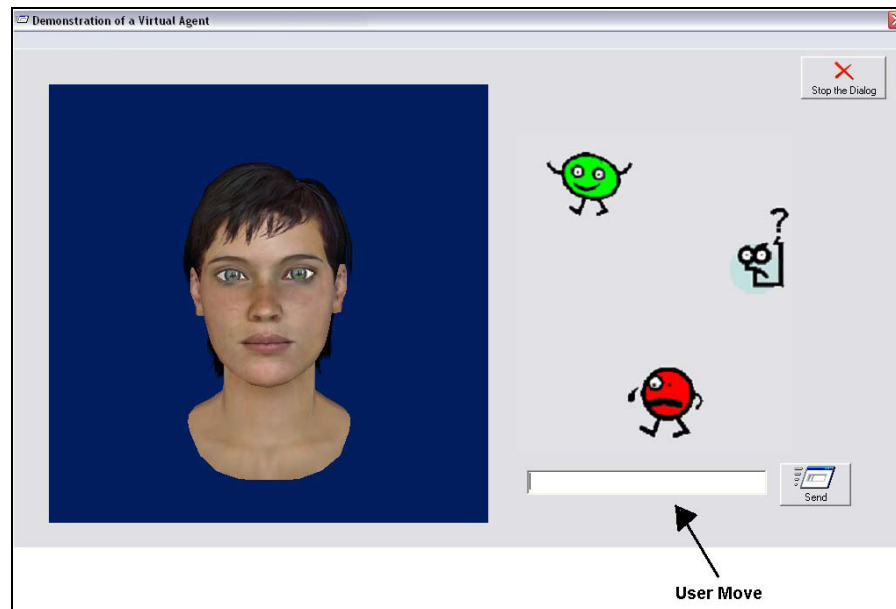


Figure 4.2: The subject's interface of a text-based WoZ studies

4.3.1.3 Procedure

At any participants was first displayed a scenario describing the application domain and the dialogue goal. After they filled out an electronic pre-test questionnaire (Appendix C) aimed at assessing their level of knowledge, habits and interest for healthy eating, in addition to their cultural background. This took no longer than five minutes to complete. Then the interaction started. While in the first study, subjects interacted via a keyboard, in the second one, they interacted with speech and via a touch screen. In both cases, subjects were invited to express themselves freely. At last, they filled out the electronic post-test questionnaire (Appendix C) that took no longer than five minutes to complete.

4.3.2 Results

The dialogs collected were *thirty* text-based and *thirty* speech-based dialogues (with 1600 moves overall).

Literature on argumentation in agent systems proposes several languages for the formalization of the argumentation exchanges between Persuader and Receiver [119]. The communication language among artificial agents proposed by Cohen and Levesque [29] neatly stated the semantics of ‘illocutionary acts’ [5, 136] in terms of the effects the Speaker intends to achieve: the hypothesis was that this effect always consists in ‘communicating own mental state’, with the Speaker’s ‘sincerity’ as a strong assumption about communication conditions. While this work on communication language among artificial agents is of primary importance in the immediate interpretation of a given sentence in terms of an agent’s beliefs and intentions, the analysis of the dialogs showed its more limited use in human natural language communication. In analyzing the corpus of WoZ dialogues, several types of users’ reaction to a System’s persuasion move were founded, which might not be represented by this a kind of language. In particular, WoZ dialogs were employed to investigate two main aspects of the users’ responses: Their social attitude (as an indirect evaluation of their persuasion level and their ‘interpersonal stance’) towards the ECA and their reactions to the suggestion received. Although there is no doubts about the importance to identify the user’s level of engagement in the dialogue and the originality of the method formulated to recognize it [28, 91, 25], for the purpose of my thesis, I focus on the analysis of the user’s moves when reacts to the persuader’s suggestion move.

If the dialogue is natural in its developing, users will tend to not accept a-critically the System’s suggestions. Therefore, was more important observing

the user's reaction to the suggestions received so as to select an appropriate strategy and respond intelligently to it.

The analysis of the user's reaction to a persuasion attempt was grounded on Walton's argumentation schemes and their later interpretations and refinements [143, 57]. As said in Chapter 3, Argumentation schemes are common types of defeasible arguments, evaluated by a set of related critical questions. The majority of argumentation schemes are focused on 'persuading to believe' (Argument from Evidence, Argument from Expert Opinion, Argument From Position to Know). Among the few of them which are aimed at 'persuading to do', the most commonly applied are the Argument from Consequences and the Practical Reasoning. Critical questions (CQs) can be seen as '*representing additional relevant factors that might cause an argument to default*' [151]. They are used in everyday conversational arguments '*when a user is confronted with the problem of replying to an argument or making some assessment of what the argument is worth and whether to accept it*'. [150]. From the viewpoint of the Receiver, CQs are questions that inquire about the conditions or circumstances that tend to challenge premises of a suggestion or the suggestion itself. Starting from analysis of the critical questions of these schemes I defined a set of possible users' reaction to a System's persuasion move.

Any dialogue was analyzed so as to isolate the System's persuasion attempt and all the users' moves which followed it. These moves were translated into formal logic representations and formalized as speech acts. Persuasions moves combined discourse plans representing different argumentation schemes: For examples, *Argument from Consequences* was combined with *Argument from Evidence* in the move "You should try to increase the proportion of fruit and vegetables in your diet! They proved to be very effective for health, which seems to be a value to you. I'm sure you may do it if you wish!" which

includes a suggestion supported by an evidence one about some user attitudes. To analyse the user's reaction to these move, both the suggestion and the arguments which support it had to be considered. Ten distinct type of persuasion attempts occurred with different frequencies in the corpus. Table 4.6 shows an example (from the corpus) of how users rendered, in their reactions to the suggestion received, the CQs of a scheme of *Practical Reasoning*.

Practical Reasoning	System move:
PREMISE1: Bringing about S _n is my goal PREMISE2: To bring about S _n I need to bring about S ₁ CONCLUSION: Therefore, I need to bring about S ₁	International research demonstrated the importance of fruits and vegetables in a correct diet. It recommends a daily assumption of a portion of row and a portion of cooked vegetables and two or three portions of fruits. Precooked food helps in controlling the portions.
CQ1: Are there an alternative possible of action to bringing about S ₁ that could also lead to the goal?	U1: uhm... but I don't like fresh fruits: how may I substitute them?
CQ2: Is S ₁ the best (or most favourable) of the alternatives?	U2: But I know fresh food is better than precooked products.
CQ3: Do I have goals other than S ₁ that may be better to achieve and that should have priority?	U3: But... a sin of gluttony is better than any healthy and balanced diet!
CQ4: Is it possible to bring about S ₁ in the given circumstances?	U4: I can't eat vegetables because I suffer of colitis
CQ5: Would bringing about S ₁ have known bad consequences that ought to be taken into account?</CQ>	U5: Are you sure that precooked food is not dangerous for health?

Table 4.6: Examples of User's reaction to System's suggestion

These examples demonstrate that, although the system adopted a purely rational persuasion strategy, users introduced various a-rational elements in their CQs (see for example, U3). In addition, not all reactions we found in our corpus could be classified in one of the critical questions defined in Walton's schemes. Several examples of perplexity, requests of more information, provision of information about their own situation, or clear objections were founded in the WoZ corpus. Example of speech acts in the corpus was:

Suggest(S, Ψ) for the System's attempt and **AskJustify**(U, Φ) or **Rebuttal**(U, Φ) for the user's reactions, where S and U represent, respectively, the System and the User, and the upper-case Greek letters Φ was used to represent speech act themselves and lower-case letter Ψ for the propositional content of the speech acts. Table 4.7 describes a possible set of communicative acts that correspond to user's reaction recognized in the corpus. The set was identified starting from Searle's classification of speech acts [136] and Kibble's studied on communicative acts in persuasion inner dialogues [73].

Comm. Act	Purpose	Examples
UNCERTAIN	Receiver nods without expressing any clear opinion	Mmm
ASKIF	Receiver ask the truth value of a fact	Do you think my diet is correct?
ASKINFO	Receiver asks for more information about some topic	How could I substitute fruits?
ASKJUSTIFY	Receiver asks the system to justify its statement	And how do you know it?
INFORM	Receiver provides some evidence about his/her attitudes or behaviour	I eat meat, fish, vegetables, lots of fruits...
CONFIRM	Receiver declares to agree with the evidence provided by the system	Right, I agree
DISCONFIRM	Receiver declares to disagree with the evidence provided by the system	No, you're wrong. I don't agree
OBJECT	Receiver argues about the truth value of a premise of the suggestion	Are you joking? So you mean I have to bring a fruit bag with me, at work?
ACCEPT	Receiver declares to agree with the received suggestion	Understood! So I should try to do it?
COMMIT	Receiver commits him/herself to apply the received suggestion	Ok, I will do it
CHALLENGE	Receiver declares to not be persuaded by the suggestion	So many portions of fruits? I've heard contrary theories on this topic
REJECT	Receiver refuses the suggestion	But... a sin of gluttony is better than any healthy and balanced diet!
REBUTTAL	Receiver presents an exception that falsifies the suggestion	I don't want to avoid sweets at all

Table 4.7: Set of communicative user's reaction identify in the WoZ corpus.

4.3.3 Conclusion

Understand the user's reaction to the suggestions received is essential to select an appropriate strategy and respond intelligently to it. The analysis of WoZ dialogs allowed to identify a set of possible communicative acts that correspond to user's reaction recognized in the corpus.

Although the ECA adopted, in the WoZ study, a purely rational persuasion strategy, subjects introduced various a-rational elements in their reactions both as linguistic and acoustic sign. The following are some examples of subjects' responses to the following ECA's suggestion: "International research demonstrated the importance of fruits and vegetables in a correct diet. It recommends a daily assumption of a portion of raw and a portion of cooked vegetables and two or three portions of fruits. Precooked food helps in controlling the portions".

U1: But... a sin of gluttony is better than any healthy and balanced diet!

U2: Are you joking? So you mean I have to bring a fruit bag with me, at work?

But also many other acoustic expressions of irony or laughter were identified in the speech-based corpus [91].

Therefore, also several forms a-rational reactions were expressed by users in the WoZ corpus.

Chapter 5

The Proposed Approach

The definition of persuasion explains in this work comes mainly from Miceli et al.'s general definition of *intentional attempt to induce an intention through communication, and in a non-coercive way*. As far as methods to represent the persuasive information, O'Keefe [101] suggests defining persuasion as "*human communication designed to influence others by modifying their beliefs, values or attitudes*". By influencing others, one may intend attempting to modify either their beliefs or their intentions, and may name 'argumentation' and 'persuasion' the respective communication processes: That is, argumentation means induce a belief, persuasion means induce an intention to do something. In particular, inducing to do require acting on the Receiver's beliefs [23] therefore argumentation is used in persuasion. In both cases, influencing is not a direct and rough suggestion, but is supported by a careful selection of the target beliefs, values or attitudes and of the methods to activate or strengthen them. Factors related to the Receiver, the context in which the persuasion occurs and the source of information provided are considered, by O'Keefe to be of primary importance for the success of a persuasion attempt. According to Fogg [51], computer tools may increase the

persuasion power by providing tailored information or by leading people through a selected process.

Thinking on how an argumentation (or persuasion) message may be formulated, given a goal to achieve, Walton reflected on the relationship between the phase of ‘reasoning’ and of ‘argumentation’. In Walton [147], the following statement by Govier is reported: *“Argument is a publicly expressed tool of persuasion. Typically it takes thinking to construct an argument. Reasoning is distinguished from arguing along these lines: reasoning is what you may do before you argue, and your argument expresses some of your (best) reasoning. But much reasoning is done before and outside the context of argument”*. I built this work around the distinction between a phase of reasoning and a phase of formulating an argument. In the phase of reasoning, the Persuader works on a representation of the Receiver’s mental state to select a promising strategy, given its knowledge of the situation and to repair to its possible failure. During argument formulation, the Persuader translates the selected strategy into a discourse plan that may be used to generate a persuasive message or a possible dialog simulation between the Persuader and the Receiver. In both cases, outcome is rendered with the media available (for example, text or ECA).

Again, as rose by Walton [147], *“Are reasoning and argument essentially the same thing? Or is one a proper subpart of the other? Or can you have reasoning that is not in argument?”*. The phase of argumentation is concerned to the problem of enthymemes that is *“propositions not explicitly stated in the text of discourse, even though it may be clear enough that the speaker was relying on it, or including it, as part of the argument”* [148]. Generally, they are propositions presupposed by the interlocutors, being presumed to be part of their common knowledge, or known the positions of the speaker. In those cases, the Persuader assumes that the receiver will likely fill

those gaps, and that this will increase the intelligibility and strength of the persuasion message. However, the problem is more complex especially in emotional persuasion. In this case, accepting a suggestion is not the direct consequence of accepting all the premises of the reasoning followed by the Persuader –emotions are viewed and experienced as subjective, spontaneous, endogenously and autonomously produced reactions. As Weaver [157] already pointed out, “*the missing proposition of an enthymeme is sometimes suppressed because the maker of an argument knows that, if we look carefully at his premises, we may question or reject some of them*”. Much advertising, as well as a considerable part of political argumentation is presented in the form of enthymemes for just this purpose. Walton and Reed [146] also acknowledge that dialectical factors are involved in the use of enthymemes. In particular, in the context of a critical discussion, an arguer will try to use premises that the audience accepts. Therefore, the Persuader will try to select, among the available premises, the most agreeable ones, and conversely try to conceal the less agreeable ones, especially if weak or questionable in themselves.

Researchers in natural argumentation and persuasion typically distinguish between *rational* or *cognitive* modes of persuasion and *irrational* or *emotional* ones. Conversely, according to Miceli et al.’s a-rational Theory of persuasion (see Chapter 3), this work is an attempt to build a computational model in which *rational* and *emotional* modes of persuasion may be integrated to produce effective strategies in different contexts. It is worth specifying that, while it is generally considered the role of the emotions expressed by the Receiver and the Persuader in the persuasion process (for example, emotional communication style or emotional facial expression), the model proposed considers the influence of emotions aroused by the Persuader on the Receiver’s mental state, that is, the role of emotional strategies in influencing the attitude of the Receiver.

5.1 Persuasion Strategies

A most promising strategy has to be selected on the basis of the Receiver's presumed mental state.

In conditions of cognitive consistency, a persuasion message's main goal is to *recommend the desired behavior* by influencing the attitudes that might positively affect Receiver's intention to conform to the desired behavior [101]. Persuader might achieve this goal by

- influencing Receiver's values and goals, whether they are rational or emotional;
- enhancing the perceived relevance of attitudes for behavioral changes; and
- strengthening the Receiver's awareness of his ability to conform to the desired behavior.

When Receiver's attitudes and behavior are inconsistent, Persuader might encourage Receiver to behave more consistently by either inducing feelings of hypocrisy (*"You haven't been eating in accordance with your desire to be healthy, but now there is a chance to do so"*) or mentioning the positive (or negative) consequences of doing (or not doing) it (*"Here is a chance to act according to your attitude: and just think how bad you will feel if you don't take it"*).

Appeals matched with the Receiver's motivations will more likely succeed than those engaging no salient desires. Knowledge of the Receiver's *wants* (preferences, goals, moral beliefs and significant values) is therefore essential in selecting the aspects on which to focus the persuasion process, that is, the outcomes the suggested behavior would enable.

5.2 Knowledge representation formalism:

Belief Networks to represent uncertainty

Walton said [152], “*Practical reasoning is characteristically based on uncertainty or incomplete knowledge of a particular (changing) situation*”. I verify experimentally (see Chapter 4) that uncertainty must be represented when either emotional or rational strategies are described. Argumentation and persuasion present at least two sources of uncertainty in their process [19]: Data and link between data and claim. Indeed, uncertain expressions may be founded in the Toulmin’s Qualifier and Data, and in some of the critical questions of Walton’s argumentation schemes (see Chapter 3): the strength of an argument depends on the medium-strength link between the promises and the conclusion (that has a degree of uncertainty) and the data (that may be observed with some degree of uncertainty or came from an argumentation process [74]. So, uncertainty has a substantial role in affecting the success of a persuasion strategy [147]. Persuader tries to exploit uncertainty factors (Receiver’s presumed mental state) when planning a prospectively successful strategy in a given context [41]: That is, he will believe that Receiver is more or less likely to hold a given belief or goal, he will presume the value Receiver likely attaches to the goals (either rational or emotional), his likely propensity to feel specific emotions and the intensity of the emotions probably felt.

Therefore, rather than representing the Persuader's reasoning on the Receiver's mind in a logical framework, I decide to represent *persuasion strategies*, as well as the *Receiver’s model*, with Belief Networks (BNs).

BN is a well-known formalism to simulate probabilistic reasoning in directed acyclic graphs whose nodes represent random variables and whose oriented arcs represent any kind of relationship among variables [108]. A probability distribution is assigned to the variables associated with the ‘root

nodes' of the network (those which have no parents) and a conditional probability table to the other nodes.

5.3 Preliminary Notations

In modeling formalism, I adopt the BDI model [120] with the extra of the emotion component to the belief, desire and intention ones, thus going towards BDI&E formalism. In addition, I adopt the definition of goal proposed by Miceli et al [96], that extend the description of goal properties presented by [29], introducing other properties of goals such as:

- *active* or *inactive* property. A goal is active when it is included in the agent's "goal balance" [22]; that is, when the agent starts to assess its importance and/or feasibility through comparison with other candidate goals, in view of its possible translation into an intention. An active goal may become an intention if that goal is finally chosen for pursuit.
- *pre-existent* vs. *generated* property. A goal is generated when it is that is newly represented in the agent's mind; and
- different degrees of *value* or importance to the agent.

Consideration of these properties is necessary in modeling persuasion strategies, both emotional and non emotional: These strategies attempt to activate the Receiver's inactive goals or to generate in the Receiver new goals (that is, the Receiver did not have before) or to increase/decrease the value of some goals, in order to make the Receiver having some intention instrumental to those goals. These general properties of goals enrich and make more dynamic the models of agents' mental attitudes.

While all the formal systems stemming from Rao and Georgeff's [120] and Cohen and Levesque's [29] researches in the domain of multi-agent systems (MAS) aim at building a framework of agents' attitudes to represent their behaviors in a dynamic way, here the aim is rather to model the behavior of a Persuader who reasons on the different possible ways to induce an intentional state in a Receiver.

Let us introduce the following notations (synthesized in Table 5.1):

- P and R are constants denoting, respectively, the agent Persuader and the agent Receiver
- a is a variable denoting an action (like, to eat vegetables); e_i, e_j, \dots, e_n are variables denoting emotions (like, shame, pride, good mood, fear joy ...); $g_i, g_j, g_h, \dots, g_m$ are formulae denoting states of the world - in particular, of R - (like, R is in good health, R is in shape, R is overweight, but also R saves face, ...); the formula $\text{Feel}(R, e)$ denotes, in particular, the affective state 'R feels the emotion e '.
- Bel , Int , A-Goal , V-Goal are modal operators denoting the various aspects of the mental state of R which are relevant in the persuasion process: That is, respectively, beliefs, intentions, active-goals and valued-goals. The first term of these operators denotes an agent; the second one is a formula. In particular:
 - $(\text{V-Goal } R \ g_i)$ stands for " g_i , is a valued goal to R ";
 - $(\text{A-Goal } R \ g_i)$ for " R 's goal g_i , is active";
 - $(\text{Bel } R \ \text{Implies}(a, g))$ for " R believes that doing a implies achieving g_i in a more or less near future";
 - $(\text{Bel } R \ \text{CanDo}(R, a))$ for " R believes that conditions hold for him to do a ";
 - $(\text{Int } R \ \text{Do}(R, a))$ for " R intends to do a "

- The symbol ‘ $\rightarrow?$ ’ denotes ‘uncertain implication’ and is represented in the BN with oriented arcs linking premises to conclusions. In the Bayesian formalism, the rule $(A_1 \wedge A_2 \wedge \dots \wedge A_n) \rightarrow? B$ is interpreted as a conditional probability expression $P(B|A_1, A_2, \dots, A_n) = m$ stating that, among all the worlds satisfying A_1 and A_2 and...and A_n , those that also satisfy B constitute a fraction of size m . This uncertain implication is specified with a table of the probabilities that B is true, conditional on all combinations of values for A_1, A_2, \dots, A_n . It enables to assign different weights to the premises in establishing the truth value of the consequence.
- The generic strategy of *induction of intentions* is represented by the following relation (Miceli et al., 2006):

$$[(V\text{-Goal } R \ g_i) \wedge (A\text{-Goal } R \ g_i) \wedge (Bel \ R \ Implies(a, g_i)) \wedge (Bel \ R \ CanDo(R, a))] \\ \rightarrow? (Int \ R \ Do(R, a))$$

Formula	Meaning
$(V\text{-Goal } R \ g_i)$	g_i is a valued goal to R
$(A\text{-Goal } R \ g_i)$	g_i is an active goal to R
$(Bel \ R \ Implies(a, g_i))$	R believe that performing a implies achieving g_i
$(Bel \ R \ Implies(g_j, g_i))$	R believe achieving g_j implies achieving g_i
$(Bel \ R \ CanDo(R, a))$	R believes that he or she is in the condition to perform a
$(Int \ R \ Do(R, a))$	R intends to perform a
$Feel(R, e_i)$	R feels the emotion e_i

Table 5.1: Some notations

5.4 User Model

Rather than acquiring information about R through direct questions, P attempts to implicitly infer it, with some level of uncertainty, from knowledge of R 's personality traits and living habits. The user model includes a *specific*

knowledge and a *general knowledge* component. The specific knowledge collects facts about the user acquired during the dialogue. The second component represents criteria to infer R's goals and abilities under conditions of uncertainty in the form of *elementary belief networks* (EBNs). EBNs are networks with only one leaf node representing uncertain implications. These networks represent evidence that supports the attribution of a given personality trait to R from a set of rules derived from Myers-Briggs personality assessment questionnaires². Other rules represent the relationships between R's personality traits and his goals. The two sets of rules are built on the basis of the Big Five theory of personality traits, which formalizes how five personality traits (neuroticism, extraversion, agreeableness, conscientiousness, openness to experience) impact individual's motivations, which in turn affect their performance.

Let's look at a few examples of uncertain implications in the user model's general Knowledge component.

First, R's goals can be inferred from knowledge of R's personality traits as well as, from knowledge of R's habits. Consider $P_1(R) \dots P_n(R)$ as R's Properties. The former may be rendered with an implication of the type

$$[P_1(R) \wedge P_2(R) \wedge \dots \wedge P_n(R)] \rightarrow ?(V\text{-Goal } R \text{ } g)$$

while the last with the following rules:

$$[P_1(R) \wedge P_2(R) \wedge \dots \wedge P_m(R)] \rightarrow ?(\text{Personality}(R))$$

$$\text{Personality}(R) \rightarrow ?(V\text{-Goal } R \text{ } g)$$

² Myers-Briggs personality questionnaires are available at the following website:
www.teamtechnology.co.uk/tt/t-articl/mb-simpl.htm

In both cases, the knowledge is represented in two *Valued_Goal* EBNs (Figure ??) that may be instantiated differently by attributing a combination of values to the variables they include.

The following are four examples of goals inferred from knowledge of R: The first two are examples of inference from personality, and the last two from habits.

“Individuals who feel comfortable around people, like to talk in group, and are skilled in handling social situations are probably extraverts and making friends is likely to be important to these subjects”

$[FeelsComfortableAroundPeople(R) \wedge LikesToTalkInGroups(R) \wedge$
 $SkilledInSocialSituations(R)] \rightarrow ? Extraverted(R).$
 $Extraverted(R) \rightarrow ?(V\text{-Goal } R \text{ MakeFriends}).$

“Individuals who respect others and are interested in the others wellbeing are probably Agreeable and supporting biological farmers is likely to be important to these subjects”

$[RespectsOthers(R) \wedge ConcernedWithOthersWellbeing(R)] \rightarrow ?Agreeable(R)$
 $Agreeable(R) \rightarrow ?(V\text{-Goal } R \text{ SupportFarmers})$

“Individuals who make sport regularly, undergo regular check-ups and are interested in medical TV programs are probably interested in being in good health” becomes

$[MakesSport(R) \wedge MakesRegularCheckUps(R) \wedge LooksAtTvProg(R)] \rightarrow ?$
 $(V\text{-Goal } R \text{ GoodHealth})$

“Individuals who make sport regularly, are ever on diet and like to wear beautiful dresses are probably interested in having a good look” becomes

$[MakeSport(R) \wedge IsOnDiet(R) \wedge LikesBeautifulDresses(R)] \rightarrow ?$

(V-Goal R GoodAppearance)

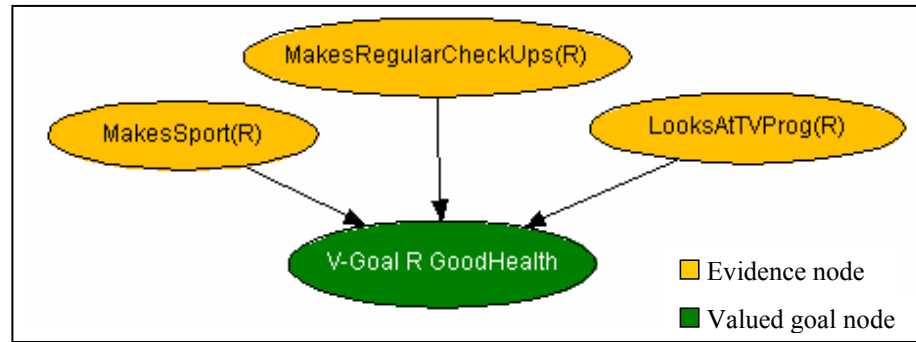


Figure 5.1: An example of *Valued_Goal* EBN in which the goal is inferred from R's habits

Similar criteria are applied to infer whether conditions hold for R to perform the suggested action. Consider again $P_1(R) \dots P_n(R)$ as R's Properties. R's ability to perform the action a may be rendered with an implication of the type

$[P_1(R) \wedge P_2(R) \wedge \dots \wedge P_n(R)] \rightarrow ? (Bel R CanDo(R,a))$

This knowledge is represented in *Ability* EBN (Figure 5.2) and may be instantiated into several EBNs, each with an action which depends on the application domain. For example:

“Individuals who have some time free during the day, like cooking and do it with good results, live in a place in which good vegetables are available, and have no physical problem to eat vegetables are probably in the condition to eat vegetables” is

$[HasFreeTime(R) \wedge GoodCook(R) \wedge AvailableVeg(R) \wedge IsNotDiseased(R)] \rightarrow ?$
 $(Bel\ R\ CanDo(R, EatVeg))$

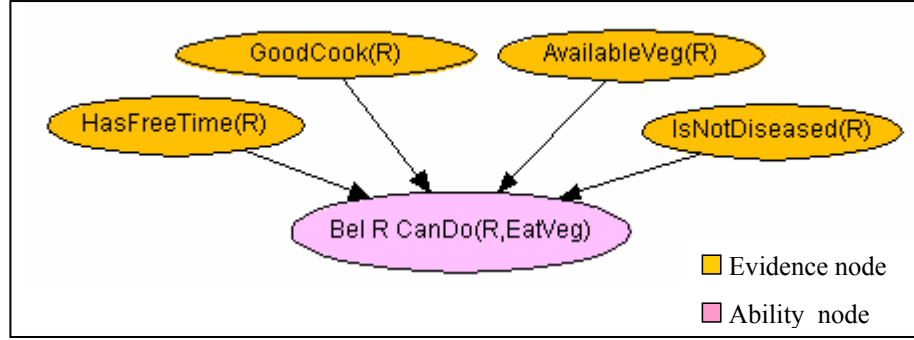


Figure 5.2: An example of *Ability* EBN with the action of eating fruit and vegetables

5.5 Reasoner: The Reasoning Module

In the phase of reasoning P works on a representation of R's mental state to simulate the presumed effect of different persuasion strategies on R. Come from this process the presumed most promising strategy to induce in R the intention to do a certain action in a given domain and to repair the failure if the selected strategy fails.

5.5.1 The Persuasion Knowledge Base

Persuasion model is defined in term of goals and beliefs from P's perspective that may employ rational as well as emotional strategies (but also a mixture of them) to induce intention in R [96]. Fragments of persuasion strategies are represented, as well, with EBNs and are classified according to the type of leaf node.

The generic *Induction-of-intentions* represents the following relation among the components of R's mental state

$$[(V\text{-Goal } R \ g) \wedge (A\text{-Goal } R \ g) \wedge (Bel \ R \ Implies(a,g)) \wedge (Bel \ R \ CanDo(R,a))] \rightarrow ? \\ (Int \ R \ Do(R,a)) \quad [i]$$

which may be read as “if R has goal g and this goal is active, and R believes that doing a implies achieving g in a more or less near future, and R believes that conditions hold for him to do a , then probably R intends to do a ”.

Intention may be induced by acting either on rational goals or on emotional goals (that is, goal to feel a certain emotion) and the strategy is called, respectively, *Rational induction of intention* or *Emotional induction of intention*. In both cases, the implication is represented in *Intention* EBN (Figure 5.3) and may be instantiated into several EBNs, each with an action which depends on the application domain and goal -for instance to be in good health, make friends, support biological farmers, or feel in good mood.

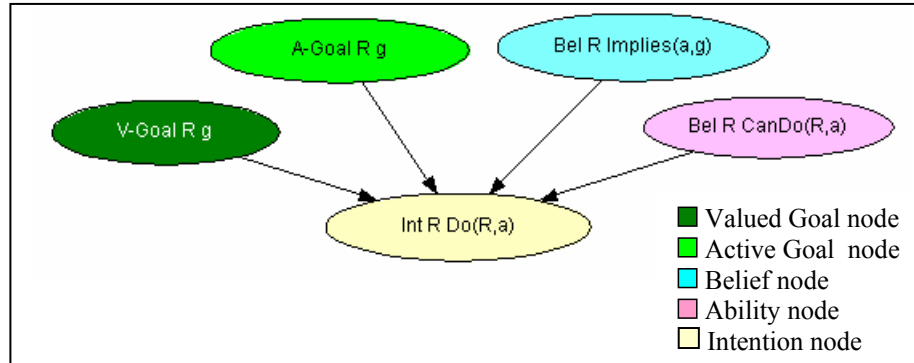


Figure 5.3: The generic *Intention* EBN

Induction-of-beliefs represent justifications of a belief, for instance about a means-end implication. As an example, Argumentation from Examples may be rendered with an implication of the type:

$$[(Bel \ R \ Implies(a,g_1)) \wedge (Bel \ R \ Implies(a,g_2)) \wedge \dots \wedge (Bel \ R \ Implies(a,g_n))] \rightarrow ? \\ (Bel \ R \ Implies(a,g)), \quad \text{where } g_1, \dots, g_n \text{ are subgoals of } g.$$

that may be instantiated differently by attributing a combination of values to the variables they include. For example:

$$[(\text{Bel } R \text{ Implies}(\text{EatVeg}, \text{StringMuscle\&Bones})) \wedge \\ (\text{Bel } R \text{ Implies}(\text{EatVeg}, \text{TonifiedBody})) \wedge \\ (\text{Bel } R \text{ Implies}(\text{EatVeg}, \text{BetterSkin\&Hair}))] \rightarrow ?(\text{Bel } R \text{ Implies}(\text{EatVeg}, \text{GoodHealth}))$$

may be read as “if *R* believes that eating vegetables strengthens muscles and bones, tones up and rehydrates the body and is of benefit for hair and skin, then he probably believes that eating vegetables contributes to being in good health”.

A belief may be induced, as well, in terms of Appeal to Expert Opinion, to Popular Opinion, Appeal to Position to Know, Appeal to Friendly Personal Experience or other argumentation strategies: Therefore, induction-of-belief can be represented with several *Belief* EBNs, for instance, *Belief_ExpertOpinion* EBNs or *Belief_Examples* EBNs (Figure 5.4), and others, each of them, in turn, may be instantiated in several EBNs according to the action and the goal. The effectiveness of each of *Belief* EBNs may be influenced by *R*’s characteristics (For example, an induction of belief expressed in term of Appeal to Expert Opinion may be more effective in rational individuals rather than an Appeal to Popular Opinion).

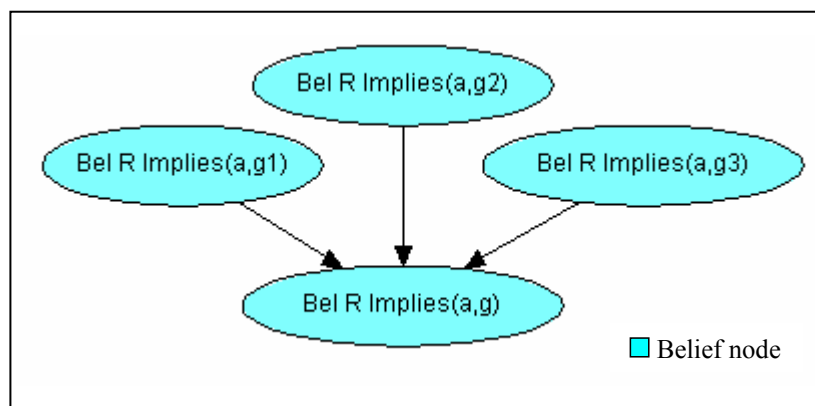


Figure 5.4: The generic *Belief_Examples* EBN

Rational-activation-of-goal represents, the activation, through a belief, of an intermediate goal which is instrumental to the final one (from P's perspective). It may be rendered with implications of the type:

$$(\text{Bel } R \ g_k) \rightarrow ?(\text{A-Goal } R \ g_h) \quad [\text{ii}]$$

$$[(\text{A-Goal } R \ g_h) \wedge (\text{Bel } R \ \text{Implies}(g_i, g_h))] \rightarrow ?(\text{A-Goal } R \ g_i) \quad [\text{iii}]$$

which may be read as “if *R* believes that a certain domain state is true, then, this belief may likely cognitively activate a pre-existing goal. Once this goal has been activated, if *R* believes that another goal⁴ (the final goal in *P*'s perspective) is useful to achieve it, then, this will generate, in turn, that goal”.

Rational-activation-of-goal is represented in *Rational_Activation_Goal* EBN (Figure 5.5) and may be instantiated into several EBNs, each with an instrumental goal that may be either a rational goal (like, to be in good health) or an emotional goal (like, to feel cheerful), also for the same final goal.

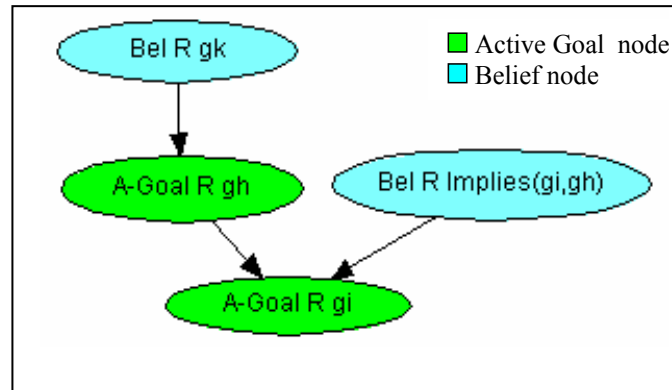


Figure 5.5: The generic *Rational_Activation_Goal* EBN

³ The state of the world g_k is often expressed by listing some R 's critical properties (for example, P_1, \dots, P_n).

⁴ Notice that the goal g_i has twice functions: from R 's perspective, g_i is an instrumental goal (sub-goal) for achieving R 's main goal g_h ; from the P 's perspective, g_i is the goal to active (final goal) while g_h is a sub-goal useful for the activation of g_i .

Emotional-activation-of-goal represents the activation, through an emotion, of an intermediate goal which is instrumental to the final one (from P's perspective). It may be represented as follows:

$$(\text{Bel } R \text{ } g_j)^5 \rightarrow ? \text{ Feel } (R, e_i) \quad [\text{iv}]$$

$$\text{Feel } (R, e_i) \rightarrow ? (\text{A-Goal } R \text{ } g_n) \quad [\text{v}]$$

$$[(\text{A-Goal } R \text{ } g_n) \wedge (\text{Bel } R \text{ Implies}(g_i, g_n))] \rightarrow ? (\text{A-Goal } R \text{ } g_i) \quad [\text{vi}]$$

which may be read as “if *R* believes that a certain state is true, then this belief may arouse an emotional state in *R* which in turn may generate (and activate) a newly goal. If *R* believes that another goal⁶ (the final goal in *P*'s perspective) is useful to achieve it, then, this will generate, in turn, that goal”.

Emotional-activation-of-goal is represented in *Emotional_Activation_Goal* EBN (Figure 5.6) and may be instantiated into several EBNs, each with a different emotion to arouse (like pride, shame, good mood, fear joy, and so on) and different instrumental goal (either rational goal or an emotional one). The effectiveness of each of *Emotional_Activation_Goal* EBNs may be influenced by *R*'s characteristics (For example, the goal ‘to be in good health’ activates through fear may be more effective in hypochondriac individuals rather than in Individuals with a high estimate of them).

⁵ The state of the world g_j is often expressed by listing the some *R*'s critical properties (for example, P_1, \dots, P_n).

⁶ As in Footnote 3.

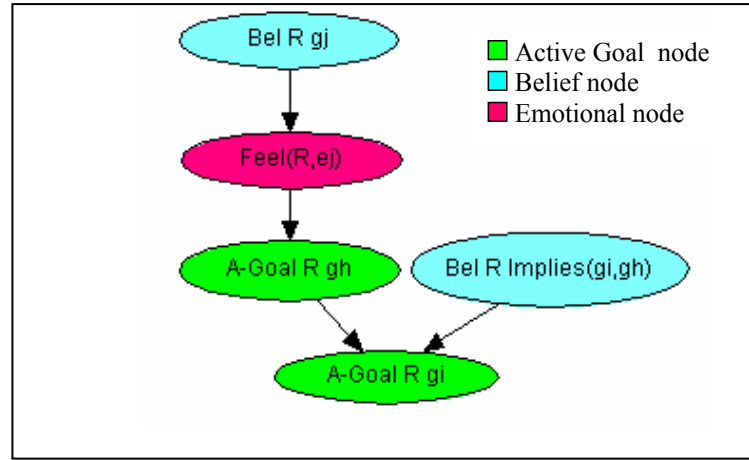


Figure 5.6: The generic *Emotional_Activation_Goal* EBN

5.5.2 The Reasoning Process

P reasons on R's mental state in order to select the most promising strategy to induce in R the intention to do a certain action in a given domain. To simulate the reasoning followed by P, a complex Belief Network (BN) is dynamically built by chaining forward several EBNs, starting from the data available about R. In this algorithm, EBNs are employed in a 'what-if' mode to test the persuasion strength of alternative candidate strategies.

Two kinds of information about R may be introduced in the EBNs: facts about R's life style and hypotheses about R's personality traits. P exploits its information about R to compute the degree of importance of the various -rational and emotional- goals to R and infer the goal on which focus the persuasion strategy. Then, the EBN related to the selected goal and the EBNs including the previous R's characteristics and the selected goal are chained forward into a BN. Previous evidence is introduced and propagates into BN so as to determine the persuasion strength of this pure strategy (that is, a strategy focused on one goal -either rational or emotional): The strategy is an *induction of intention* to do a certain action supported by evidence in favor of the R's importance of the selected goal and R's capability to do the action. If P

believes that the pure strategy is not enough to persuade R then he tests a mixed strategy: That is, he identifies another support strategy to combine with the pure one in order to increase the persuasive power. Both in the case of pure strategy and in the case of mixed one, P may strengthen the persuasion power of the selected strategy by reasoning, also in a “what-if” mode, on two information that may be used to influence R’s attitude: The induction of beliefs and the (either rational or emotional) activation of the goal. In more details:

- First, the available evidence about R’s characteristics is propagated in all the EBNs whose leaf node is a valued goal node (that is, *Valued_Goal* EBNs). The effect of propagating this evidence on the probability of every valued node is observed: this probability serves as an index of the associated goal’s degree of importance to R. Two stacks, registering separately the degree of importance (posterior probability) of rational and emotional goals are built. The valued node with the highest probability value is identified and its goal g_i is taken as the highest degree of importance: g_i is chosen as the candidate goal (main goal) on which to focus the persuasion strategy, and the associated *Valued_Goal* EBN is selected from the KB.
- Second, a complex BN is built: the selected *Valued_Goal* EBN, and the instantiated *Ability* EBN (including R’s characteristics) and *Intention* EBN (including goal g_i) are chained forward. R’s evidence is then introduced in this complex BN, and the effect of propagating this evidence on the probability of the intention node is observed:
 - If this probability exceeds a given threshold, then this is taken as the most promising strategy to R; in this case, a purely rational or purely emotional strategy will be applied (according to the type of the goal);
 - Otherwise, the algorithm is applied recursively to the first goal g_j in the other stack. So if g_i was a rational goal, g_j will be an

emotional one (and the inverse). The two complex BNs are assembled through their common ability node; in this way, a mixed strategy that combines a rational goal (g_i) with an emotional one (g_j) will be applied: g_i and g_j are called, respectively, *main goal* and *support goal*.

- Third, the intention node of the selected strategy (both in the case of pure strategy that in the case of the mixed) is observed. If its probability value deceed a given threshold then additional knowledge may be introduced in the BN in order to strengthen the persuasion power of the selected strategy. Others EBNs may be iteratively chained forward to reinforce the belief and the active-goal root nodes in the BN. Among all the instantiations of *Belief* EBNs, *Rational_Activation_Goal* EBNs and *Emotional_Activation_Goal* EBNs are selected those whose leaf node matches the node to be strengthened in the BN. Then:
 - Each of *Belief* EBNs is chained forward (one by one) to the BN and the effect of propagating all R's evidence on the probability of the intention node is observed: the *Belief* EBN which determines the highest probability value is select as the most appropriate in the considered context. A new BN is built. In case of mixed strategy, if the probability value of the intention node deceed a given threshold, then the process is also applied to the support goal.
 - Again, the intention node of the new BN is observed. If its probability value deceed a given threshold maybe the problem is the goal g (or the main goal in the mixed case) itself. That is, despite all attempts to strengthen the persuasion power of the strategy has been done, R does not seem to have a sufficient intention to perform the action suggested. Even if g 's value to R

is high, maybe it is not active in R. Therefore, the previous process is applied to the selected *Rational_Activation_Goal* EBNs and *Emotional_Activation_Goal* EBNs in order to identify the most appropriate goal activation between the two (emotional or rational) and built the final BN.

Lastly, if the selected strategy fails, the two stacks will be employed to repair the failure, by selecting the next promising candidate goal (either rational or emotional or a mixture of them).

Figure 5.7 is a complex BN that represent a pure emotional strategy supported by the Induction-of-beliefs and Emotional-activation-of Goal. BN is built by chaining forward the following EBNs: Intention, Valued_Goal, Ability, Belief_ExpertOpinion and Emotional_Activation_Goal.

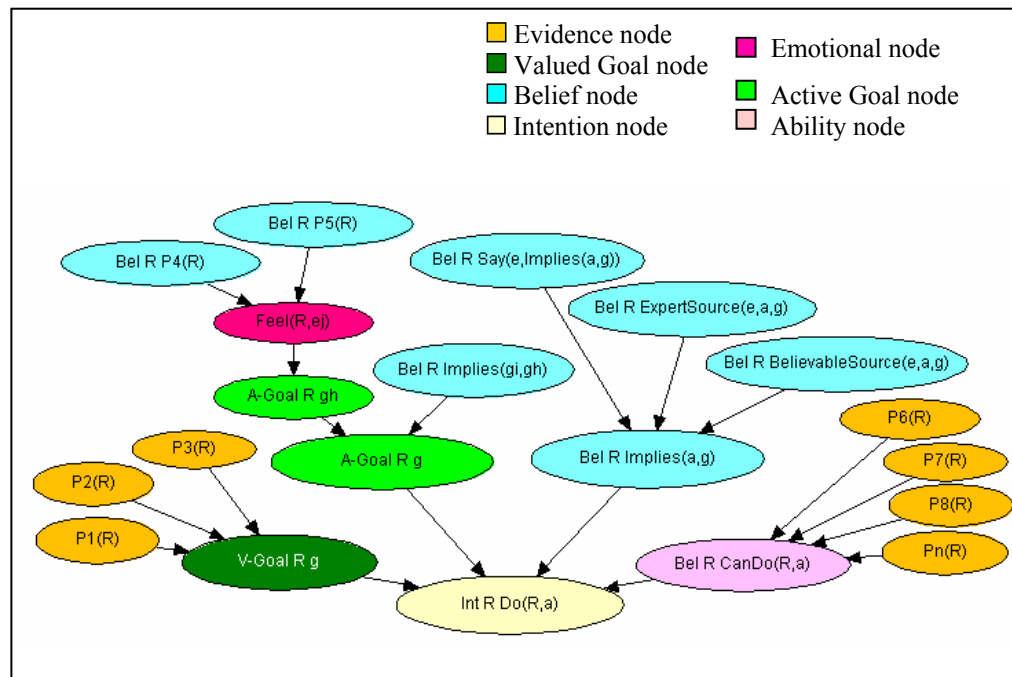


Figure 5.7: An example of complex BN that represent

5.6 Arguer: The Argumentation Module

In the planning phase, P translates the selected persuasion strategy into a natural language message or a possible dialog simulation between P and R by a typical two-step process involving discourse planning, followed by surface generation. Come from this process a natural language messages used by P as persuasion attempt to persuade R (monologic viewpoint) or a possible dialog simulation in which P replies to R's reaction at suggestion received (dialogical viewpoint).

5.6.1 Argumentation Knowledge Base

After reasoning on the R's mental state, P must construct the arguments to express the selected strategy: That is, P must translate the BN into a Discourse Plan (DP). Items to possibly include in the argument correspond to the variables associated with nodes of EBNs that form the BN (Table 5.2). The way these items are combined in the message (order in which to present them and relationships among the various parts) is represented in *Elementary Argumentation Plans* (EAPs): That is, EAPs are a coherent translation of EBNs.

BN node name	Communicative act in the DP
V-Goal R g_i	Claim P V-Goal R, g_i
Bel R Implies(a, g_i)	Claim P Implies(a, g_i)
Bel R CanDo(R, a)	Claim P CanDo(R, a)
Int R Do(R, a)	Suggest P ShDo(R, a)
Property(R)	Remind P <i>Property</i> (R) or Inform P <i>Property</i> (R)

Table 5.2: Mapping between BN nodes and communicative acts in the DP

EAPs are built on two theoretical grounds: Walton’s Argumentation Schemes [153] and Rhetorical Structure Theory (RST) [81]. Although the principle behind an EAP reflects the theory behind an argumentation scheme, their structure is not the same: some of the scheme’s critical questions become preconditions in the plans, as well as their premises. Moreover, EAPs represent the association between *rhetorical relations* (RRs) and argumentation scheme. That is, RRs linking preconditions among themselves and to the conclusion depend on the type of argumentation scheme employed (Table 5.3).

Argumentation scheme	Rhetorical Relation
Argument from Consequences	Motivation
Argument from Problem To Solution	Solutionhood
Argument from Position To Do	Enablement
Argument from Expert Opinion	Evidence
Argument from Popular Opinion	
Argument from Examples	
Appeal to Position to Know	
Argument from Friendly Personal Experience	
Argument from Evidence to Hypothesis	

Table 5.3: Mapping between Rhetorical Relations and Argumentation Scheme

Since EAPs are based on RST they are a tree structure represented as xml files. XML is the appropriate format for semistructured data, that is, data with a natural tree structure. A tree is a special case of a graph: there are no closed loops or circuits but all the nodes are connected. XML documents satisfy this definition and thus exhibit a natural tree structure.

EAPs are xml files whose root node represents the plan name and the situation in which it applies, leave nodes correspond to communicative acts (I

call them *c_act* nodes), and intermediate nodes are RRs describing the relationship among their own parent node and their own child nodes (I call them *RR_nodes*).

In agreement with Miceli and colleagues [96], I distinguish between ‘persuasion’, which is aimed at influencing directly an intention, and ‘argumentation’, which is aimed at influencing some attitude behind intention. So, I name the plans according to this distinction: *Persuasion Plans* and *Argumentation plans*.

5.6.1.1 Persuasion Plan

Persuasion Plan is a coherent representation of induction-of-intention strategy. Two variants of persuasion plans are built from Walton’s Argument from Consequences: *direct* variant makes a suggestion, gives the justification, and ends with the claim of readiness to act, and *indirect* variant includes the same components but introduces the suggestion after the supporting reasons. In both cases, the conclusion is expressed with a ‘Suggest’ communicative act (Suggest P ShDo(R,a)); this act is connected to the reasons that justify it ((Claim P V-Goal R g) and (Claim P Implies(a,g))) by a RR of *motivation*. This part of the plan is connected with the statement that conditions exist to perform the suggested action (Claim P CanDo(R,a)) by a RR of *enablement*.

In the *direct* variant (Figure 5.8), the suggestion `<c_act type="Suggest" term="ShDo(R,a)"/>` is presented first, and then the reasons that justify it (`<c_act type="Claim" term="V-Goal R g"/>` and `<c_act type="Claim" term="Implies(a,g)"/>`). The final line claims that R is in the condition to perform the action `<c_act type="Claim" term="CanDo(R,a)"/>`.


```

<plan name="Persuasion" form="direct" action="a" goal="g">
  <RR name="Enablement">
    <RR name="Motivation">
      <c_act type="Suggest" term="ShDo(R,a)"/>
    <RR name="Joint">
      <c_act type="Claim" term="V-Goal R g"/>
      <c_act type="Claim" term="Implies(a,g)"/>
    </RR>
  </RR>
  <c_act type="Claim" term="CanDo(R,a)"/>
</RR>
</plan>

```

Figure 5.8: Direct form of Persuasion plan

In the *indirect* variant the plan includes the same components but introduce the Suggestion after the supporting reasons (Figure 5.9).

```

<plan name="Persuasion" form="indirect" action="a" goal="g">
  <RR name="Enablement">
    <RR name="Motivation">
      <RR name="Joint">
        <c_act type="Claim" term="V-Goal R g"/>
        <c_act type="Claim" term="Implies(a,g)"/>
      </RR>
      <c_act type="Suggest" term="ShDo(R,a)"/>
    </RR>
    <c_act type="Claim" term="CanDo(R,a)"/>
  </RR>
</plan>

```

Figure 5.9: Indirect form of Persuasion plan

The two variants of persuasion plan may be assembled through their common ability node so as to translate the mixed persuasion strategy. There are two possible variant of mixed form of persuasion plan according to the type of combination between goal and support goal. Figure 5.10 represents a

persuasion plan that reflects a mixed persuasion strategy in which the main goal is classified as rational and the support goal is classified as emotional.

```
<plan name="Persuasion" form="mixed" action="a" goal="g1"
supportGoal="g2">
  <RR name="Enablement">
    <RR name="Joint">
      <RR name="Motivation">
        <c_act type="Suggest" term="ShDo(R,a)"/>
        <RR name="Joint">
          <c_act type="Claim" term="V-Goal R g1"/>
          <c_act type="Claim" term="Implies(a,g1)"/>
        </RR>
      </RR>
    <RR name="Motivation">
      <RR name="Joint">
        <c_act type="Claim" term="V-Goal R g2"/>
        <c_act type="Claim" term="Implies(a,g2)"/>
      </RR>
      <c_act type="Suggest" term="ShDo(R,a)"/>
    </RR>
  </RR>
  <c_act type="Claim" term="CanDo(R,a)"/>
</RR>
</plan>
```

Figure 5.10: Mixed form of persuasion plan in which the main goal is classified as rational and the support goal is classified as emotional

As said in experimental study about corpus collection (see Chapter 4), I saw several such cases of item ordering in the corpus, especially when subjects used emotional strategies. This justifies the introduction of two variants of persuasion plans: in general, *direct* plans are used to translate *rational induction of intention* strategies, while *indirect* plans are mainly used for *emotional* one.

5.6.1.2 Argumentation Plans

To support Persuasion plan's premises, P uses *argumentation plans*, whose conclusion is a goal or belief.

The *Goal-strengthening plan* (Figure 5.11) is built from the Argument from Evidence argumentation scheme and is a coherent translation of the Valued_Goal EBN, either when goal is inferred from R's habits or R's personality traits. In particular, the last is a case in which enthymemes are applied: The elements related to the R's personality are omitted to avoid failing of the persuasive attempt because they are classified as affected R's features. Goal-strengthening plan demonstrates the selected goal's value to R by listing a set of features $P_i(R)$. The goal's value is expressed with a 'Claim' communicative act (Claim P V-Goal R g), and this act is connected to the reasons that justify it (Remind P $P_1(R)$, Remind P $P_2(R)$, ..., Remind P $P_n(R)$) by a RR of *evidence*.

```
<plan name="GoalStrengthening" action="a" goal="g">
  <RR name="Evidence">
    <c_act type="Claim" term="V-Goal R g"/>
    <RR name="Joint">
      <c_act type="Remind" term="P1(R)"/>
      <c_act type="Remind" term="P2(R)"/>
      .....
      <c_act type="Remind" term="Pn(R)"/>
    </RR>
  </RR>
</plan>
```

Figure 5.11: Goal-strengthening plan

P may strengthen the persuasion power of a strategy also by making specific reference to the inconsistency between R's beliefs and goals and his behavior. This is even more true if P has evidence proving that R is almost certainly committed to achieve a goal g while R doesn't make the action a that is important to have g. From this point of view, an appeal to inconsistency of R may be rendered as a variant of Goal-strengthening plan (Figure 5.12) in which

inconsistency is expressed with a Claim communicative act (Claim P Inconsistent(R,g)). This act is connected to the reasons that justify it, that is, the *contrast* between the goal's value to R (Claim VGoal(R,g) and their evidence Remind P P₁(R), Remind P P₂(R), ..., Remind P P_n(R)) and the R's inconsistent behavior (Remind P DoesNot(R,a)) by a RR of *evidence*.

As said in experimental study about corpus collection (see Chapter 4), I saw several such cases of evoking the inconsistency between R's goal and his behavior, either when subject used rational or emotional strategies or a mixed of them. This justifies the introduction of the variant of Goal-strengthening plan to evoke the inconsistency in R.

```
<plan name="InconsistencyGoalStrengthening" action="a"
goal="g">
  <RR name="Evidence">
    <c_act type="Claim" term="Inconsistent(R,g)" />
    <RR name="Contrast">
      <RR name="Evidence">
        <c_act type="Claim" term="V-Goal R g" />
        <RR name="Joint">
          <c_act type="Remind" term="P1(R)" />
          <c_act type="Remind" term="P2(R)" />
          .....
          <c_act type="Remind" term="Pn(R)" />
        </RR>
      </RR>
    <c_act type="Remind" term="DoesNot(R,a)">
  </RR>
</RR>
</plan>
```

Figure 5.12: A variant of Goal-strengthening plan to evoke dissonance between R's goal and behavior

The *Ability-Proof plan* (Figure 5.13) is again built from the Argument from Evidence argumentation scheme and is a coherent translation of the Ability EBN. It demonstrates that conditions hold for R to perform the suggested action by listing a set of features P_i(R). The ability to perform the action is expressed with a 'Claim' communicative act (Claim P CanDoI(R,a)),

and this act is connected to the reasons that justify it (Remind P $P_1(R)$, Remind P $P_2(R)$, ..., Remind P $P_m(R)$) by a RR of *evidence*.

```
<plan name="AbilityProof" action="a">
  <RR name="Evidence">
    <c_act type="Claim" term="CanDo(R,a)" />
    <RR name="Joint">
      <c_act type="Remind" term="P1(R)" />
      <c_act type="Remind" term="P2(R)" />
      .....
      <c_act type="Remind" term="Pm(R)" />
    </RR>
  </RR>
</plan>
```

Figure 5.13: Ability-Proof plan

The *Belief-Induction plan* is a coherent representation of induction-of-belief strategy. It may be built from several argumentation schemes (for instance, Argument from Expert Opinion, Argument from Popular Opinion, Argument from Examples, Argument from Friendly Personal Experience, and so on) to support an action-goal implication. Figure 5.14 and Figure 5.15 are two examples of Belief-induction plans built, respectively, from Belief_ExpertOpinion EBNs and Belief_Examples EBNs. In both cases, the action-goal implication is expressed with a ‘Claim’ communicative act (Claim P $\text{Implies}(a,g)$) and is connected to the reason that justify it (Inform⁷ P $\text{Say}(\text{exp}, \text{Implies}(a,g))$, Inform P $\text{ExpertSource}(\text{exp}, a, g)$, and Inform P $\text{BelievableSource}(\text{exp}, a, g)$ in the first case, and Inform P $\text{Implies}(a, g_1)$ ⁸, Inform P $\text{Implies}(a, g_2)$, ..., Inform P $\text{Implies}(a, g_m)$ in the second one) by a RR of *evidence*.

The induction of belief may be supported, as well, with a plan representing the Appeal from Position to know scheme or from an emotional variant of this scheme called Appeal from Friendly Personal experience (Figure 5.16). In this case, P appeals to the experience of R’s friend, a person in the position to know

⁷ P uses *Remind* when the information was provided by R, and uses *Inform* for new data.

⁸ Notice that g_1, g_2, \dots, g_m are subgoal of g . For examples, if g is the goal to be in good health then g_1, g_2, \dots, g_m are the subgoals to strengthen muscles and bones, tone and rehydrate the body and to have benefits for the hair and skin

(because he had a personal experience in the domain). In this particular situation, friendship adds some emotional strength to persuasion.

```
<plan name="BeliefInductionFromExpertOpinion" action="a"
goal="g" expert="exp">
  <RR name="Evidence">
    <c_act type="Claim" term="Implies(a,g)"/>
    <RR name="Joint">
      <c_act type="Inform" term="Say(exp,Implies(a,g))"/>
      <c_act type="Inform" term="ExpertSource(exp,a,g)"/>
      <c_act type="Inform" term="BelievableSource(exp,a,g)"/>
    </RR>
  </RR>
</plan>
```

Figure 5.14: Example of Belief_induction plan from Argument To Expert Opinion

```
<plan name="BeliefInductionFromExamples" action="a" goal="g">
  <RR name="Evidence">
    <c_act type="Claim" term="Implies(a,g)"/>
    <RR name="Joint">
      <c_act type="Inform" term="Implies(a,g1)"/>
      <c_act type="Inform" term="Implies(a,g2)"/>
      .....
      <c_act type="Inform" term="Implies(a,gm)"/>
    </RR>
  </RR>
</plan>
```

Figure 5.15: Example of Belief_induction plan from Argument from Examples

```
<plan      name="BeliefInductionFromFriendlyPersonalExperience"
person="x" action="a" goal="g">
  <RR name="Evidence">
    <c_act type="Claim" term="Implies(a,g)"/>
    <RR name="Joint">
      <c_act type="Inform" term="Say(x,Implies(a,g))"/>
      <c_act type="Inform" term="FriendOf(x,R)"/>
      <c_act type="Inform" term="PersonalExperience(x,a,g)"/>
    </RR>
  </RR>
</plan>
```

Figure 5.16: Example of Belief_induction plan from Argument from Friendly Personal Experience

A particular type of argumentation plan is the *Goal-Activation plan* (Figure 5.17) that is a representation of activation-of-goal strategy (either rational or emotional). Goal-Activation plan is an exemplary case in which enthymemes have a basic role. Some of the elements of the activation reasoning process are not only likely to be omitted, but should be omitted from the argumentation message, to avoid failing of the persuasive attempt. This is even more true in emotional goal activation where the arousal of emotions may be perceived as a form of manipulation, and therefore as unfair by R, if he detects or suspects that P is “playing with her emotions”.

Therefore, either in rational or in emotional activation, *Goal-Activation plan* is an attempt to active a goal in R (and then to increase its value to R) by giving one or more specific ‘activating’ information (based on presumed or observed R’s characteristics) so as to implicitly trigger the whole process in R. In particular, *Goal-Activation plan* is built from the Argument from Problem to Solution scheme. In the plan, one or more statements expressing R’s critical properties (Inform P P1(R) and Inform P P2(R)) (that R might be able to avoid or confirm) are connected to the action presented as a mean for achieving R’s sub-goal g^9 (Suggest Do(R,a,g)) by a RR of *solutionhood*.

```
<plan name=" GoalActivation" action="a" goal="g">
  <RR name="Solutionhood">
    <RR name="Joint">
      <c_act type="Inform" term="P1(R)"/>
      <c_act type="Inform" term="P2(R)"/>
      .....
      <c_act type="Inform" term="P1(R)"/>
    </RR>
    <c_act type="Suggest" term="Do(R,a,g)"/>
  </RR>
</plan>
```

Figure 5.17: Goal-Activation plan

⁹ A goal g is a sub-goal in R’s perspective but is the main goal in P’s perspective

5.6.3 Discourse Plan

After reasons on R's mental state in order to select the most promising strategy to R in a given domain, P has to translate the selected strategy into a DP. That is, P explores the BN and decides the items to mention, their presentation order and the rhetorical relations among them. Also, he has to decide whether to include an appeal to cognitive inconsistency as a form of encouragement to a more consistent behavior.

DP is dynamically built combine the EAPs that correspond to the EBNs in the BN. In this algorithm, EAPs are employed to expand the c_act nodes of the tree. In more detail:

- First, the algorithm considers the type (pure/mixed) of the selected persuasion strategy so as to select the correspond persuasion plan:
 - If it is a case of pure persuasion strategy then, if the goal on which to focus the strategy is classified as rational, then it is selected the direct variant of the persuasion plan; otherwise, it is selected the indirect variant of it.
 - Otherwise, the algorithm identifies the main goal and the support goal and selects a mixed variant of the persuasion plan according to the type of combination between the two goals.

In both cases, the selected persuasion plan is instantiated with the corresponding value of the goal/goals and action.

- Second, the selected persuasion plan is handled as a master template that includes the basic part of the message (that is, the c_act nodes). To construct a complex DP that contains all the components of the BN it is necessary to expand the corresponding c_act nodes in the DP with the respective argumentation plans. In particular,

- A Goal-Strengthening plan has to be selected from the KB. Especially, if the probability value of the valued goal node in the BN exceed a given threshold, then the InconsistencyGoal-strengthening plan is selected according to the selected goal g. Otherwise, among all the Goal-Strengthening plans is selected that in which at least one of the c_act node has the attribute “term” that matches the valued goal node in the BN.
- Among all the Ability-Proof plans of the EAPs KB is selected that in which at least one of the c_act node has the attribute “term” that matches the ability node in the BN.
- If the belief node in the BN has parent nodes (at least one) then a Belief-Induction plan must be selected from the EAPs KB. All of them which have at least one of the c_act nodes that matches the belief node are selected from the EAPs KB. Among these is chosen that in which the attribute “term” of the c_act nodes match all the belief node’s parent nodes in the BN.

The nodes `<c_act type="Claim" term="V-Goal R g"/>`, `<c_act type="Claim" term="CanDo(R,g)"/>` and `<c_act type="Claim" term="Bel R Implies(a,g)"/>` in the persuasion plan are substitute with the content of these selected argumentation plans.

In the case of a mixed strategy, the procedure is iterated twice: once for the main goal and the other for the support goal.

- Third, to complete the translation of the selected persuasion strategy into a DP the algorithm has to include the Goal-Activation plan, if an activation-of-goal strategy is included in the BN. In the case of mixed strategy the following procedure is applied only to the main goal. If the action goal node in the BN has parent nodes then a Goal-Activation plan have be selected from the EAPs KB. Among all the

Goal-Activation plan is selected those in which the attributes “term” of the `c_act` nodes match all the action goal node’s root nodes in the BN. In this case, the goal activation become the first communicative act of the persuasion attempt: That is, the `<c_act type="Suggest" term="Do(R,a,g)"/>` of the selected Goal-Activation plan is substitute with the content of the building DP and a new final DP is constructed.

Figure 5.18 is a translation of a pure emotional strategy expressed in the BN (Figure 5.7) into a DP. The DP includes the following EAPs: a direct form of Persuasion plan, a Goal-Strengthening, an Action-Proof, a Belief-Induction-From-Expert-Opinion and a Goal-Activation.

```

<plan name="DiscoursePlan" action="a" goal="g">
  <RR name="Solutionhood">
    <RR name="Joint">
      <c_act type="Inform" term="P1(R)"/>
      <c_act type="Inform" term="P2(R)"/>
      .....
      <c_act type="Inform" term="P1(R)"/>
    </RR>
    <RR name="Enablement">
      <RR name="Motivation">
        <RR name="Joint">
          <RR name="Evidence">
            <c_act type="Claim" term="V-Goal R g"/>
            <RR name="Joint">
              <c_act type="Remind" term="P1(R)"/>
              <c_act type="Remind" term="P2(R)"/>
              .....
              <c_act type="Remind" term="Pn(R)"/>
            </RR>
          </RR>
          <RR name="Evidence">
            <c_act type="Claim" term="Implies(a,g)"/>
            <RR name="Joint">
              <c_act type="Inform" term="Say(exp,Implies(a,g))"/>
              <c_act type="Inform" term="ExpertSource(exp,a,g)"/>
              <c_act type="Inform" term="BelievableSource(exp,a,g)"/>
            </RR>
          </RR>
        </RR>
      </RR>
      <c_act type="Suggest" term="ShDo(R,a)"/>
    </RR>
    <RR name="Evidence">
      <c_act type="Claim" term="CanDo(R,a)"/>
      <RR name="Joint">
        <c_act type="Remind" term="P1(R)"/>
        <c_act type="Remind" term="P2(R)"/>
        .....
        <c_act type="Remind" term="Pm(R)"/>
      </RR>
    </RR>
  </RR>
</plan>

```

Figure 5.18: An example of DP that translates the pure emotional strategy expressed in the BN in Figure 5.7

5.6.4 Natural Language Generation

Monolog and dialog are fundamentally different [121]. Equally though, monolog and dialog have no intrinsic differences: It is generally assumed that monolog is a trace of the dialogical process of constructing an argument (for example, Eemeren and Grootendorst [47] used the notion of "implicit discussion", while Kibble [73] that of "inner dialogue"). Persuasive monolog may be seen as emerging from a process of internal argumentation in which P attempts to anticipate potential challenges or clarification requests [73]. Therefore, the same DP may be used to simulate a particular type of persuasive dialogue in which no retraction is evident.

According to Kibble there is a distinction between discourse plan and text plan: In the former, component propositions are linked by coherence relations while in the last, constituents may be re-ordered or pruned from the plan. Hence, while the DP is the Text Plan (henceforth TP) in the dialogic viewpoint, it has to be translated in a TP by a phase of pruning in monologic one.

In both cases, by adapting the language, a simple surface generation phase translates individual communicative acts and rhetorical relations in the TP into natural language sentences that may be rendered with the media available (for example, natural language or ECA).

5.6.4.1 Monologic viewpoint: generating a persuasive message

To formulate its persuasion message in natural language P may applied some pruning rules to the DP in order to translate it into a TP, that is a plan in which some parts are omitted with the intent to avoid including too many details or because there are considered too obvious or again, because their presentation do not increase the persuasive effect of the text. For example,

among all the elements in the DP P must decide if and when to justify its suggestion, that is whether to mention, in the message, the premises that motivated its choice (R's goals, the behavior-consequences relationship and R's presumed ability to perform the action).

Pruning rules are grounded on Marcu's studies [84] about the techniques that are likely to increase the persuasiveness of the text. In particular, P considers four different situations in which applied a pruning process, according to the type of the strategy (pure or mixed) represented in the DP and the type of the goal (rational or emotional):

Pure strategy focus on rational goal. This is a case in which the properties that justify the goal's value to R might be too obvious, if they were presented. Therefore, all the child nodes of the c_act node which has the attribute term=V-Goal R g are cut out from the TP. The only exception is when the properties are an evident proof of the high goal's value to R: in this case, P uses the R's properties to prove the inconsistency between R's goal and behavior, without stresses on the goal's value to R. Therefore, only the c_act node which has the attribute term=V-Goal R g is cuts out from the TP.

Pure strategy focus on emotional goal. According to the DP, the suggestion is introduced after the motivations that justify it. Therefore, the properties that justify the goal's value to R have to be presented because they might increase R's attitude to listen the suggestion. The only exception is when the effectiveness of the persuasion strategy is augmented by a goal activation in order to increase the goal's value to R. In this case, P decides not to present the properties that justify the goal's value to R because they might be too obvious, if they were presented and they could decrease the effectiveness of the persuasive text. Therefore, all the child nodes of the c-act node which has the attribute term=V-Goal R g are cut out from the TP. Moreover, if the strategy

evokes the inconsistency between R's goal and behavior, then c_act node which has the attribute term=V-Goal R g are cut out from the TP.

Mixed strategy focus on rational main goal and emotional support goal. Firstly, P decides to prune out the second occurrence of the suggest communicative act because its repetition may decrease the effectiveness of the message: Therefore, the c_act node which has the attribute term=ShDo(R,a) related to the support strategy is pruned out from the TP. Consider g1 as main goal and g2 as support goal. Then, the properties that justify the g1's value to R might be too obvious, if they were presented. Therefore, all the child nodes of the c_act node which has the attribute term=V-Goal R g1 are cut out from the TP. The only exception is when the properties are an evident proof of the high g1's value to R: In this case, P uses the R's properties to prove the inconsistency between R's goal and behavior, without stresses on the g1's value to R. Therefore, only the c_act node which has the attribute term=V-Goal R g1 is cuts out from the TP. Moreover, to avoid a too complex message, P decides to use the support strategy simply by presenting the evidence proving R's presumed ability to perform the action and the action- g2 implication, and not to stress on the g2's value to R. Therefore, the subtree having the c-act node which has the attribute term=V-Goal R g2 as root is cut off from the TP (That is, the root node and all its child nodes). The only exception is when the properties are an evident proof of the high g2's value to R: In this case, P uses the R's properties to prove the inconsistency between R's goals and behavior, without stresses on the g2's value to R. Therefore, only the c_act node which has the attribute term=V-Goal R g2) is cuts out from the TP.

Mixed strategy focus on emotional main goal and rational support goal. Firstly, P decides to prune out the second occurrence of the suggest communicative act because its repetition may decrease the effectiveness of the message: Therefore, the c_act node which has the attribute term=ShDo(R,a) related to the

support strategy is pruned out from the TP. Consider g_1 as main goal and g_2 as support goal. According to the DP, the suggestion is introduced after the motivations that justify it. Therefore, the properties that justify the g_1 's value to R have to be presented because they might increase R's attitude to listen the suggestion. The rule presents two exceptions:

- One is observed when the effectiveness of the persuasion strategy is augmented by a goal activation of g_1 in order to increase the g_1 's value to R. In this case, P decides not to present the properties that justify the g_1 's value to R because they might be too obvious, if they were presented and they could decrease the effectiveness of the persuasive text. Therefore, all the child nodes of the c-act node which has the attribute term=V-Goal R g_1 are cut out from the TP.
- The other is observed when the properties are an evident proof of the high g_1 's value to R: In this case, P uses R's properties to prove the inconsistency between R's goal and behavior, without stresses on the g_1 's value to R. Therefore, the c_act node which has the attribute term=V-Goal R g_1 is cuts out from the TP.

Then, to avoid a too complex message, P generally uses the support strategy simply by emphasizing on the g_2 's value to R, without stresses on the evidence that prove it. Therefore, all the child nodes of the c-act node which has the attribute term=V-Goal R g_2 are cut out from the TP. The only exception is when exception the properties are an evident proof of the high g_2 's value to R: In this case, P uses the R's properties to prove the inconsistency between R's goals and behavior, without stresses on the g_2 's value to R. Therefore, only the c_act node which has the attribute term=V-Goal R g_2 is cuts out from the TP.

Figure 5.19 represents the TP that is the result of the pruning process to the DP in Figure 5.18. The TP is now ready to generate the most effectiveness

persuasive message to R. If the selected strategy fails and, then, the persuasive message is not so much effectiveness, the two stacks (one of rational and the other of emotional goals) may be used to repair the failure by selecting the next promising candidate goal (either rational or emotional).

```
<plan name="DiscoursePlan" action="a" goal="g">
  <RR name="Solutionhood">
    <RR name="Joint">
      <c_act type="Inform" term="P1(R)"/>
      <c_act type="Inform" term="P2(R)"/>
      .....
      <c_act type="Inform" term="P1(R)"/>
    </RR>
  <RR name="Enablement">
    <RR name="Motivation">
      <RR name="Joint">
        <c_act type="Claim" term="V-Goal R g"/>
        <RR name="Evidence">
          <c_act type="Claim" term="Implies(a,g)"/>
          <RR name="Joint">
            <c_act type="Inform" term="Say(exp,Implies(a,g))"/>
            <c_act type="Inform" term="ExpertSource(exp,a,g)"/>
            <c_act type="Inform" term="BelievableSource(exp,a,g)"/>
          </RR>
        </RR>
      </RR>
    <RR name="Evidence">
      <c_act type="Claim" term="CanDo(R,a)"/>
      <RR name="Joint">
        <c_act type="Remind" term="P1(R)"/>
        <c_act type="Remind" term="P2(R)"/>
        .....
        <c_act type="Remind" term="Pm(R)"/>
      </RR>
    </RR>
  </RR>
  <c_act type="Suggest" term="ShDo(R,a)"/>
</RR>
</RR>
</RR>
</plan>
```

Figure 5.19: The TP that is the outcome of the pruning process to the DP in Figure 5.18.

5.6.4.2 Dialogic viewpoint: simulating a dialog between P and R

In a dialog perspective, argumentation, rather than a predefined, integrated set of propositions, is seen as a sequence of moves in which two parties (P and R) are reasoning together on some argument.

While monologic persuasion is characterized by the three steps of planning, plan revision and surface realization that are common to any NLP task, in the ‘pure’ persuasion dialogues the sequence of exchanges includes some typical phases, and forms of reasoning, by P:

1. *P makes a proposal*: after reasoning on R’s mental state, P proposes some action or some claim, by giving reasons as grounds for supporting the proposal
2. *P observes R’s reaction*: P waits for R’s reaction, that is, what does R say, or express differently,
3. *P classifies R’s reaction*: P identifies the type of R’s reaction, that is, a request of justification, an objection, with or without counter-argumentation, a refusal, and so on,
4. *P reasons on the R’s reaction*: P interprets and reasons on R’s reaction in order to select the most appropriate response.
5. *P replies to R’s reaction*: P presents the selected response to justify or defend the own proposal.

A P’s suggestion (or persuasion attempt) may be criticized by R in several ways: by questioning the goal premises; by attacking them with counter-arguments alleging that one or more of them is false; by undercutting the inferential link between premises and conclusion with critical questions; by rebutting the practical reasoning inference with counter-arguments asserting

that the conclusion is false or by putting forward a proposal arguing for a different action, and contending that the arguments for this opposed proposal are stronger [149]. P must be able to respond appropriately to all these situations.

At every dialogue step, P has to decide which part of its reasoning to make explicit in generating the argument and which one to hide or to postpone. In addition, a refined ability to observe R's reaction, interpret it and reason on the consequences of this reaction on the persuasion plan must be added to the system. Here, I focus on P's ability to reason on R's reaction in order to repair with an apposite reply.

According to the set of user's reaction recognized in the WoZ corpus (see Chapter 4), P considers two types of R's reactions: *non-destructive* and *destructive* ones. In particular:

- *Non-destructive* are the reactions which do not involve a failure of the persuasion attempt and therefore do not require a re-planning phase (and, of course, a new reasoning phase).
- *Destructive* are the reactions that involve a failure of the persuasion attempt. These may be temporary and then, require a re-planning phase (for example, R denies the goal's value to self) or permanent and then, determine the end of all process (for example, R rebuts the action because he is not able to perform it).

Moreover, R may react by accepting P's suggestion or by committing in the P's suggested action.

Table 5.4 explains the set of R's reaction to the received suggestion considered by P. Although this is only a subset of the types of moves that can occur in persuasion dialogues, they are a good start for asymmetric dialogues.

		R's Comunica tive act	Purpose	Content
Non-destructive R's reactions		AskJustify	R asks to justify P's suggestion	Suggest P ShDo(R,a)
		Challenge	R declares to not be persuaded by P's suggestion	Suggest P ShDo(R,a)
		AskInfo	R asks for more information about a P's statement	Claim P V-Goal R g
				Claim P Implies(a,g)
				Claim P CanDo(R,a)
		Object	R argues about the truth value of a premise of P's suggestion	Claim P V-Goal R g
				Claim P Implies(a,g)
				Claim P CanDo(R,a)
Destructive R's reactions	Temporary	Deny	R refuses goal's value to self	Claim P V-Goal R g
		Inform	R provides some evidence about his/her attitudes or behaviour	All
	Permanent	Rebuttal	R presents an exception that falsifies P's suggestion	Claim P CanDo(R,a)
		Reject	R refuses P's suggestion	Suggest P ShDo(R,a)
		Accept	R declares to agree with the P's suggestion	Suggest P ShDo(R,a)
		Commit	R commits him/herself to apply P's suggestion	Suggest P ShDo(R,a)

Table 5.4: Mapping between R's reaction during the dialog and RR in the TP

It is worth specifying that the last four R's reactions (Rebuttal, Reject, Accept and Commit) cause the end of all process, either for a failure (first two) or the success (last two) of the persuasion strategy. For the remaining types of reactions, a correspondence between R's reactions and the RRs in the TP may help P to identify the most appropriate reply (Table 5.5).

R's reaction	RR
AskJustify/Challenge	Motivation
Askinfo/Object	Evidence
Deny	Joint

Table 5.5: Mapping between R's reaction during the dialog and RR in the TP

According to the type of the TP, P's persuasion attempt to induce an intention in R may be a simple communicative act of Suggest P ShDo(R,a) or may support it by a list of R's properties to evoke inconsistency (Remind P $P_1(R)$, ..., Remind P $P_n(R)$) or to active R's goal (Inform P $P_1(R)$, ..., Inform P $P_m(R)$). An easy pruning process of the TP returns the P's suggestion (*first dialogue move*). This may be criticized by R in several ways (*second dialogue move*). A simple algorithm of exploration of the TP enables P to respond to R's reactions (*third dialog step*). In particular:

- First, the investigated R's reaction is spit in two parts: on one hand the communicative act and on the other, its target. For example, consider the R's reaction Object R (Claim P V-Goal R g): Object is the communicate act and V-Goal R g is the target. Then the RR associated to the communicative act is identified.
- Second, a walk of the TP enable to arrive at the c_act node whose attribute "term" matches the identified target. Then, starting from this c_act node, the algorithm goes up across its parents until the RR node whose attribute "name" matches the identified RR is reached. Again, starting from this RR node, the algorithm goes down until the c_act node(s) necessary to reply is (are) reached. In particular:

- AskJustify R (Suggest P ShDo(R,a)) and Challenge R (Suggest P ShDo(R,a)) are interpreted as a questioning of the action suggested by P and require a Claim P Implies(a,g) as P's response.
- AskInfo R (Claim P V-Goal R g), AskInfo R (Claim P CanDo(R,a)), Object R (Claim P V-Goal R g), and Object R (Claim P CanDo(R,a)) are interpreted, respectively, as a questioning of the goal and ability's premises and require list R's property (that is, Remind P P₁(R), ..., Remind P P_n(R)), as P's response.
- AskInfo R (Claim P Implies(a,g)) and Object R (Claim P Implies(a,g)) are interpreted as a questioning of the action-goal implication and require list the information proving the action-goal relation (for example, Inform P Implies(a,g₁), ..., Inform P Implies(a,g_n) or Inform P Say(exp,Implies(a,g)) and Inform P ExpertSource(exp,a,g), and Inform P BelievableSource(exp,a,g)), as P's response.
- Deny R (Claim P V-Goal R g) requires different actions according to the type of the persuasion plan:
 - A new reasoning and planning activity is required in the contest of pure strategy: they focus on the next goals identified as most promising in the two stacks during the phase of reasoning.
 - Otherwise, that is, in the context of mixed strategy:
 - If R denies the main goal's value to self, P may reply by highlighting about the action-support goal implication, that is, Claim P Implies(a,supportGoal).

- Otherwise, that is, R denies the support goal's value to self, a new reasoning and planning activity is required, like in the pure strategy context described above.
- Inform R $P_m(R)$ requires a new reasoning and planning activity because new R's evidence was added.
- Rebuttal R (Claim P CanDo(R,a)) and Reject R (Suggest P ShDo(R,a)) are interpreted, respectively, as R's impossibility and refusal to perform the action suggested by P. They are failures that cannot be repaired and cause the stop of all processes.
- Accept R (Suggest P ShDo(R,a)) and Commit R (Suggest P ShDo(R,a)) are interpreted as a good result of P's persuasion attempt and cause the stop of all processes.

The dialog turns between P and R are stopped by a permanent destructive R's reactions or when R agrees to P's suggestion.

5.7 Conclusion

In this Chapter I described a computational model in which, according to the a-rational Theory of persuasion [96], *rational* and *emotional* modes of persuasion may be integrated to produce effective strategies in different contexts.

Figure 5.20 represents a possible architecture of the model proposed. Three knowledge sources are used to select and formulate user-adapted persuasion attempts or argue about them:

- USER MODEL to reason about the Receiver's presumed characteristics,

- *PERSUASION KNOWLEDGE BASE* to model rational and emotional strategies, and
- *ARGUMENTATION KNOWLEDGE BASE* to translate every strategy into a discourse plan.

The model is ground on the distinction between a phase of reasoning and a phase of formulating an argument [147]. In the reasoning module (*REASONER*), the Persuader works on a representation of the Receiver's mental state to select a promising strategy or to repair to its possible failure, given its knowledge of the situation. In the argumentation module (*ARGUER*), the Persuader translates the selected strategy into a discourse plan that may be used to generate a persuasive message (*PERSUASIVE MESSAGE*) or a possible dialog simulation between the Persuader and the Receiver (*PERSUASIVE DIALOGUE SIMULATION*). In both cases, outcome is rendered with the media available (for example, natural language or ECA).

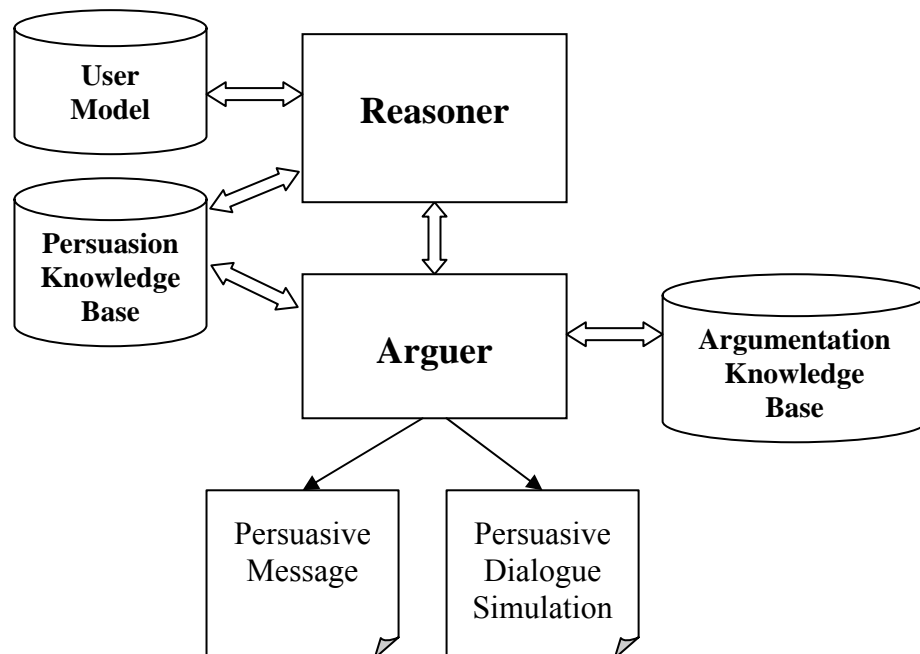


Figure 5.20: A possible architecture of the proposed model

The model may be used to build prototype persuasion systems in different domain, either as persuasion support application [92] or as a persuasion component of a more complex dialogue system [90]. In the former, the system may be a support for human persuaders to compare the persuasion strength of alternative strategies, or to select the argumentation plan to follow in order to induce an intention to change (a habit or a behavior) in a receiver with –partially known- characteristics. In the last, the system may be a persuasion component of an advice-giving dialogue system which acquire information about the user, provides information on request or according to its own plans, suggest lines of action, and tries to persuade user to follow them justifying or supporting its choices or revise them if needed.

The following Chapter is an explanation of a user-adapted persuasion system called PORTIA to support human persuader in a specific domain.

Chapter 6

The PORTIA Prototype

PORTIA¹⁰ is a user-adapted persuasion system built to test the persuasion model proposed in the previous chapter. Although the system is domain-independent, the knowledge base (henceforth KB) and the examples described in the following paragraphs come from the *Healthy Eating* domain. This is the application area considered in the preliminary experimental studies (see Chapter 4) and in the formulation of the model.

The key points of the proposed model are the separation between *reasoning* and *argumentation* phases in the persuasion process and the use of *Belief Networks* to represent the uncertainty inherent in this form of practical reasoning. The challenge of the model is to provide persuasion system with the capability of reasoning and evaluating the persuasive power of different strategies to a given user, and combining *rational* and *emotional* modes of persuasion in order to produce effective persuasion attempt in different contexts.

¹⁰ From the character in “The Merchant of Venice” of William Shakespeare, who was skilled in argumentation.

PORTIA is meant as a persuasion support application: It might support human persuader to compare the persuasion strength of alternative strategies, or to select the argumentation plan to follow in order to induce an intention to change (a habit or a behavior) in a receiver with -partially known- characteristics. Under this perspective, the system is used by a human persuader for the purpose said above and its output is presented to a receiver (the final user of the system) that merely listens to the persuasive message (monologic viewpoint) appropriate to him or reacts to the suggestion received by selecting a reply from the restrict set of possible reactions (dialogic viewpoint). In the last case, the system is a user-adapted persuasion system to simulate persuasion dialogs.

Moreover, PORTIA uses an ECA to convey the suggestion or to simulate persuasion dialogs. The ECA is a new metaphor of human-computer interaction which should give the illusion of cooperating with a human partner rather than just ‘using a tool’. Therefore, from the receiver’s viewpoint, PORTIA is a talking-head female young character called talking-head character Valentina. I believe that she¹¹ might hardly be seen as a substitute of the therapist in the Healthy Eating domain. She might rather play the role of a ‘competent friend’, who knows about the user and exploits this knowledge to select the most promising strategy *to induce an intention to change* a habit or a behavior in the user.

Henceforth, U will denote the final User of the system (that is, the addressee of the persuasive message/the persuasion dialog), and HP the Human Persuader. PORTIA’s goal is to induce in U the intention to eat healthier, therefore, the action suggested is eating more fruit and vegetables (henceforth EatVeg).

¹¹ As a female young character, I use "she" for Portia.

6.1 The Reasoner's Knowledge Base: The EBNs

EBNs are used to represent the persuasion strategies, as well as the U's model. They are chaining forward to dynamically build a more complex BN used by PORTIA to reasoning on U's mental state. Probabilistic reasoning on the consequences of evidence about some nodes on the rest of the network is performed by means of a variety of approximation algorithms, all aimed at reducing the inherent time complexity of the problem. PORTIA applied the algorithm developed by Spiegelhalter [139].

Table 6.1 represents a summary of the notations used in the PORTIA's KB.

Formula	Meaning
$(VGoal\ U\ g_i)$	g_i is a valued goal to U
$(AGoal\ U\ g_i)$	g_i is an active goal to U
$(Bel\ U\ Implies(a, g_i))$	U believe that performing a implies achieving g_i
$(Bel\ U\ Implies(g_j, g_i))$	U believe achieving g_j implies achieving g_i
$(Bel\ U\ CanDo(U, a))$	U believes that he or she is in the condition to perform a
$(Int\ U\ Do(U, a))$	U intends to perform a
$Feel(U, e_i)$	U feels the emotion e_i

Table 6.1: Some notations

As said in the previous chapter, EBNs are probabilistic networks with only one leaf node representing uncertain implications. Their nodes are classified into seven types:

- *Evidence nodes* represent U's facts (habits or characteristics). They are labeled as $Property(U)$ (for example, $MakesSport(U)$, $IsOnDiet(U)$), and are yellow colored.

- *Personality Trait nodes* represent U's personality traits. They are labeled as $\text{Personality}(U)$ (for example, $\text{Extraverted}(U)$, $\text{Neurotic}(U)$), and are violet colored.
- *Valued Goal nodes* represent the presumed goal's value to U. They are labeled as $\text{VGoal } U \ g_i$, and are dark-green colored.
- *Active Goal nodes* represent the presumed active property of U's goal. They are labeled as $\text{AGoal } U \ g_i$, and are light-green colored.
- *Emotional nodes* represent the U's emotional state. They are labeled as $\text{Feel}(U, e_i)$, and are fuchsia colored.
- *Belief nodes* represent knowledge that the system believes known to U. They are labeled as $\text{Implies}(\text{EatVeg}, g_i)$, or $\text{Implies}(g_i, g_j)$ and are light-blue colored.
- *Ability nodes* represent presumed U's capabilities to perform the action suggested. They are labeled as $\text{CanDo}(U, \text{EatVeg})$, and are pink colored.
- *Intention nodes* represent the presumed U's intention to perform the action suggested. They are labeled as $\text{Int } U \ \text{Do}(U, \text{EatVeg})$, and are light-yellow colored.

Some of these nodes are interface node, that is, input or output nodes needful to physically link EBNs (see Implementation paragraph). They are nodes with simple or dashed gray contour.

The problem of how to estimate parameters when building probabilistic models is a matter of discussion. BN parameters can be estimated by learning them from a corpus of data (frequentist approach) or according to subjective experience or common sense (neo-bayesian approach). In developing PORTIA,

I adopted a neo-bayesian approach, by extracting knowledge on one hand from psychological theories and on the other hand from the results of preliminary experiments (see Chapter 4).

6.1.1 The User Model

Understanding the presumed weight of U's goals is crucial to select the most promising persuasion strategy in a given context. To simplified the implementation, PORTIA considers a restrict set of goals relevant in the Healthy Eating domain and classifies them as rational or emotional. In particular:

Rational goal set = {To be in good health, to have a good appearance, to eat healthy foods}.

Emotional goal set = {To make friends, to be in good mood, to support farmers, to enjoy tasting new foods}.

Rather than acquiring this information about U through direct questions, PORTIA attempts to implicitly infer it, with some level of uncertainty, from knowledge of U's personality traits and living habits. According to the proposed persuasion model, the user model includes a *specific knowledge* and a *generic knowledge* component: The former is a collection of U's facts, while the last represents rules to infer U's goals and abilities in the form of EBNs. In particular, U's rational and emotional goals can be inferred, respectively, from knowledge of U's habits and personality traits.

The followings are the criteria behind the *Valued_Goal* EBNs for rational goals:

“Individuals who make sport regularly, undergo regular check-ups, and are interested in medical TV programs are probably interested in being in

good health, especially if they are not so young” becomes the **vgoal_goodhealth** EBN (Figure 6.1).

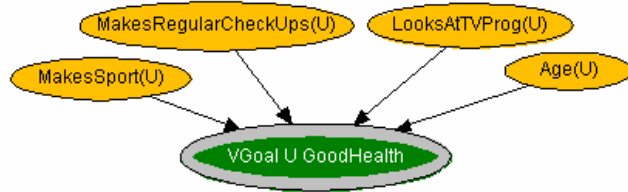


Figure 6.1: The *vgoal_goodhealth* EBN

“Individuals who make sport regularly, are ever on diet and like to wear beautiful dresses are probably interested in having a good look, especially if they are female” becomes the **vgoal_goodapp** EBN (Figure 6.2).

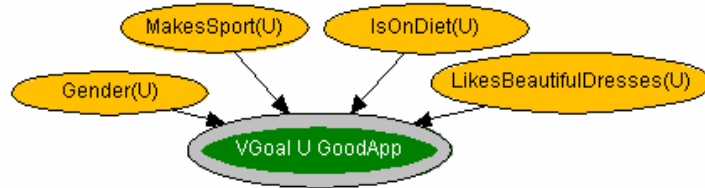


Figure 6.2: The *vgoal_goodapp* EBN

“Individuals who avoid eating fried foods and, more generally, fatty foods are probably interested in eating healthy foods” becomes the **vgoal_healthyfoods** EBN (Figure 6.3).

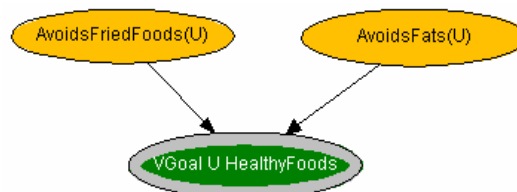


Figure 6.3: The *vgoal_healthyfoods* EBN

The followings are the criteria behind the *Valued_Goal* EBNs for emotional goals:

“Individuals who feel comfortable around people, like to talk in group, and are skilled in handling social situations are probably extraverts and making friends is likely to be important to these subjects” becomes the **vgoal_makefriends** EBN (Figure 6.4)

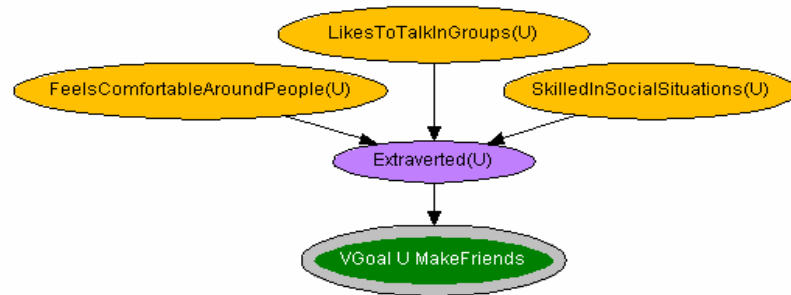


Figure 6.4: The *vgoal_makefriends* EBN

“Individuals who have frequent mood swings, and are often feel blue are probably Neurotic and being in good mood is likely to be important to these subjects” becomes the **vgoal_goodmood** EBN (Figure 6.5)

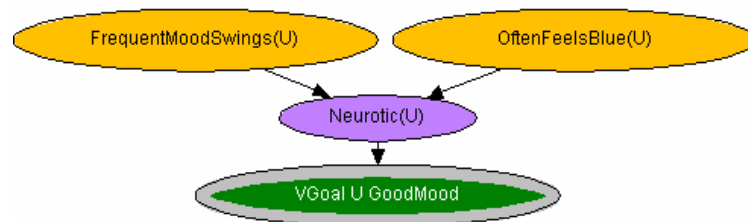


Figure 6.5: The *vgoal_goodmood* EBN

“Individuals who respect others and are interested in the others wellbeing are probably Agreeable and supporting biological farmers is likely to be important to these subjects” becomes the **vgoal_supportfarmers** EBN (Figure 6.6)

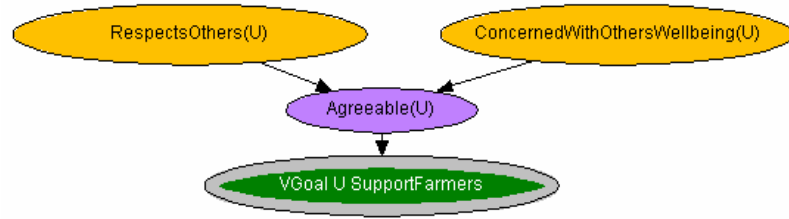


Figure 6.6: The *vgoal_supportfarmers* EBN

“Individuals who have an active imagination and are intellectually curious are probably open to experience and enjoying tasting new foods is likely to be important to these subjects” becomes the **vgoal_enjoytastingnewfoods** EBN (Figure 6.7)

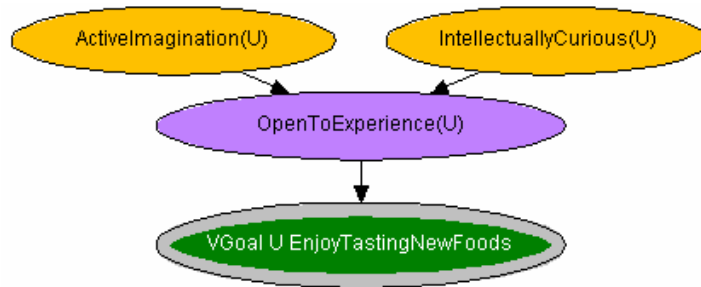


Figure 6.7: The *vgoal_enjoytastingnewfoods* EBN

An important addressed issue concerned the assigning parameters to the *Valued_Goal* EBNs, especially the prior -posterior probabilities of the various U’s goals. That is, what can be presumed is the weight of these goals in the absence of any evidence, and how this weight changes when some evidence about U is available? As far as goals or needs hierarchy is concerned, I referred to [88] (Figure 6.8):

- *Physiological* needs are the need to breathe, to regulate body temperature, the need for water, for sleep, the need to eat and to dispose of bodily wastes. Sexual activity is also placed in this category, as well as bodily comfort, activity, exercise etc.

- *Safety* needs include security of employment, of revenues and resources, physical security, moral and physiological security, familiar security and health.
- *Love/belonging* needs involve emotionally-based relationships in general, such as friendship, sexual intimacy, and having a family.
- *Status* needs are the need to be respected, to self-respect and to respect others.
- *Being* needs include *self-actualization* (personal potential, self-fulfillment, seeking personal growth and peak experiences) and *self-transcendence* (helping others to achieve self-actualization as a way of providing a route to achieve personal growth, integration, and fulfillment).

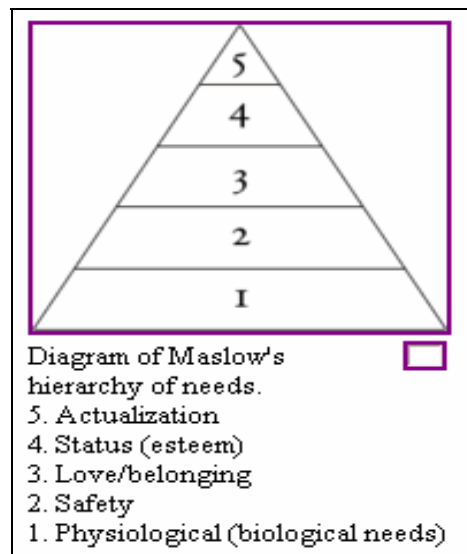


Figure 6.8: Hierarchy of needs, according to Maslow

By following this theory, higher level goals was associated with higher prior probabilities. For example: the goal of *being in good health* (safety in Maslow's hierarchy) has the highest weight, followed by *making friends* (love-belonging in the hierarchy) and *having a good appearance* (status-esteem). The weight of goals or values, like to *be in good mood*, *enjoy tasting new foods*,

support farmers or *eat healthy foods* is lower. Clearly, this hierarchy is only a default image of presumed goals’ strength in the population: it is not identical to all individuals but can change according to specific situations. In addition, it is well known that individuals do not always behave consistently with their goals [49]: The persuasion process aims at re-establishing some consistency between scale of values and actual behavior.

Similar criterion to those above is behind the *Ability* EBNs for infer U’s capability to perform the action suggested, that is, to eat more fruit and vegetable.

“Individuals who have some time free during the day, like cooking and do it whit good results, live in a place in which good vegetables are available, and have no physical problem to eat vegetables are probably in the condition to eat vegetables” becomes the **cando** EBN (Figure 6.9)

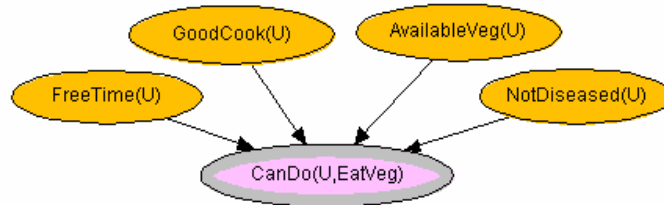


Figure 6.9: The *cando* EBN

6.1.2 The Persuasion Strategies

PORTIA may employ a combination of ‘rational’ and ‘emotional’ strategies. In particular, emotions may be introduced in the persuasion process in two forms: by selecting an emotional goal or by activating, through arousal of U’s emotion, an intermediate goal which is instrumental to the final one. Table 6.2 below summarizes the PORTIA’s persuasion KB.

<u>PORTIA’s Persuasion KB</u>					
<u>General induction of intentions</u>					
[(VGoal U g _i)∧(AGoal U g _i)∧(Implies (EatVeg,g _i))∧(CanDo(U,EatVeg))] (Int U Do(U,EatVeg)) [i]					
Rational induction of intention g _i ∈ { <i>Rational goal set</i> }			Emotional induction of intention g _i ∈ { <i>Emotional goal set</i> }		
<u>Activation of goal</u>					
Activation through a belief or an emotion of an intermediate goal which is instrumental to the final one					
<i>Rational activation</i> (Bel U g _k) ¹² →?(AGoal U g _h) [ii] [(AGoal U g _h)∧(Implies(g _i ,g _h))] (AGoal U g _i) [iii]			<i>Emotional Activation</i> (Bel U g _j) ¹³ →? Feel (U,e _j) [iv] Feel (U,e _j)→?(AGoal U g _h) [v] [(AGoal U g _h)∧ (Bel U Implies(g _i ,g _h))] (AGoal U g _i) [vi]		
<u>Induction of beliefs</u>					
Argumentation about means-end implication.					
<i>Appeal to Expert Opinion</i>	<i>Appeal to Popular Opinion</i>	<i>Appeal to Position to Know</i>	<i>Appeal to Friendly Personal Experience</i>	<i>Appeal to Examples</i>	<i>Others</i>

Table 6.2: A summary of the Persuasion Strategies used by PORTIA

Persuasion strategies are also represented as belief networks: every uncertain implication in the Table 6.2, instantiated with appropriate values of g and e , corresponds to an EBN. In this paragraph I present only few examples of instantiated EBNs.

¹² The state of the world g_k is often expressed by listing some U 's critical properties.

¹³ The state of the world g_i is often expressed by listing the some U 's critical properties.

The generic strategy of *induction of intentions* is represented in the *Intention* EBN and may be instantiated into several **intention** EBNs, each with a given goal (either rational or emotional). According to U's goals considered by PORTIA, there are seven instances of intention EBN in the KB (one for each goal). Figure 6.10 and Figure 6.11 present two examples of instantiated intention EBNs for the goals of being in good health and making friends. An important addressed issue concerned the assigning parameters to the *intention* EBNs, in particular the relative impact of the various components of the implication [i] ((VGoal U g_i), (AGoal U g_i), (Implies (EatVeg,g_i)), and (CanDo(U,EatVeg))), with their combination of truth values) on the intention to perform the action (Int U Do(U,EatVeg)). That is, does this impact depend on the particular type of goal? The hypothesis is that, given a probability distribution of values for the variables in its premises, the probability of the intention-node (Int U Do(U,EatVeg)) does not depend on the goal involved, at least in the considered application domain. Therefore, parameters in the EBNs that represent instances of [i] are all the same.

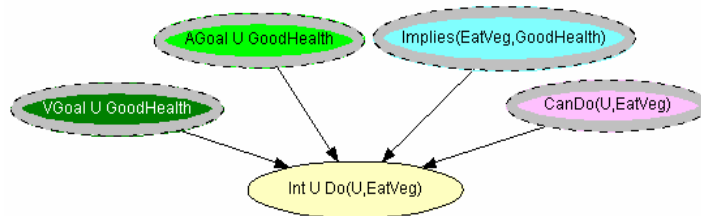


Figure 6.10: The *intention_goodhealth* EBN represent the induction of intentions through a rational goal

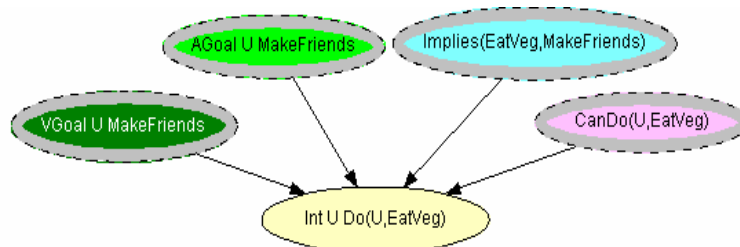


Figure 6.11: The *intention_makefriends* EBN represent the induction of intentions through an emotional goal

The strategies of *activation of goal* (either rational or emotional) are represented into two *Activation_goal* EBNs each of them may be instantiated into several **agoal** EBNs according to the type of instrumental goal and/or emotion. Therefore, each U's goal may be activated through different rational and emotional ways. PORTIA considers a restrict set of instrumental goals and emotions, and then, a restrict set of agoal EBNs: For each U's goal, there are an instance of **agoal_rational** EBNs and two instances of **agoal_emotional** EBNs. The effectiveness of each of agoal EBNs may be influenced by U's characteristics (For example, the goal 'to be in good health' activates through fear may be more effective in hypochondriac individuals rather than in individuals with high self-esteem). Figure 6.12 and Figure 6.13 present two examples of instantiated agoal_emotional EBNs for the goals of being in good health and making friends, while Figure 6.14 presents two examples of instantiated agoal_rational EBNs for the same goals. Table 6.3 and Table 6.4 summarize the goal activations introduced in the Persuasion KB.

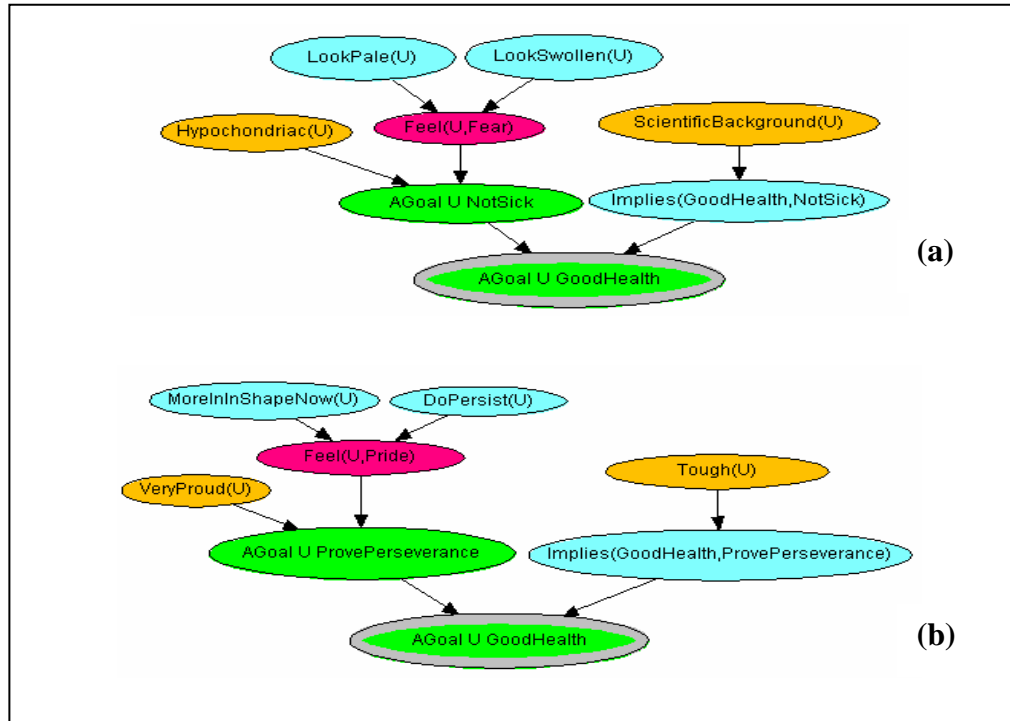


Figure 6.12: Two instances of emotional activation of the goal to be in good health: *agoal_emotional_goodhealth_fear* (a) and *agoal_emotional_goodhealth_pride* (b) EBNs

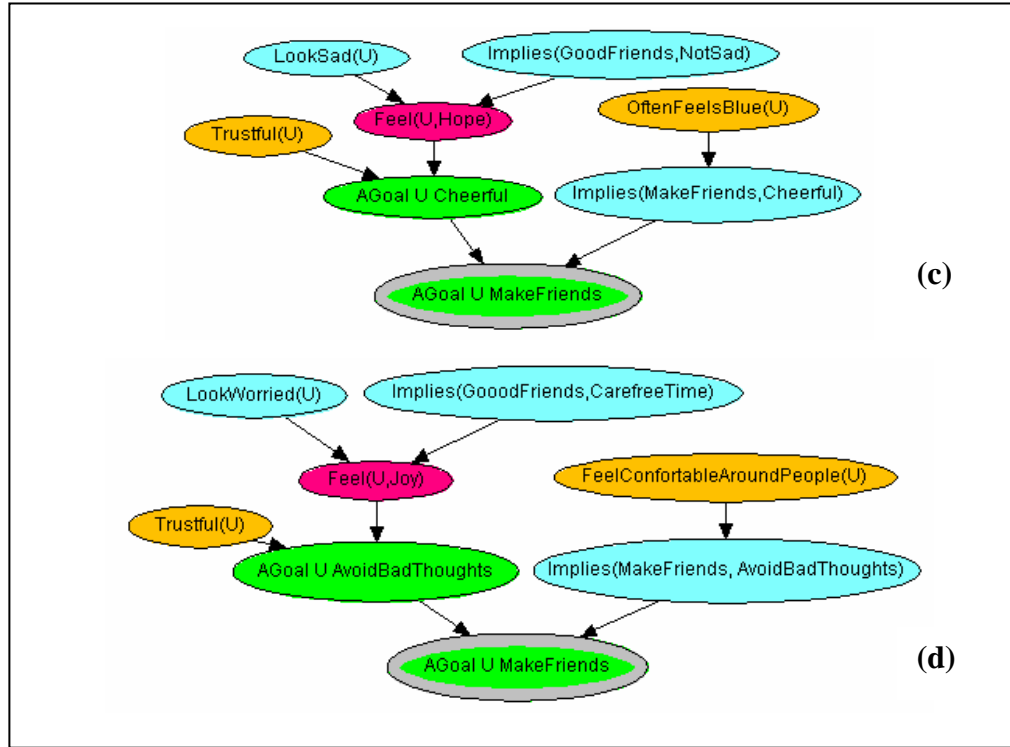


Figure 6.13: Two instances of emotional activation of the goal to make friends: *agoal_emotional_makefriends_hope* (c) and *agoal_emotional_makefriends_joy* (d) EBNs

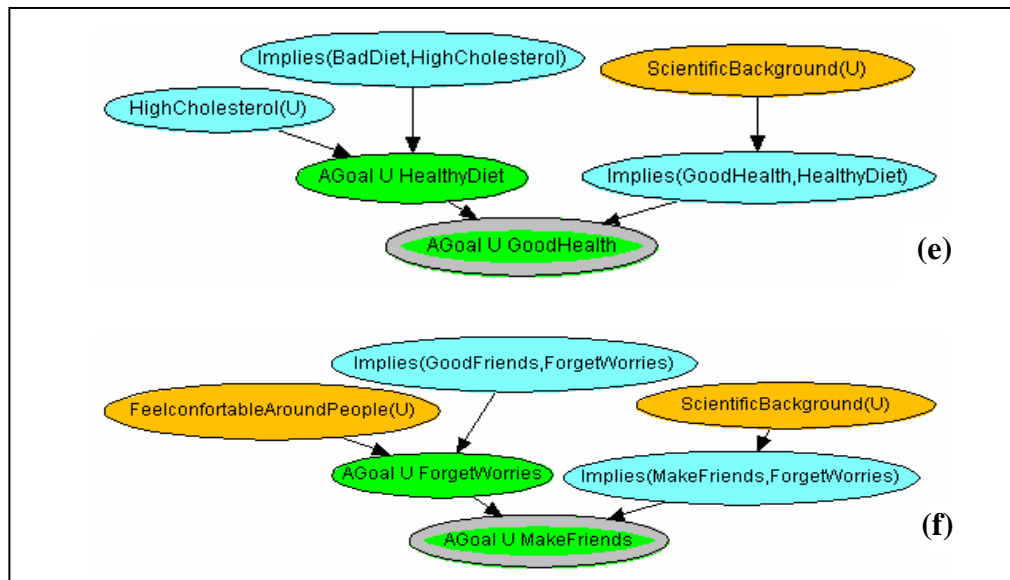


Figure 6.14: Two instances of rational activation of the goals to be in good health and make friends: *agoal_rational_makefriend* (e) and *agoal_rational_makefriends* (f) EBNs

An important addressed issue concerned the assigning parameters to the *agoal* EBNs, especially the question related to the strength of emotional and rational goal activation strategies in the absence of any evidence. Parameters in the EBNs were assigned so as to make strategies of emotional goal activation stronger than the rational ones. This was a result of the preliminary experiment in which emotional strategies were considered to be more effective than rational (see Chapter 4).

	U's goal to active	Emotion aroused	Instrumental goal
Rational Goal	To be in good health	Fear	To be not sick
		Pride	To prove own perseverance
	To have a good appearance	Shame	To save face
		Hope	To be cheerful
	To eat healthy foods	Fear	To be in good health
		Hope	To be in good health
Emotional Goal	To make friends	Hope	To be cheerful
		Joy	To Avoid Bad Thought
	To be in good mood	Anger	To prove ability to react
		Fear	To be in good health
	To support farmers	Pride	To prove own perseverance
		Hope	To improve environment
	To enjoy tasting new foods	Joy	To make new experiences
		Pride	To improve self-image

Table 6.3: A summary of the emotional Activation of Goal used by PORTIA

	U's goal to active	Instrumental goal
Rational goal	To be in good health	To adopt a healthier diet
	To have a good appearance	To be in shape
	To eat healthy foods	To lose weight
Emotional goal	To make friends	To forget worries
	To be in good mood	To be in shape
	To support farmers	To preserve environment
	To enjoy tasting new foods	To make new experience

Table 6.4: A summary of the rational Activation of Goal used by PORTIA

The strategies of *induction of beliefs* may be represented into several *belief* EBNs, according to the type of argumentation used to justify the action-goal implication (that is, Appeal to Expert Opinion, to Popular Opinion, to

Position to Know, to Friendly Personal Experience, to Examples, and so on). Each of them, in turn, may be instantiated into several **implies** EBNs according to the U's goal. Therefore, each action-goal relation (For instance, EatVeg-GoodHealth, EatVeg-MakeFriends, EatVeg-GooaApp, and so on) may be justified through different type of induction of beliefs. PORTIA considers a restrict set of possible argumentation, and then, a restrict set of belief EBNs in the KB: For each action-goal implication, there are one instance of **implies_expertopinion** EBN, one of **implies_popularopinion** EBN, and one of **implies_friendlypersonalexperience** EBN. Figure 6.15 and Figure 6.16 are two examples of instantiated implies EBNs for the goals of being in good health and making friends.

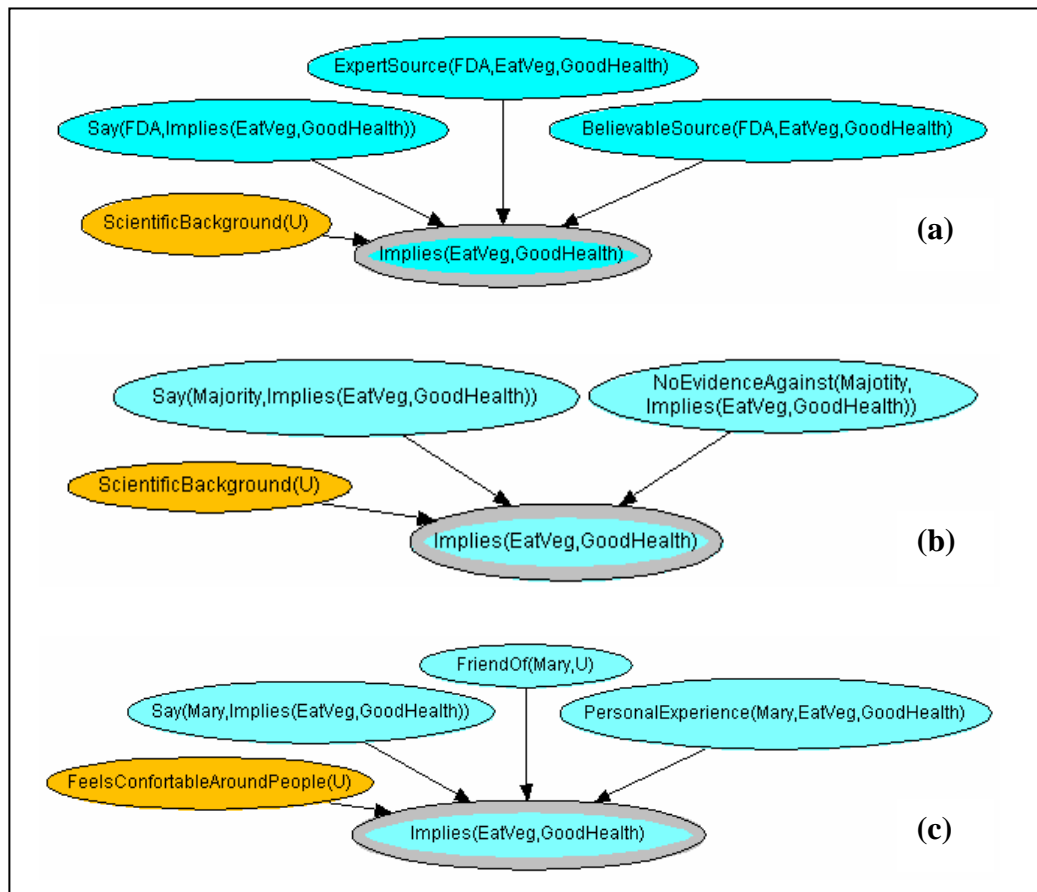


Figure 6.15: Instances of induction of beliefs for the goal to be in good health: *implies_expertopinion_goodhealth* (a), *implies_popularopinion_goodhealth* (b), and *implies_friendlypersonalexperience_goodhealth* (c) EBNs

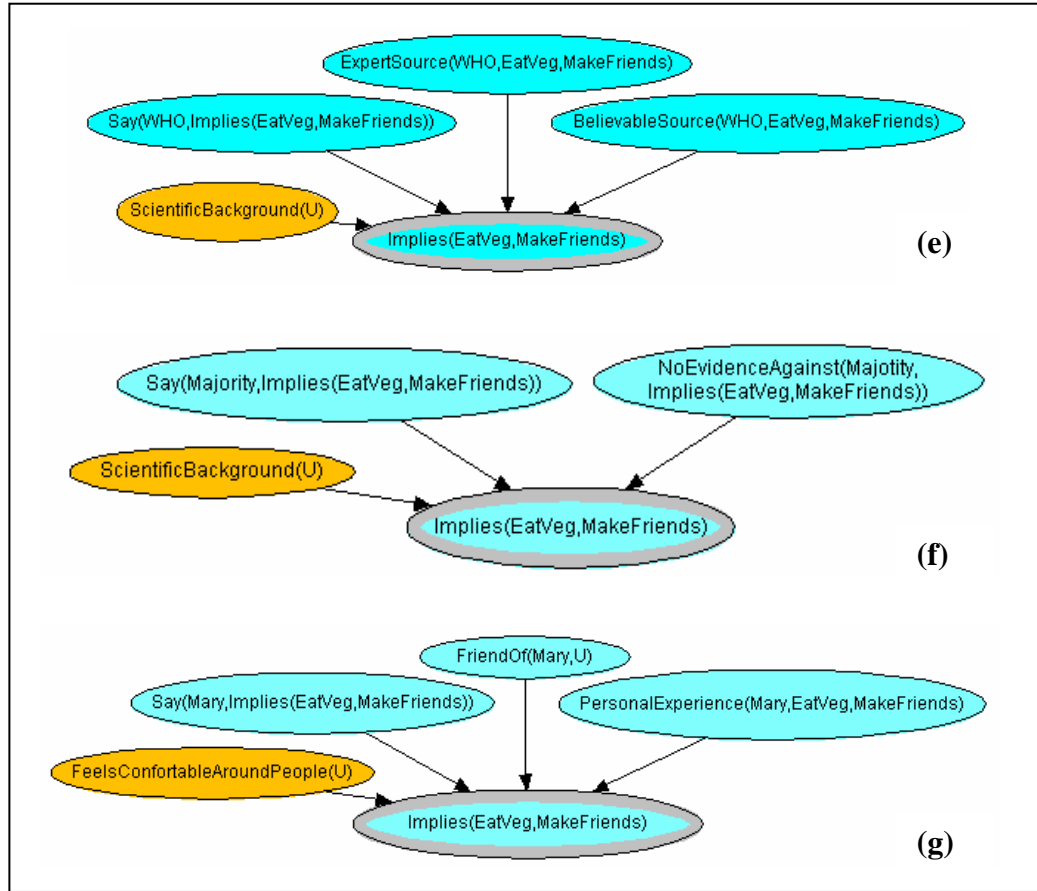


Figure 6.16: Instances of induction of beliefs for the goal to make friends: *implies_expertopinion_makefriends* (e), *implies_popularopinion_makefriends* (f), and *implies_friendlypersonalexperience_makefriends* (g) EBNs

An important addressed issue concerned the assigning parameters to the belief EBNs, especially the question related to the relative strength of alternative strategies arguing on the action-goal relation. That is, does this strength depend on the context in which strategies are used? I suspect that U's characteristics influence the strength of strategies arguing on the action-goal relationship. For example, rational people are probably more easily persuaded by an Appeal to Expert Opinion, while sociable people might be more easily persuaded by an Appeal to a Friendly Personal Experience, and so on. However, to my knowledge no theory or experiments support this hypothesis.

6.2 The Arguer's Knowledge Base: The EAPs

EAPs are a coherent translation of EBNs into arguments. Items to possibly include in the EAPs correspond to the variables associated with nodes of EBN (Table 6.5). EAPs are combined to dynamically build a more complex argument expressing the selected strategy, that is, the translation of the BN into a DP.

BN node name	Communicative act in the DP
VGoal U g_i	Claim P VGoal U g_i
Bel U $\text{Implies}(a, g_i)$	Claim P $\text{Implies}(a, g_i)$
Bel U $\text{CanDo}(U, a)$	Claim P $\text{CanDo}(U, a)$
Int U $\text{Do}(U, a)$	Suggest P $\text{ShDo}(U, a)$
Property(U)	Remind P <i>Property</i> (U) or Inform P <i>Property</i> (U)

Table 6.5: Mapping between BN nodes and communicative acts in the DP in PORTIA's KB

As said in the previous chapter, although the principle behind the EAPs reflects the theory behind an argumentation scheme, two new elements are added in this component of PORTIA's KB. On one hand, hypotheses about which emotional items should be said, and which ones should be omitted (an instantiation of the concept of enthymeme). On the other hand, definition of the rhetorical relations (RRs) associated with every argumentation scheme. In particular, while all the components of the EBNs representing rational strategies are presented in the EAPs, the nodes representing U's affective features (personality traits or emotional states) are omitted. For example, in the EAP associated with *agoal_emotional* EBN, the activated emotion $\text{Feel}(U, e_i)$, the instrumental goal ($\text{AGoal } U g_h$) and the implication ($\text{Bel } U \text{Implies}(g_i, g_h)$) will not appear in the EAP. Regarding the RRs, Table 6.6 explains the association between RRs and argumentation scheme employed in PORTIA's KB.

Argumentation scheme	Rhetorical Relation
Argument from Consequences	Motivation
Argument from Problem To Solution	Solutionhood
Argument from Position To Do	Enablement
Argument from Evidence to Hypothesis	Evidence
Argument from Expert Opinion	
Argument from Popular Opinion	
Argument from Friendly Personal Experience	

Table 6.6: Mapping between RRs and Argumentation Scheme in PORTIA's KB

EAPs are a tree structure represented as xml files. Root node represents the plan name and the situation in which it applies (that is, the attributes *name*, *action* and *goal*). Leave nodes represent communicative acts (**c_act nodes**) split in their significant attributes *type* and *term*. Intermediate nodes represent RRs (**RR_nodes**) through its attribute *name*. c_act_nodes include also two minor attributes: *said*, and *prob*. The first true/false attribute is relevant in the dialog simulation to indicate when the node is communicable or has already been communicated. The second represent the probability value of the BN-node associated to the c_act node, that is, a value ranging from 0 to 1. In particular, when attribute prob=0.5 then the associated node in the BN is not a U's evidence and then is not communicable. Otherwise, when attribute prob=1 then the associated node in the BN is a U's evidence and then may be communicated. Minor attributes are not considered in this paragraph to avoid overloading the readability of the plan.

6.2.1 The Persuasion Plan

Persuasion Plan is a coherent representation of *intention* EBN and is represented through **intention EAP**. It should be thought of as a master template that includes the basic part of the persuasion strategy.

As said in the previous chapter, PORTIA may select a pure or a mixed strategy (that is, respectively, purely rational or emotional strategy or a mixture of them), therefore, she has to consider different variants of intention EAP. PORTIA represents induction of intention through a single goal by two variants of intention EAPs, according to the type of U's goal: **intention_direct** EAP for rational goals and **intention_indirect** EAP for emotional goal. Both EAPs include the same components but presented them with different order. In the direct variant the suggestion is presented first, then the reasons that justify it, and finally the claim of readiness to act. On the contrary, in the indirect variant the suggestion is presented after the supporting reasons, and then the claim of readiness to act. In both cases, the intention EAPs have to be instantiated with the corresponding value of goal/goals and action. Figure 6.17 represents two instances of induction of intention, one through the rational goal of being in good health, and one through the emotional goal of making friends.

PORTIA represents induction of intention through main and support goal by combining the two variant of intention EAP (direct and indirect) through their common ability node. In particular, PORTIA considers two variants of intention EAPs according to the type of combination between main goal and support goal: **intention_mixed_rat_emo** EAP when main and support goals are, respectively, rational and emotional goals, and **intention_mixed_emo_rat** EAP when otherwise. Figure 6.18 represents an instance of induction of intention that combine the main goal of being in good health with the support goal of making friends.

```

<plan name="Persuasion" form="direct" action="EatVeg"
    goal="GoodHealth">
    <RR name="Enablement">
    <RR name="Motivation">
    <c_act type="Suggest" term="ShDo(U,EatVeg)"/>
    <RR name="Joint">
    <c_act type="Claim" term="VGoal U GoodHealth"/>
    <c_act type="Claim" term="Implies(EatVeg,GoodHealth)"/>
    </RR>
    </RR>
    <c_act type="Claim" term="CanDo(U,EatVeg)"/>
    </RR>
</plan>

```

(a)

```

<plan name="Persuasion" form="indirect" action="EatVeg"
    goal="MakeFriends">
    <RR name="Enablement">
    <RR name="Motivation">
    <RR name="Joint">
    <c_act type="Claim" term="VGoal U MakeFriends"/>
    <c_act type="Claim" term="Implies(EatVeg,MakeFriends)"/>
    </RR>
    <c_act type="Suggest" term="ShDo(U,EatVeg)"/>
    </RR>
    <c_act type="Claim" term="CanDo(U,EatVeg)"/>
    </RR>
</plan>

```

(b)

Figure 6.17: Two instances of persuasion plan for the goals to be in good health and to make friends: Respectively, *intention_direct* **(a)**, *intention_indirect* **(b)** EAPs

```

<plan name="Persuasion" form="mixed" action="EatVeg"
goal="GoodHealth" supportGoal="MakeFriends">
  <RR name="Enablement">
    <RR name="Joint">
      <RR name="Motivation">
        <c_act type="Suggest" term="ShDo(U,EatVeg)"/>
        <RR name="Joint">
          <c_act type="Claim" term="VGoal U GoodHealth"/>
          <c_act type="Claim" term="Implies(EatVeg, GoodHealth)"/>
        </RR>
      </RR>
    <RR name="Motivation">
      <RR name="Joint">
        <c_act type="Claim" term="VGoal U MakeFriends"/>
        <c_act type="Claim" term="Implies(EatVeg, MakeFriends)"/>
      </RR>
      <c_act type="Suggest" term="ShDo(U,EatVeg)"/>
    </RR>
  </RR>
  <c_act type="Claim" term="CanDo(U, EatVeg)"/>
</RR>
</plan>

```

Figure 6.18: An instance of *induction_mixed_rat_emo* EAP representing the induction of intention that combine the induction through main goal of being in good health with the induction through support goal of making friends

6.2.2 The Argumentation Plans

Argumentation plans are used to support the Persuasion Plan so as to construct a complex DP that contains all the components of the BN. PORTIA consider four types of argumentation plans: Goal-strengthening plans, Ability-Proof plan, Belief-Induction plans, and Goal-Activation plans.

Goal-strengthening plans are represented in **vgoal** EAPs and are a coherent translation of *vgoal* EBNs. There are as many *vgoal* EAPs as *vgoal* EBNs and each of them supports the candidate goal's value to U. The following figures explain the *vgoal* EAPs in the PORTIA's KB.

```
<plan name="VGoal" action="EatVeg" goal="GoodHealth">
  <RR name="Evidence">
    <c_act type="Claim" term="VGoal U GoodHealth"/>
    <RR name="Joint">
      <c_act type="Remind" term="MakesSport(U)"/>
      <c_act type="Remind" term="MakesRegularCheckUps(U)"/>
      <c_act type="Remind" term="LooksAtTVProgram(U)"/>
    </RR>
  </RR>
</plan>
```

Figure 6.19: The *vgoal_goodhealth* EAP

```
<plan name="VGoal" action="EatVeg" goal="GoodApp">
  <RR name="Evidence">
    <c_act type="Claim" term="VGoal U GoodApp"/>
    <RR name="Joint">
      <c_act type="Remind" term="MakesSport(U)"/>
      <c_act type="Remind" term="IsOnDiet(U)"/>
      <c_act type="Remind" term="LikesBeautifulDresses(U)"/>
    </RR>
  </RR>
</plan>
```

Figure 6.20: The *vgoal_goodapp* EAP

```
<plan name="VGoal" action="EatVeg" goal="HealthyFoods">
  <RR name="Evidence">
    <c_act type="Claim" term="VGoal U HealthyFoods"/>
    <RR name="Joint">
      <c_act type="Remind" term="AvoidsFriedFoods(U)"/>
      <c_act type="Remind" term="AvoidsFats(U)"/>
    </RR>
  </RR>
</plan>
```

Figure 6.21: The *vgoal_healthyfoods* EAP

```

<plan name="VGoal" action="EatVeg" goal="MakeFriends">
  <RR name="Evidence">
    <c_act type="Claim" term="VGoal U MakeFriends"/>
    <RR name="Joint">
      <c_act type="Remind"
        term="FeelsComfortableAroundPeople(U)"/>
      <c_act type="Remind" term="LikesToTalkInGroups(U)"/>
      <c_act type="Remind"
        term="SkilledInSocialSituations(U)"/>
    </RR>
  </RR>
</plan>

```

Figure 6.22: The *vgoal_makefriends* EAP

```

<plan name="VGoal" action="EatVeg" goal="GoodMood">
  <RR name="Evidence">
    <c_act type="Claim" term="VGoal U GoodMood"/>
    <RR name="Joint">
      <c_act type="Remind" term="FrequentMoodSwings(U)"/>
      <c_act type="Remind" term="OftenFeelsBlue(U)"/>
    </RR>
  </RR>
</plan>

```

Figure 6.23: The *vgoal_goodmood* EAP

```

<plan name="VGoal" action="EatVeg" goal="SupportFarmers">
  <RR name="Evidence">
    <c_act type="Claim" term="VGoal U SupportFarmers"/>
    <RR name="Joint">
      <c_act type="Remind" term="RespectsOthers(U)"/>
      <c_act type="Remind"
        term="ConcernedWithOthersWellbeing(U)"/>
    </RR>
  </RR>
</plan>

```

Figure 6.24: The *vgoal_supportfarmers* EAP

```

<plan name="VGoal" action="EatVeg"
  goal="EnjoyTastingNewFoods">
  <RR name="Evidence">
    <c_act type="Claim" term="VGoal U EnjoyTastingNewFoods"/>
    <RR name="Joint">
      <c_act type="Remind" term="ActiveImagination(U)"/>
      <c_act type="Remind"
        term="IntellectuallyCurious(U)"/>
    </RR>
  </RR>
</plan>

```

Figure 6.25: The *vgoal_enjoytastingnewfoods* EAP

PORTIA considers a variant of each of goal-strengthening plans to translate the appeal to more consistency between U's goal and behavior. The variants are represented in **vgoal_inconsistency** EAPs. Figure 6.26 and Figure 6.27 explain two of these, the first for the goal of being in good health, and the second for making friends.

```
<plan name="VGoalInconsistency" action="EatVeg"
      goal="GoodHealth">
  <RR name="Evidence">
    <c_act type="Claim" term="Inconsistent(U, GoodHealth)"/>
    <RR name="Contrast">
      <RR name="Evidence">
        <c_act type="Claim" term="VGoal U GoodHealth"/>
        <RR name="Joint">
          <c_act type="Remind" term="MakesSport(R)"/>
          <c_act type="Remind" term="MakesRegularCheckUps(U)"/>
          <c_act type="Remind" term="LooksAtTVProgram(U)"/>
        </RR>
      </RR>
    <c_act type="Remind" term="DoesNot(U,EatVeg)>
  </RR>
</RR>
</plan>
```

Figure 6.26: The *vgoal_inconsistency_goodhealth* EAP

```
<plan name="VGoalInconsistency" action="EatVeg"
      goal="MakeFriends">
  <RR name="Evidence">
    <c_act type="Claim" term="Inconsistent(U, MakeFriends)"/>
    <RR name="Contrast">
      <RR name="Evidence">
        <c_act type="Claim" term="VGoal U MakeFriends"/>
        <RR name="Joint">
          <c_act type="Remind"
            term="FeelsComfortableAroundPeople(U)"/>
          <c_act type="Remind" term="LikesToTalkInGroups(U)"/>
          <c_act type="Remind"
            term="SkilledInSocialSituations(U)"/>
        </RR>
      </RR>
    <c_act type="Remind" term="DoesNot(U,EatVeg)>
  </RR>
</RR>
</plan>
```

Figure 6.27: The *vgoal_inconsistency_makefriends* EAP

Ability-Proof plan is represented in **cando** EAP and is a coherent translation of *cando* EBN. Figure 6.28 explains the cando EAP in the PORTIA's KB.

```
<plan name="CanDo" action="EatVeg">
  <RR name="Evidence">
    <c_act type="Claim" term="CanDo(R,EatVeg)" />
  <RR name="Joint">
    <c_act type="Remind" term="FreeTime(U)" />
    <c_act type="Remind" term="GoodCook(U)" />
    <c_act type="Remind" term="AvailableVeg(U)" />
    <c_act type="Remind" term="NotDiseased(U)" />
  </RR>
</RR>
</plan>
```

Figure 6.28: The *cando* EAP

Belief-Induction plans are represented in **implies** EAPs and are a coherent translations of *implies* EBNs. As said above, PORTIA considers three argumentation strategies to justify each action-goal implication, and then three *implies* EAPs for each U's goal: *implies_expertopinion* EAP, *implies_popularpinion* EAP, and *implies_friendlypersonalexperience* EAP. Figure 6.29 and Figure 6.30 explain the belief-induction plans for the goals of being in good health and making friends.

```

<plan name="ImpliesExpertOpinion" action="EatVeg"
      goal="GoodHealth" expert="FDA">
  <RR name="Evidence">
    <c_act type="Claim" term="Implies(EatVeg,GoodHealth)"/>
    <RR name="Joint">
      <c_act type="Inform"
            term="Say(FDA,Implies(EatVeg,GoodHealth))"/>
      <c_act type="Inform"
            term="ExpertSource(FDA,EatVeg,GoodHealth)"/>
      <c_act type="Inform"
            term="BelievableSource(FDA,EatVeg,GoodHealth)"/>
    </RR>
  </RR>
</plan>

```

(a)

```

<plan name="ImpliesPopularOpinion" action="EatVeg"
      goal="GoodHealth">
  <RR name="Evidence">
    <c_act type="Claim" term="Implies(EatVeg,GoodHealth)"/>
    <RR name="Joint">
      <c_act type="Inform"
            term="Say(Majority,Implies(EatVeg,GoodHealth))"/>
      <c_act type="Inform"
            term="NoEvidenceAgainst
                  (Majority,Implies(EatVeg,GoodHealth))"/>
    </RR>
  </RR>
</plan>

```

(b)

```

<plan name="ImplesFriendlyPersonalExperience"
      person="Mary" action="EatVeg" goal="GoodHealth">
  <RR name="Evidence">
    <c_act type="Claim" term="Implies(EatVeg,GoodHealth)"/>
    <RR name="Joint">
      <c_act type="Inform" term="FriendOf(Mary,U)"/>
      <c_act type="Inform"
            term="Say(Mary,Implies(EatVeg,GoodHealth))"/>
      <c_act type="Inform"
            term="PersonalExperience(Mary,EatVeg,GoodHealth)"/>
    </RR>
  </RR>
</plan>

```

(c)

Figure 6.29: The three belief-induction plans for the goal of being in good health. The *implies_expertopinion_goodhealth* EAP **(a)**, the *implies_popularopinion_goodhealth* EAP **(b)**, and the *implies_friendlypersonalexperience_goodhealth* EAP **(c)**

```

<plan name="ImpliesExpertOpinion" action="EatVeg"
  goal="MakeFriends" expert="WHO">
  <RR name="Evidence">
    <c_act type="Claim" term="Implies(EatVeg,MakeFriends)"/>
    <RR name="Joint">
      <c_act type="Inform"
        term="Say(WHO,Implies(EatVeg,MakeFriends))"/>
      <c_act type="Inform"
        term="ExpertSource(WHO,EatVeg,MakeFriends)"/>
      <c_act type="Inform"
        term="BelievableSource(WHO,EatVeg,MakeFriends)"/>
    </RR>
  </RR>
</plan>

```

(d)

```

<plan name="ImpliesPopularOpinion" action="EatVeg"
  goal="MakeFriends">
  <RR name="Evidence">
    <c_act type="Claim" term="Implies(EatVeg,MakeFriends)"/>
    <RR name="Joint">
      <c_act type="Inform"
        term="Say(Majority,Implies(EatVeg,MakeFriends))"/>
      <c_act type="Inform"
        term="NoEvidenceAgainst
          (Majority,Implies(EatVeg,MakeFriends))
      </RR>
    </RR>
  </plan>

```

(e)

```

<plan name="ImplesFriendlyPersonalExperience"
  person="Mary" action="EatVeg" goal="MakeFriends">
  <RR name="Evidence">
    <c_act type="Claim" term="Implies(EatVeg,MakeFriends)"/>
    <RR name="Joint">
      <c_act type="Inform" term="FriendOf(Mary,U)"/>
      <c_act type="Inform"
        term="Say(Mary,Implies(EatVeg,MakeFriends))"/>
      <c_act type="Inform"
        term="PersonalExperience(Mary,EatVeg,MakeFriends)
    </RR>
  </RR>
</plan>

```

(f)

Figure 6.30: The three belief-induction plans for the goal of making friends. The *implies_expertopinion_makefriends* EAP **(d)**, the *implies_popularopinion_makefriends* EAP **(e)**, and the *implies_friendlypersonalexperience_makefriends* EAP **(f)**

Goal-Activation plans are represented in **agoal** EAPs and are a coherent translation of agoal EBNs. There are as many agoal EAPs as agoal EBNs in the PORTIA's KB and each of them are an attempt to active the U's goal (and then to increase its value to U). Figure 6.31 and Figure 6.32 explain the activation goal plans for the goals of being in good health and making friends.



Figure 6.31: The three activation goal plans for the goals of being in good health: the *agoal_emotional_goodhealth_fear* EAP **(a)**, the *agoal_emotional_goodhealth_pride* EAP **(b)**, and the *agoal_rational_goodhealth* EAP **(c)**

```

<plan name="AGoal" action="EatVeg" goal="MakeFriends">
  <RR name="Solutionhood">
    <RR name="Joint">
      <c_act type="Inform" term="LookSad(U)"/>
      <c_act type="Inform" term="Implies(GoodFriends,NotSad)"/>
    </RR>
    <c_act type="Suggest" term="Do(R,EatVeg,MakeFriends)"/>
  </RR>
</plan>

```

(d)

```

<plan name="AGoal" action="EatVeg" goal="MakeFriends">
  <RR name="Solutionhood">
    <RR name="Joint">
      <c_act type="Inform" term="LookWorried(U)"/>
      <c_act type="Inform"
        term="Implies(GoodFriends,CarefreeTime)"/>
    </RR>
    <c_act type="Suggest" term="Do(R,EatVeg,MakeFriends)"/>
  </RR>
</plan>

```

(e)

```

<plan name="AGoal" action="EatVeg" goal="Makefriends">
  <RR name="Solutionhood">
    <RR name="Joint">
      <c_act type="Inform"
        term="Implies(GoodFriends,ForgetWorries)"/>
    </RR>
    <c_act type="Suggest" term="Do(R,EatVeg,GoodHealth)"/>
  </RR>
</plan>

```

(f)

Figure 6.32: The three activation goal plans for the goals of being in making friends: the *agoal_emotional_makefriends_hope* EAP **(d)**, the *agoal_emotional_makefriends_joy* EAP **(e)**, and the *agoal_rational_makefriends* EAP **(f)**

6.3 PORTIA at Work

This paragraph demonstrates PORTIA's functionality by presenting two significant examples. The first one is a complete example in which rational and emotional strategies are combined in a mixed persuasion strategy. The second one is an example of emotional strategy whose persuasion power is strengthened by making specific reference to the inconsistency between U's goal and behavior.

6.3.1 Example 1

Let us consider the following starting conditions.

U is a *man below 40 years* who regularly *makes sport* and *medical check-ups*. He is a *hypochondriac*, too. He is probably an extravert because he *feels comfortable around people*. Moreover, he *likes cooking and does it with good results*.

REASONING Phase

a. Selecting the most promising persuasion strategy by inferring the presumed goals' value to U.

In this phase, PORTIA exploits her information about U to compute the degree of importance of the various -rational and emotional- goals to U and infer the goal/goals on which focus the persuasion strategy. Two kinds of information about U may be introduced into PORTIA: 'facts' about life style (top left side window in Figure 6.33) and hypotheses about personality traits (top right side window in Figure 6.33).

Reasoning component of PORTIA propagates the U's evidence into her EBN-KB (that is, *Valued_Goal EBNs*). She infers that, although '*to be in good*

health’ is the presumed most important goal to U, the associated rational persuasion strategy does not seem to induce in U the desired level of intention to eat healthier and a mixed strategy could be more effective to U . Therefore, PORTIA selects the goal with the highest value among the emotional goals and infers that the two candidate goals on which focus the persuasion strategy are the rational goal *to be in good health* and the emotional goal *to make friends* (bottom window in Figure 6.33). Figure 6.33 represents the PORTIA’s Resoning Window. It includes two windows to set U’s characacteristics: The *U Fact Setup Window* (top left side) enables to set facts about U, while *U Pers Setup Window* (top right side) enables to set facts related to U’s personality traits. A *Log Windows* (bottom side) display the salient steps of the reasoning process. Two buttons enable to generate a persuasive text or a dialog simulation.

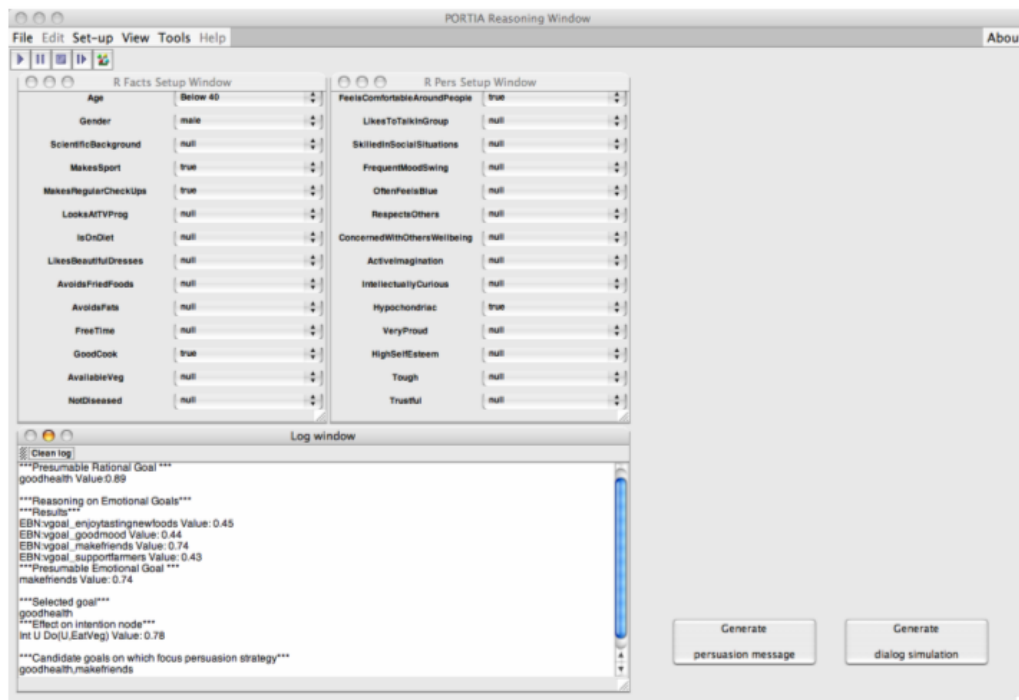


Figure 6.33: The PORTIA’s Resoning Window

b. *Selecting an appropriate goal-activation and action-goal argumentation strategy.*

In this phase, rather than automatically making a choice, PORTIA reasons in a ‘what-if mode’, to suggest alternative ways to strengthen the persuasion power of the selected strategy. Two types of information, expressed as sentences, may be used to influence U’s attitudes: activation goal sentences - representing activation of goal strategies, and action-goal implication ones - representing belief induction strategies. As said before, PORTIA considers different ways to activate a given goal (either cognitively or emotionally), and to argue on the action–goal implication, therefore, every strategy may be triggered by one or more sentences. However, their effect depends on U’s characteristics and context but, to my knowledge, is not yet psychologically clear. Due to this lack of knowledge, rather than making an automatic choice, alternative strategies are displayed in the ‘What If I Say’ window (right side of Figure 6.34). The HP can test the effect of alternative strategies on R’s mind but is left free to make the final choice.

According to the candidate goals, PORTIA suggests three different ways to active the main goal (and then to increase goal’s value to U) and two different ways per goal to support the action-goal implication. Among all the strategies tested (bottom windows in Figure 6.34), HP selects the *emotional activation strategy through arousal of fear*, and the belief induction strategies through *appeal to expert opinion* and *appeal to popular opinion*, respectively, for the goals of being in good health and making friends. Figure 6.34 represents the complete PORTIA’s Reasoning Window. In addition to the setup and log windows, it include the *What if I say window* (right side) that enables to test the additional effect of activation goal sentences or action-goal sentences (*What If* button) and select the most appropriate of them (*Ok* button).

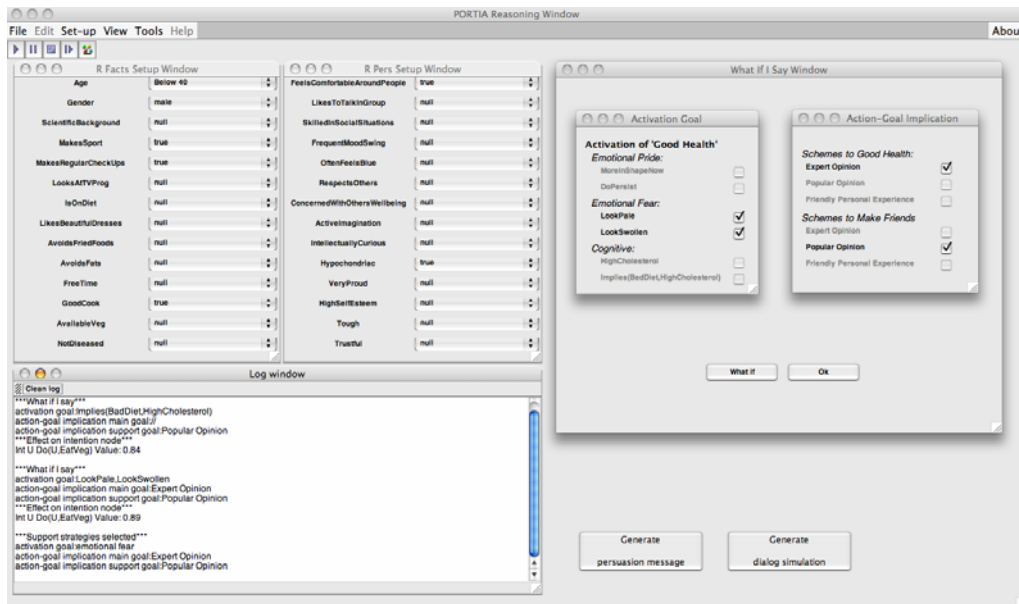


Figure 6.34: The complete PORTIA's Reasoning Window

Figure 6.35 represents the result of PORTIA's reasoning process, that is, the BN built by chaining forward the following EBNs:

- intention_goodhealth EBN (Figure 6.10)
- intention_makefriends EBN (Figure 6.11)
- vgoal_goodhealth EBN (Figure 6.1)
- vgoal_makefriends EBN (Figure 6.4)
- agoal_emotional_goodhealth_fear EBN (Figure 6.12)
- implies_expertopinion_goodhealth EBN (Figure 6.15)
- implies_popularopinion_makefriends EBN (Figure 6.16)
- cando EBN (Figure 6.9)

The BN is the PORTIA's representation of U's mental state on which has been tested the effectiveness of the persuasion strategy.

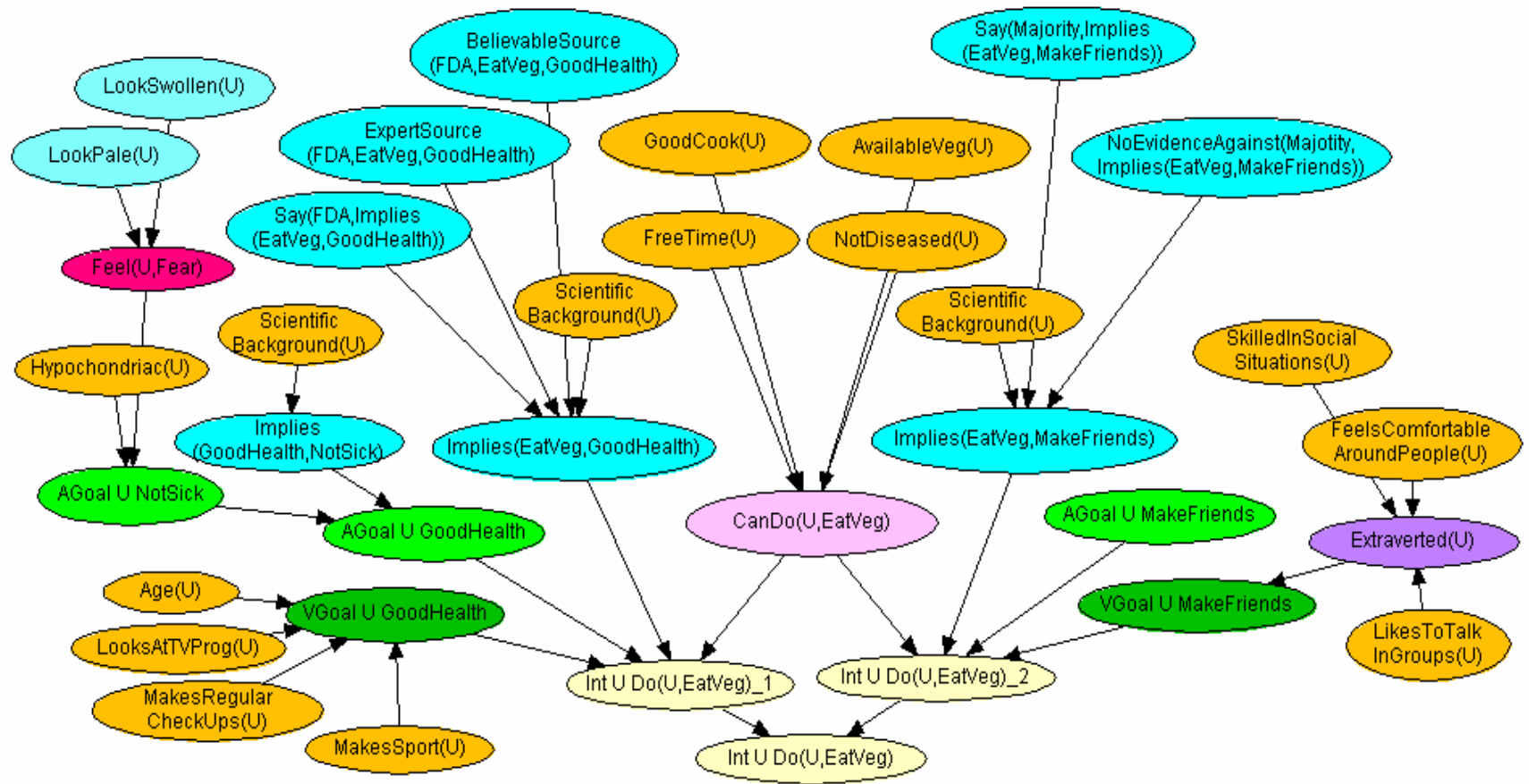


Figure 6.35: The BN used by PORTIA to simulate the effect of selected strategy on U's mental state

ARGUMENTATION Phase

c. Building the discourse plan

In this phase, PORTIA explores the BN and decides the arguments to mention, their presentation order, and the rhetorical relations among them.

According to the BN, argumentation component of PORTIA builds a DP by combining the EAPs associated to each EBNs in the BN. First, PORTIA selects the *induction_mixed_rat_emo* EAP (Figure 6.18) and instantiates the goal, supportGoal and action attributes with, respectively, *GoodHealth*, *MakeFriends* and *EatVeg*. This is a master template that includes the basic part of the arguments in the selected persuasion strategy. It does not take into account the arguments to support the goal's value to U or its activation, the claim of U's readiness to act and the action_goal implication. Therefore, according to the BN, each of the *c_act* nodes has to be expanded with the associated argumentation plan in order to construct a complex DP that includes all the argument in the strategy. In particular:

- `<c_act type="Claim" term="VGoal U GoodHealth"/>` node is substitute with the content of the *vgoal_goodhealth* EAP (Figure 6.19)
- `<c_act type="Claim" term="Implies(EatVeg, GoodHealth)"/>` node is substitute with the *implies_expertopinion_goodhealth* EAP (Figure 6.29)
- `<c_act type="Claim" term="VGoal U MakeFriends"/>` node is substitute with the *vgoal_makefriends* EAP (Figure 6.22)
- `<c_act type="Claim" term="Implies(EatVeg, MakeFriends)"/>` node is substitute with the *implies_popularopinion_makefriends* EAP (Figure 6.30)
- `<c_act type="Claim" term="CanDo(U, EatVeg)"/>` node is substitute with the *cando* EAP (Figure 6.28)

- Finally, the plan constructed so far is combined with the *agoal_emotional_goodhealth_fear* EAP (Figure 6.31).

Finally, the attribute “prob” of each of `c_act` nodes in the DP is instantiated with the probability value of the correspondent node in the BN.

The following is the DP built by PORTIA to express the arguments of the selected persuasion strategy and Figure 6.36 is its tree representation.

```

<plan name="Persuasion" form="mixed" action="EatVeg"
goal="GoodHealth" supportGoal="MakeFriends">
<RR name="Solutionhood">
  <RR name="Joint">
    <c_act type="Inform" term="LookPale(U)" prob="1"/>
    <c_act type="Inform" term="LookSwollen(U)" prob="1"/>
  </RR>
<RR name="Enablement">
  <RR name="Joint">
    <RR name="Motivation">
      <c_act type="Suggest" term="ShDo(U,EatVeg)" prob="0.82"/>
    <RR name="Joint">
      <RR name="Evidence">
        <c_act type="Claim" term="VGoal U GoodHealth" prob="0.89"/>
      <RR name="Joint">
        <c_act type="Remind" term="MakesSport(U)" prob="1"/>
        <c_act type="Remind" term="MakesRegularCheckUps(U)"
          prob="1"/>
        <c_act type="Remind" term="LooksAtTVProgram(U)" prob="0.5"/>
      </RR>
    </RR>
    <RR name="Evidence">
      <c_act type="Claim" term="Implies(EatVeg,GoodHealth)"
        prob="0.85"/>
    <RR name="Joint">
      <c_act type="Inform"
        term="Say(FDA,Implies(EatVeg,GoodHealth))" prob="1"/>
      <c_act type="Inform"
        term="ExpertSource(FDA,EatVeg,GoodHealth)" prob="1"/>
      <c_act type="Inform"
        term="BelievableSource(FDA,EatVeg,GoodHealth)"
        prob="1"/>
    </RR>
  </RR>
</RR>
</RR>
</RR>
<RR name="Motivation">
  <RR name="Joint">
    <RR name="Evidence">
      <c_act type="Claim" term="VGoal U MakeFriends" prob="0.74"/>
    <RR name="Joint">
      <c_act type="Remind"
        term="FeelsComfortableAroundPeople(U)" prob="1"/>
    </RR>
  </RR>
</RR>

```

```

        <c_act type="Remind" term="LikesToTalkInGroups(U)"
                prob="0.5"/>
        <c_act type="Remind"
                term="SkilledInSocialSituations(U)" prob="0.5"/>
    </RR>
</RR>
<RR name="Evidence">
    <c_act type="Claim" term="Implies(EatVeg,MakeFriends)"
            prob="0.85"/>
    <RR name="Joint">
        <c_act type="Inform"
                term="Say(Majority,Implies(EatVeg,MakeFriends))"
                prob="1"/>
        <c_act type="Inform"
                term="NoEvidenceAgainst
                    (Majority,Implies(EatVeg,MakeFriends))"
                prob="1"/>
    </RR>
</RR>
</RR>
    <c_act type="Suggest" term="ShDo(U,EatVeg)" prob="0.75"/>
</RR>
</RR>
<RR name="Evidence">
    <c_act type="Claim" term="CanDo(R,EatVeg)" prob="0.52"/>
    <RR name="Joint">
        <c_act type="Remind" term="FreeTime(U)" prob="0.5"/>
        <c_act type="Remind" term="GoodCook(U)" prob="1"/>
        <c_act type="Remind" term="AvailableVeg(U)" prob="0.5"/>
        <c_act type="Remind" term="NotDiseased(U)" prob="0.5"/>
    </RR>
</RR>
</RR>
</RR>
</plan>

```

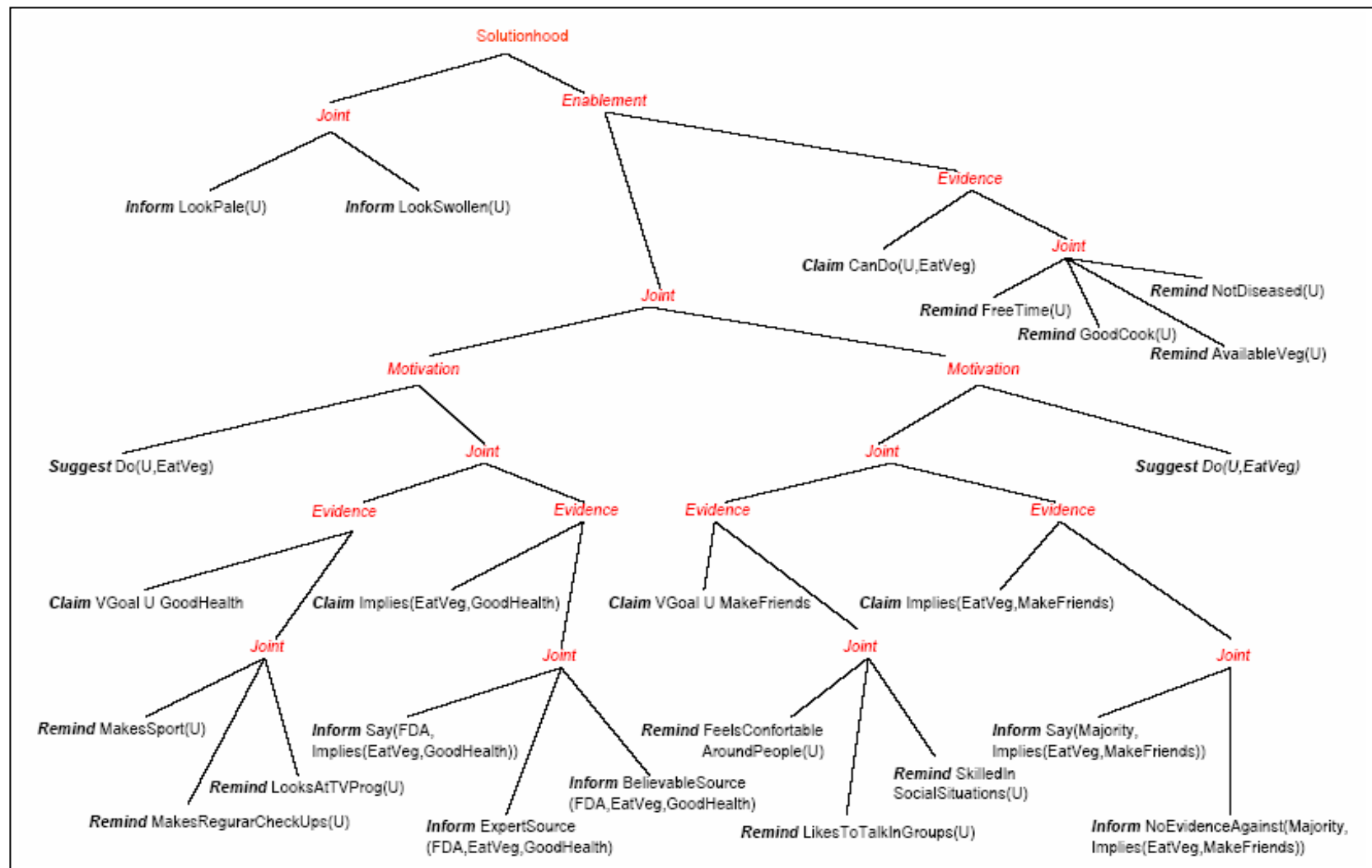


Figure 6.36: The tree representation of the DP

d. Generating persuasion message or dialog simulation

Finally, PORTIA may formulate the more effectiveness persuasion text to U or may simulate persuasion dialogue.

In the first case, PORTIA applies the pruning rules in order to translate the DP into a TP (Figure 6.37) that will be applied to generate the persuasion text. U has a passive role and merely listens to the message produced.

In the second case, U has an active role because may react to the suggestion or others sentences of the system (Figure 6.38).

In both cases, a simple surface generation module translates individual communicative acts and rhetorical relations in the plan into natural language sentences.

Figure 6.38 represents the PORTIA's Dialog Simulation Window. It include the ECA, a combo box that allows the user to select the reaction move, and two log windows to display the dialog turns as sentences (*Log Dialog* window) and as communicative acts (*Communicative Act* window).

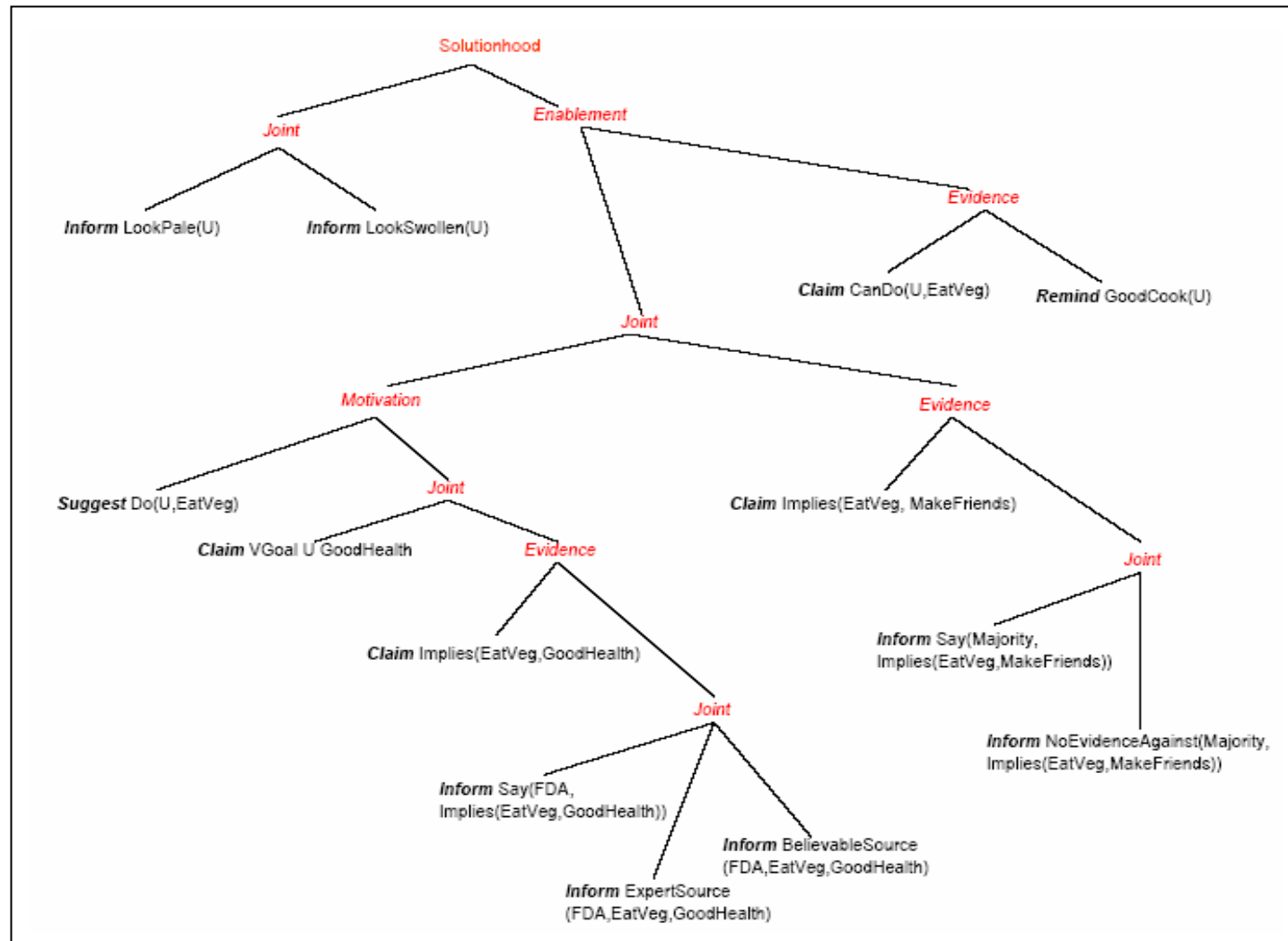


Figure 6.37: The tree representation of the TP, that is, the result of the pruning rules to the DP

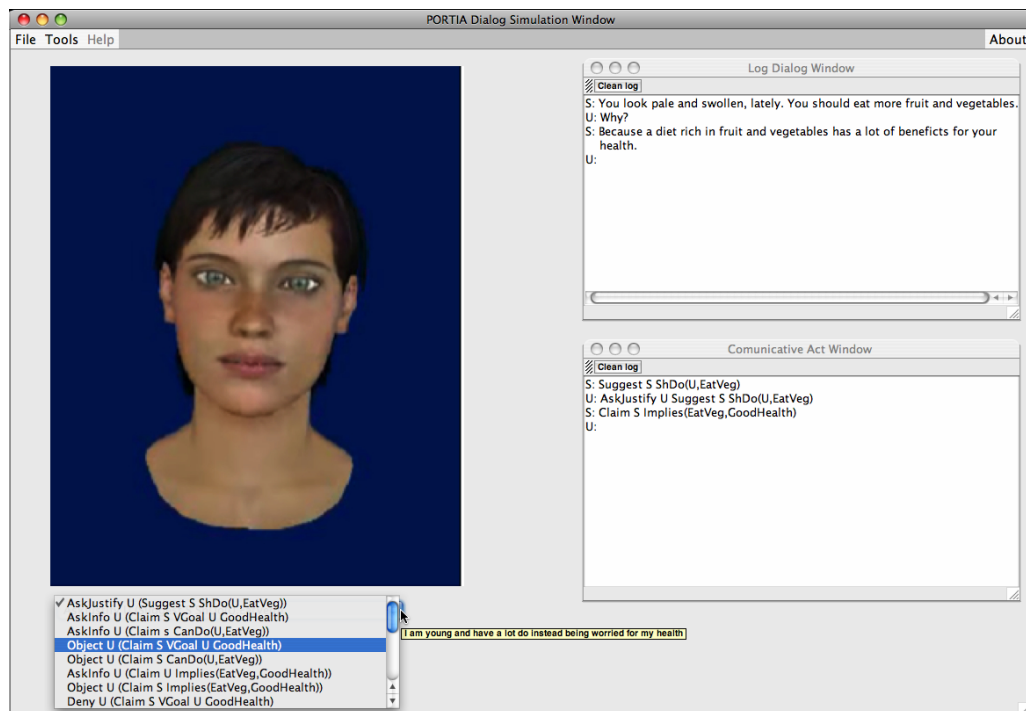


Figure 6.38: The PORTIA's Dialog Simulation Window

The following is the persuasion message played by ECA:

“You look a bit pale and swollen, lately! You should eat more fruit and vegetables because I know that you take care of your health and a diet rich in fruit and vegetables has a lot of benefits on your health. In fact, FDA says that they are very important for health and FDA is the U.S. government for drug and food, it is an authoritative voice. In addition, a dinner with fresh and tasty salads is easy to prepare and superb to spend good time with friends. In fact, this is well known by the majority and no evidence there is against. I’m sure you can do it if you wish. In fact, I know that you are a good cook!”

The following is an example of persuasion dialog that can be generated from the plan in Figure 6.36.

S: *You look a bit pale and swollen, lately! You should eat more fruit and vegetables.* ((Inform S LookPale(U)) and (Inform S LookSwollen(U)). (Suggest S ShDo(U,EatVeg)))

U: *Why?* (AskJustify U (Suggest S ShDo(U,EatVeg)))

S: *Because a diet rich in fruit and vegetables has a lot of benefits on your health.* (Claim S Implies(U,GoodHealth))

U: *I'm young and have a lot to do instead being worried for my health!* (Object U (Claim S VGoal U GoodHealth))

S: *I think that you take care of your health. In fact I know that you make sport and periodical check ups.* ((Claim S VGoal U GoodHealth). In fact (Remind S MakesSport(U)) and (Remind S MakesRegularCheckUps(U)))

U: *I don't believe that fruit and vegetables are good for my health.* (Object U (Claim S Implies(U,GoodHealth)))

S: *FDA says that they are very important for health and FDA is the U.S. government for drug and food, it is an authoritative voice.*
 ((Inform S Say(FDA,Implies(a,g)) and
 (Inform S ExpertSource(FDA,EatVeg,GoodHealth)),
 Inform S BelievableSource(FDA,EatVeg,GoodHealth)))

U: *But cooking vegetables is boring.* (Object U (Claim S CanDo(U,EatVeg)))

S: *I'm sure you can do it if you wish. In fact I know that you are a good cook!*
 ((Claim S CanDo(U,EatVeg)). In fact (Remind S GoodCook(U)))

U: *I prefer spending my time among the people and making new friends.*
 (Deny U (Claim S VGoal U GoodHealth))

S: *A dinner with fresh and tasty salads is easy to prepare and superb to spend good time with friends.* (Claim S Implies(U,MakeFriends))

U: *Ok. I will try. Thanks for your suggestions.*
 (Commit U (Suggest ShDo(U,EatVeg))).

6.3.2 Example 2

Let us consider the following starting conditions.

U is a *female over 40 years* who has a high sense of *respect for others* and is engaged in social activities that *concern the others wellbeing*. Moreover, she has enough *free time*.

PORTIA propagates the U's evidence into her EBN-KB and infers that '*to support farmers*' is the presumed most important goal to U. The associated emotional persuasion strategy seems to induce in U's mental state the desired level of intention to eat healthier and then a pure emotional strategy could be more effective to U. In addition, HP decides not to select other arguments in support of the strategy. Therefore, PORTIA selects a pure strategy focusing on emotional goal of supporting farmers as the most promising persuasion strategy to U (Figure 6.39).

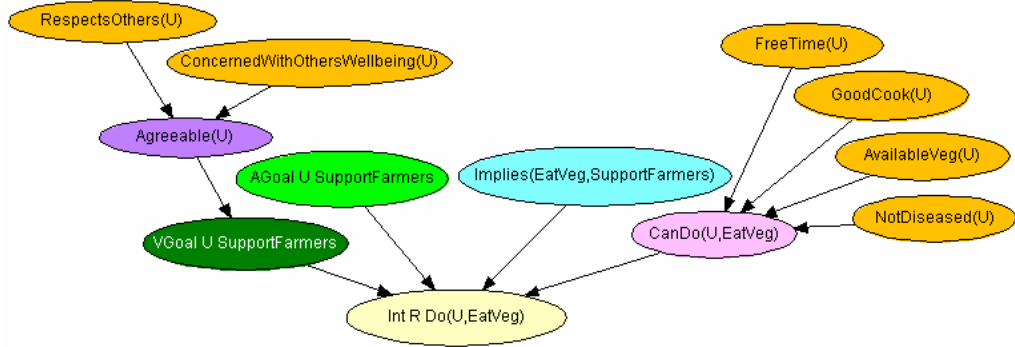


Figure 6.39: The BN used by PORTIA to simulate the effect of selected strategy on U's mental state

PORTIA explores the BN in order to select the EAPs to combine in the DP. According to the probability value of the valued goal, she decides to translate the *vgoal_supportfarmers EBN* with the variant of Goal-strengthening plan which includes a specific reference to the inconsistency between U's goal and behavior as a form of encouragement to a more consistent behavior.

The tree in Figure 6.40 represents the DP built by PORTIA to express the arguments of the selected persuasion strategy.

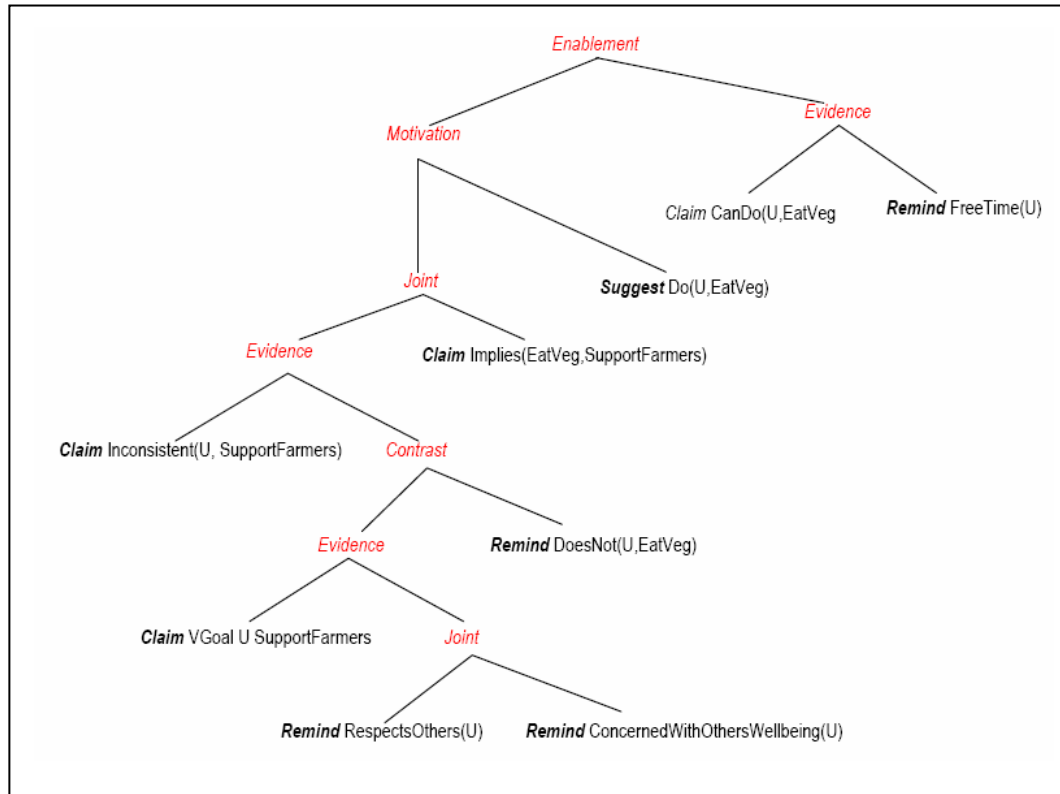


Figure 6.40: The tree representation of the DP

The following is the PORTIA's persuasion message produced after the application of the pruning rules:

"I'm surprise! You have a high sense of respect for others and are engaged in social activities that concern the others wellbeing and then, you almost exclude fruit and vegetables from your diet? Maybe you don't know that eating them you contribute to support farmers and the environment! Come on! You can, if you wish. In fact I know that you have enough free time.

6.4 The PORTIA's Architecture

PORTIA considers two main Knowledge Bases: *Reasoning KB* and *Argumentation KB*. Figure 6.41 represent the PORTIA's architecture.

To reason on a representation of U's mental state PORTIA employs the *Persuasion Strategies KB* and the *User Model KB*. Both the KBs are represented as sets of EBNs. An EBN is an *Object-Oriented Belief Network* (OoBN), that is, a network that, in addition to the usual nodes, contains *instance nodes*. An instance node is a node representing an instance of another network. In other words, an instance node represents a subnet or, following standard object-oriented terminology, may be referred to as a *class*. An instance node connects to other nodes via some of the (basic) nodes in the instance of the network. These nodes are known as *interface nodes*. Interface nodes are subdivided into a set of *input nodes* and *output nodes*. Input nodes of an instance of a network are not real nodes but only to be considered as placeholders for (basic) nodes of the network(s) containing instances of the network. These basic nodes are said to be *bound* to the input nodes (and vice versa). Output nodes of an instance of a master network are real nodes that can be specified as parents of nodes in the network containing the instance node or can be bound to an input node of another instance node of the network. Of course, the network of which instances exist in other networks can itself contain instance nodes, whereby an object-oriented network can be viewed as a hierarchical description (or model) of a problem domain.

EBNs are enabled by Hugin¹⁴ that is a useful technology to deliver advanced solutions for decision making under uncertainty. I used the Hugin Lite version. EBNs are built through Hugin Graphical User Interface Tool and

¹⁴ www.hugin.com

manipulated through Hugin's APIs. The last are powerful interfaces to dynamically build the BN from EBNs.

To translate the BN into a DP, PORTIA employs the *Argumentation Plans KB* that is represented as sets of EAPs. EAPs are XML files and are manipulated through JDOM that is, a java library for XML manipulation.

Reasoner Module and Arguer Module, as well as the interaction between them, are implemented in Java: this platform independence insures its reuse in other implementation contexts and dialogue systems.

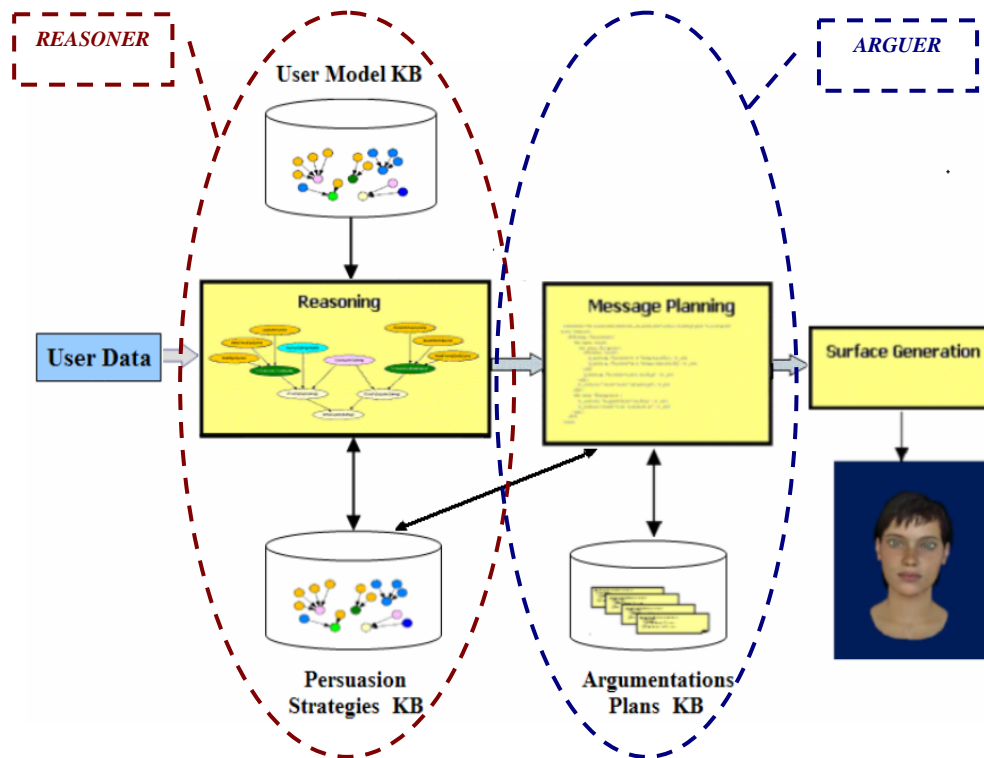


Figure 6.41: The PORTIA's architecture

Moreover, PORTIA integrates two pre-existing components: A simple surface generator to translate individual communicative acts and rhetorical relations in the TP into natural language sentences tagged with APML language [40], and an ECA to player the sentences. The tools were previously

implemented by the Research Group on Intelligent Interfaces of the University of Bari. The ECA, called Valentina, is a talking-head character with a realistic and pleasant aspect, which shows consistent facial expressions (for example, lips smiling, eyes looking downwards, arching of the eyebrows, etc.) and whose believability had been successfully evaluated [43]. Facial expressions, as well as the whole agent's behavior, are produced by giving as input the dialogue moves, tagged using the APML language [40]. An ad hoc wrapper enables translating 'meanings' in the input strings into agents' expressions ('signals'). The meaning-signal table is represented as a XML file and may be varied, so as to enable endowing the agents with various 'personalities' in pronouncing their moves. The character is implemented with PeoplePutty (distributed by Haptik¹⁵) for the body, and Microsoft TTS and Loquendo¹⁶ TTS respectively as English and Italian text-to-speech synthesizer.

¹⁵ www.haptik.com

¹⁶ www.loquendo.com

Chapter 7

Experimental Evaluation

The chapter describes a simple experimental study that should be considered as a first step towards assessing of the effectiveness of Portia. Previous studies have proved that evaluating the effectiveness of persuasion system is not easy [128] and may require long observations time of the user's behavior in order to exclude from the persuasion process the influence of external factors [10]. Therefore, before to design a complex experimental study that considers all the variables involved in the evaluation study and their correlation, I performed an empirical evaluation study in which I compared the motivational impact of a persuasive message generated by PORTIA and conveyed by Valentina with the same message presented through a text. The aim of this study was to investigate whether a message conveyed through an ECA may be considered more persuasive than a textual one.

Results of research in the field of conversational agents in the last ten years show that ECAs have been used as a new metaphor of Human Computer Interaction in several application domains. For example, ECAs have been mostly used with the role of tutor [9], personal trainer [11], healthy living advisor [44], counselors [87] and so on. In all these systems ECAs contribute

to give to the user the illusion of cooperating with an expert partner rather than just using a tool. A possible reason for this choice may depend on the fact that the interaction with an ECA has a higher motivational impact than more traditional interaction modalities [77] since it allows the instauration of a long-term social relation with the computer application [10]. In order to investigate the actual effectiveness of communication employing ECAs, several studies have been performed (for example [45, 21, 160]). From their results it is not possible to have an absolute evidence of ECAs efficacy as an interaction metaphor: apparently, their success depends not only on the ECA conversational capabilities but also on the main task and goal pursued in the application. Recently, several systems have been implemented in which ECAs aim at inducing behavioural changes in users, role which traditionally was filled by coaches or therapists, using persuasion strategies.

Starting from this perspective I wanted to investigate whether the motivational impact of a persuasion message conveyed by an ECA is higher than the one presented through a text.

To evaluate in which modality the message is more effective I used a questionnaire that measured a broad range of indirect aspects [97; 7], like as the subjective ratings of the information quality of the message, and the measure of the subject's perception of the persuasion strength of the message. Moreover, in case the message was conveyed by an ECA, I also investigated on the subject perception of the agent.

7.1 The Experimental Study: The method

7.1.1 Participants involved in the study

Participants involved in the study were recruited from the student population at the High School “ITC Romanazzi” (scientific background) and at the Scuola Superiore per Mediatori Linguistici (background in humanities), both located in Bari. In particular, they were selected so as to have thirty subjects with basic skills in computer science, and thirty subjects with less confidence in using a computer. Participants were Italian aged between 16 and 25, equally distributed by gender. According to previous studies on ECAs [28], I decided not to involve computer scientists in the study. They have a high level of experience, and knowledge about trends of research in HCI and artificial intelligence and therefore, they are more interested in evaluating characters' performance (that is, expressiveness, gestures, voice, etc.) rather than the content of the message conveyed. Moreover, their poor expectations about the ability of an ECA to actually manage a dialogue simulation induce them to challenge the application rather than enjoying the interaction.

7.1.2 Study design

The experimental setting was designed to be a 2-by-2 study where the variables involved were skills and background (high school with computer science skills vs. humanities) and output modality chosen for conveying the persuasion message (ECA vs. text). Therefore, the design was a between subject study with two conditions. Subjects were divided in two groups. Each group was composed by 30 subjects in total, 15 of them coming from the high school group and 15 coming from humanities. I administered to the first group

the message in the textual modality and to the second group the ECA modality. Participants were involved individually.

7.1.3 Preparation of material

The first material I produced was a message that reflects the strategies applied by PORTIA to formulate a persuasion message. To this aim, I made some assumptions about our subjects, including hypothesis on the presumed goal's value. In particular, consistently with the young age of participants, I supposed some facts about their life style like “playing sport”, “undergoing check ups” and “watching TV programs about health care”. Moreover, I make some assumption about their personality traits, as feeling comfortable around people. Furthermore, they live in Puglia that is a region of Italy in which good fruit and vegetables are available in large quantities.

All this information about the hypothetical user was given to PORTIA that computed the degree of importance of the various -rational and emotional- goals. The system inferred that, although ‘*to be in good health*’ was the presumed most important user goal, the associated rational persuasion strategy did not seem to induce the desired level of intention to eat healthier. Therefore, PORTIA selected the goal with the highest value among the emotional goals and inferred that the two candidate goals, on which the persuasion strategy will focus, were: (i) the rational goal ‘*to be in good health*’ and (ii) the emotional goal ‘*to make friends*’.

Hence, PORTIA selected a mixed persuasion strategy as the most promising one, to persuade our hypothetical user. This started with a suggestion to eat more fruit and vegetable. Then, it combined rational with emotional *induction of intentions strategies* which were supported by a specific reference to the inconsistency between user's beliefs and goals and his

behavior. Each induction of intentions strategies was encouraged by mentioning the relationship between the action suggested and the user's goal, that is, by an *Induction of beliefs strategy* that appeal to Expert Opinion for rational goal, and to Popular Opinion for emotional goal. The strategy ended up by proving user's ability to perform the action suggested.

PORTIA produced two versions of the message, according to the gender of the participants. The messages differed in the use of words in some sentences, according to the presumed effect on the gender. For example, in the male version the sentence *"Moreover, they contain minerals, like calcium, which are important for strong bones and tonic muscles."* was generated while in the female version the same sentence was rendered changing the appropriate argument topics (for example, *"Moreover, they contain minerals, like calcium, which are important for having strong teeth and good hair"*).

I readjusted the message generated by PORTIA through simple changes, in order to make it as general as possible so that it could be suitable for the most part of participants. For example, I modified the sentence *"I'm surprised of you! You like sports ..."* into *"I'm surprised of your generation! Most of you like sports ..."*

The following is the persuasive message produced for male participants.

*"My young friend, why don't try to eat more fruit and vegetables?
I'm surprised of your generation! Most of you like sports, undergo periodical check ups and watch TV programs about health care and then, I discover that most of you almost exclude fruit and vegetables from your diet!?...Come on!
Maybe you don't know how much more beautiful and healthy you would be if you increase the quantity of fruit and vegetables in your diet!
In fact, FDA says that they are very important for health, and FDA is the U.S. government agency for drug and food, it is an authoritative voice. Especially, fruit and vegetables are good sources of vitamin A and C, which are important for growth and repair of body tissues, to cleanse the blood and give resistance against colds. Also, vitamin A and C decreases the risk of coronary heart*

diseases and stomach cancer. Moreover, they contain minerals, like calcium, which are important for strong bones and tonic muscles. In addition, a dinner with fresh and tasty salads is easy to prepare and superb to spend good time with friends. In fact, everybody knows that and there is no evidence against this. I'm sure you can do it if you wish. In fact, I know that you live in a place in which good fruit and vegetables are available in large quantities and you can buy them in every corner of city!"

The two versions (male vs. female) of the persuasive message were manipulated in order to satisfy the two experimental conditions: two versions of simple text in electronic form and two videos of the message conveyed by Valentina.

To conduct the evaluation, I prepared two questionnaires (Appendix D): an electronic-based *pre-test questionnaire* and a paper-based *post-test questionnaire*. The former enabled to collect data about participants, including gender, background, level of knowledge on healthy eating, and facts about their life style and personality traits. It consisted of four Likert scale (from 1 to 5) and three multi-choice questions. The purposes of the pre-test questionnaire were threefold. First, to exclude that possible differences obtained in the post-test were due to difference in the healthy eating knowledge. Second, to give to the participants the illusion to evaluate a user-adapted system: in fact, participants were told the results of the pre-test questionnaire would have been used to generate a personalized message (actually, the message was generated according to the assumptions about the hypothetical user described above). Lastly, data about the subject gender allowed selecting the type of message accordingly.

The post-test questionnaire enabled to evaluate how the persuasion message was perceived as effective. The questionnaire was divided in three main parts, each of them investigated a specific aspect.

To measure the ratings of the **information quality** of the message, I included questions about degree of satisfaction, helpfulness, and easiness of the information received (with a Likert scale from 1 to 5).

To measure the *perception of the persuasion strength* of the message, I included questions about perceived persuasiveness, reliableness, and validity of the information received (with a Likert scale from 1 to 5).

To measure the *degree of recalling*, I included questions about recalling of words used in the message, as well as, effects on health and effects on strength. All the questions were single choice questions (for example, Based on the information received, these ailments are important for strong: a) teeth b) skin c) toenail d) muscles).

Finally, to assess the *perception toward the ECA* itself, I introduced questions about the perceived intelligence, believability, reliability, and helpfulness of Valentina (with a Likert scale from 1 to 5). Obviously these questions were present only in the ECA condition.

To give the participants the illusion to evaluate a working system, I built a simple Flash Application to display the pre-test, to allow participants to fill out the questionnaire, and to display the simple text or the video. Post-test was dispensed in paper form.

7.1.4 Procedure

As explained in the study design section, subjects were divided in two groups. Each group was composed by 30 subjects in total, 15 of them coming from the high school group and 15 coming from humanities. I administered to the first group the message in the textual modality and to the second group the ECA modality. Participants were involved individually.

After entering in the room, participants were invited to sit down in front of a computer and to follow the instruction displayed on the monitor. First, they received a short explanation describing the purpose of the experiment, that is, to evaluate a persuasion system that produces a message on the bases of their answer to the pre-test questionnaire. Then they filled out the pre-test. Afterward, they received the persuasive message. In the text-base experiment, subjects read the text on the monitor, while in the ECA-base experiment, they listened the message conveyed by Valentina. Finally, they received the post-test questionnaire and filled out it. At the end of the experiment subject were fully debriefed.

7.2 Results

I collected, overall, sixty pre-test questionnaires and sixty post-test questionnaires. The last were divided according to the evaluation modalities (text vs. ECA).

The analysis of the pre-test questionnaire data confirmed that possible differences obtained in the post-text were not due to differences in the healthy eating knowledge of the participants. In average, all participants were interested in information about diet, knew the importance of a correct diet even if the majority of them did not follow it (Table 7.1). This confirms our assumptions about the hypothetical user, described in the study design section.

To compare the motivational impact of the persuasion message in the two output conditions, I analyzed post-test questionnaire data using a t-test.

Results (Table 7.2) showed that the persuasion message conveyed through Valentina received an overall better evaluation than the text-based version of the same message. However, differences in the evaluation were not statistically significant for all measures.

Gender	F	48%	% of participants
	M	52%	
Interest in Diet	avg	4.5	On a Likert scale from 1 to 5
Importance of Diet	avg	4.7	
Follow correct Diet	avg	2.9	
User's eating habits	Grains	4.2	
	Proteins	3.3	
	Fruits and Vegetables	2.7	
	Fat and Sweets	4.9	
User's Characteristics	Play sport	60%	% of participants
	Make check ups	65%	
	Watch Health Care TV programs	68%	
	Follow a diet	42%	
	Wear beautiful clothes	38%	
	Feel comfortable around people	73%	
	Feel in a depressed mood	0%	
	Has Free Time	59%	
	Like Cooking	27%	

Table 7.1: Summary of pre-test results

		Text	Valentina	t value	One-sided p
Satisfaction	avg	3.9	4.1	1.05	0.30
	std.dev	0.66	0.80		
Helpfulness	avg	3.6	3.9	1.40	0.17
	std.dev	0.81	0.84		
Easiness	avg	4.0	3.3	2.77	0.008
	std.dev	0.85	0.92		
Persuasiveness	avg	3.9	4.4	2.67	0.01
	std.dev	0.89	0.67		
Reliability	avg	3.5	4.2	2.77	0.008
	std.dev	1.22	0.77		
Validity	avg	3.9	4.1	1.09	0.28
	std.dev	0.90	0.76		

Table 7.2: Results of t-test with $\alpha = 0.01$

In particular, no significant differences occurred between Valentina and text in the evaluation of the *information quality* of the message. As shown in Figure 7.1, participants involved in ECA-based experiment were more satisfied

of the information received which was considered more helpful with respect to the participants involved in the text-based one. At the same time, subjects considered the message presented through a text as easier to understand than the same conveyed by Valentina.

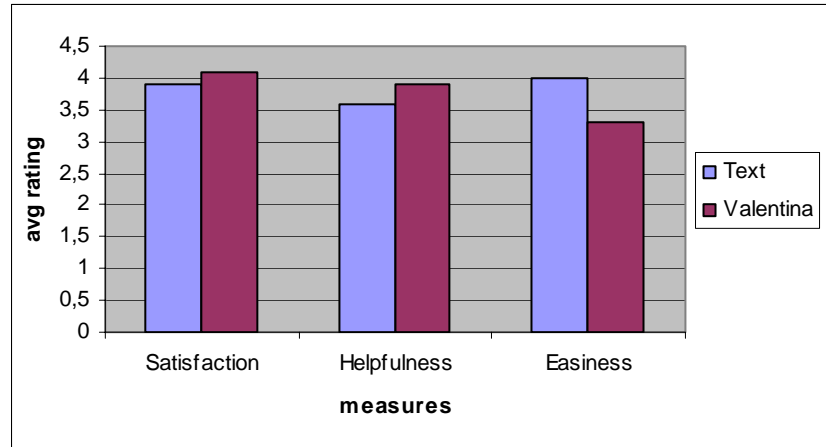


Figure 7.1: Perception of subjects towards the Information Quality of the message

On the contrary, significant differences occurred between Valentina and text in the evaluation of the *perception of the persuasion strength* of the message. As shown in Figure 7.2, participants involved in the ECA-based experiment perceived the message as significantly more persuasive and reliable rather than those involved in the text-based one.

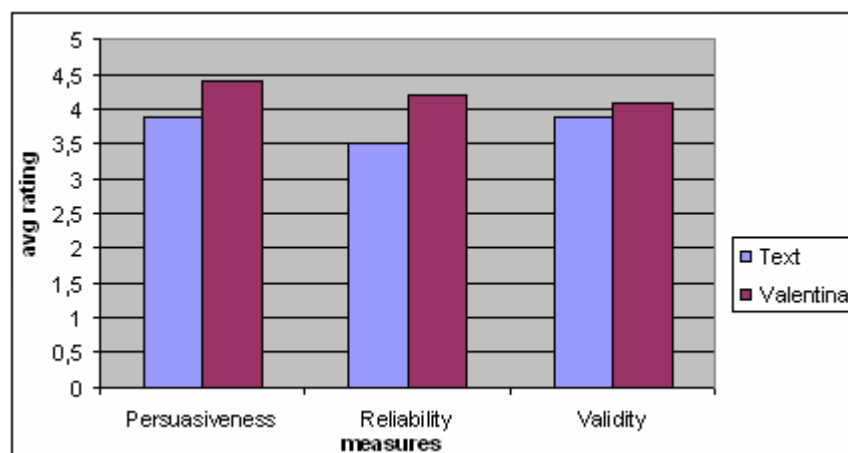


Figure 7.2: Perception of subjects towards the persuasion strength of the message

Finally, the recalling degree (words, healthy food and effects on body) resulted higher for participants that received the message in the text form. Figure 7.3 represents the proportions of correct answers given by subjects.

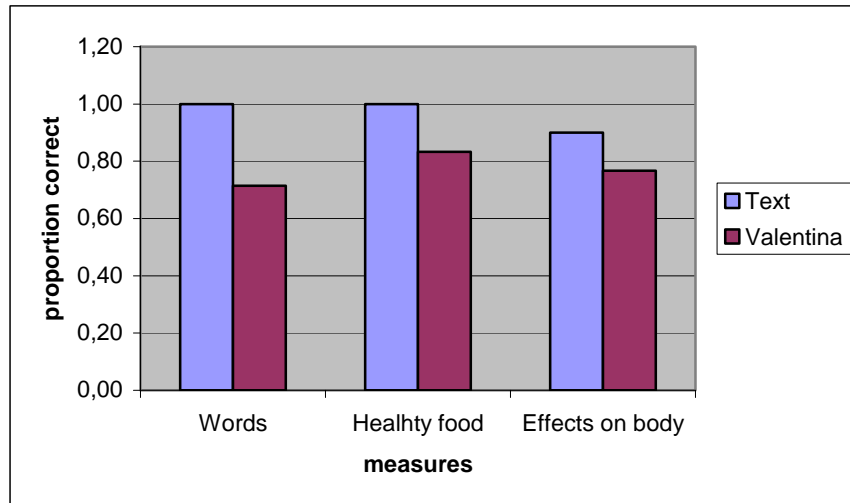


Figure 7.3: Subjects' memory performance for the two presentation conditions.

The evaluation of Valentina itself received an overall positive rating. In particular, in the Likert scale from one to six, the ECA was perceived as intelligent (3.7), likable (4.2), and helpful (4.6).

7.3 Discussion and conclusion

Results of this study are based on both (i) self-report measures about perceived information quality and persuasive strength of the message and (ii) objective measures of recalling degree about the informative content of the message.

In the Healty Eating Domain, in fact, a persuasive attempt can be considered as effective when the user changes her beliefs and therefore her behavior. According to the results about objective measures of recalling, reading a text can be considered more effective than listening and looking at an

ECA. In fact, participants' cognitive performances were higher when the persuasive message was conveyed using text rather than Valentina. A possible explanation for this phenomenon is that users involved the text-based experiment focus more on the informative context of the message. This is coherent with findings of some previous research [161, 7] which show how the presence of the face may distract participants and consequently lead them to poorer memory for target information.

However, this result is in contrast with self-report measures: subjective evaluations were more positive for the animated agent in terms of participants' perception of helpfulness, satisfaction, persuasiveness and reliability. In particular, a higher reliability of Valentina may be explained with the fact that most of users think that a machine can not lie and look at the agent as a kind of competent expert partner. On the contrary, text could be manipulated by humans.

If we want to learn a lesson from results of the present study, we could make the hypothesis that textual messages are more appropriate for simple 'information giving' tasks in which the main goal is to ensure that users remember correctly the information provided. However, subjects involved in the experiment perceived the message conveyed by Valentina as more reliable and persuasive. Therefore an ECA might be more appropriate for complementing textual messages and engaging users in a social relation in order to increase the effectiveness of the persuasion strategy.

In this perspective, it could result useful to distribute the message content along different media: the informative part could be communicated using a text and/or a picture while the persuasion part of the message that reflects the social and emotional intelligence of the reasoner could be conveyed by an ECA.

I am aware of the limitations of the study: first of all, the message was built so as to reflect a hypothetical user's stereotype, instead of being tailored to the specific characteristics of each subject involved in the experiment. It would be worth to investigate an experimental setting in which the message is completely user-adapted. Second, users did not have the opportunity to interact with the system: the interaction was limited to a videoclip, which the user watched passively. Probably, information recalling would improve for users involved in a dialog simulation with the ECA since they could ask for repetitions, explanations, examples and so on. These are both directions I intend to follow in a future work.

Chapter 8

Conclusion

Even if sometimes it is marked as negative, persuasion is a relatively new trend in the research community and persuasion technologies are already part of the everyday technological landscape.

Persuasion is a form of social influence. To simulate persuasion process, *persuasive intelligent interfaces* should have the social intelligence that enables them to observe the Receiver, so as to simulate the persuasion process used by humans to persuade someone to perform a given action. According to a typical aspect of the human persuasion, they should also have the capability to combine rational strategies with emotional ones and to adapt the persuasion to the context.

In this Thesis, I proposed a computational model of context and user-adapted persuasion, and presented a user-adapted persuasion prototype, called PORTIA developed to test the model.

The model is based on a theory of *a-rational* persuasion, and the strategies represented in the model are the result of a combination of theoretical and empirical background. The key points of the proposed model are the separation between *reasoning* and *argumentation* phases in the persuasion

process, and the use of *Belief Networks* to represent the uncertainty inherent in this form of practical reasoning. The challenge of the model is to provide intelligent interfaces capable to simulate the persuasion process used by humans to persuade someone to perform a given action. That is, *persuasive intelligent interface* with the capability of reasoning and evaluating the persuasive power of different strategies to a given user, and also combining *rational* and *emotional* modes of persuasion in order to produce effective persuasion attempt in different contexts, and from monologic or dialogic viewpoints.

PORTIA is implemented following this approach. From the user's viewpoint, PORTIA is a female young character that plays the role of a 'competent friend', who knows about the user and exploits this knowledge to select the most promising strategy to induce an intention to change a user's habit or a behavior in the *Healthy Eating* domain. She considers three different knowledge bases:

- **USER MODEL**, to reason about the user's presumed characteristics. Rather than acquiring this information through direct questions, PORTIA attempts to implicitly infer it, with some level of uncertainty, from knowledge of user's personality traits and living habits. The user model includes a *specific knowledge* and a *general knowledge* component. The former collects facts about the user (evidence). The second represents criteria to infer the user's goals and abilities under conditions of uncertainty in the form of *elementary belief networks*.
- **PERSUASION KNOWLEDGE BASE**, to model rational and emotional strategies. Persuasion model is defined in term of goals and beliefs from the Persuader's perspective that may employ rational as well as emotional strategies (but also a mixture of them) to induce the user to perform a

give action. Fragments of persuasion strategies are represented, as well, with *elementary belief networks*.

- ARGUMENTATION KNOWLEDGE BASE to translate every strategy into an argument. That is, *elementary argumentation plans* are a coherent translation *elementary belief networks*, and represent the items to include in the argument, the order in which to present them, and the relationships among the various parts.

PORTIA is grounded on the distinction between a phase of reasoning and a phase of formulating an argument. I called REASONER the reasoning module, and ARGUER the argumentation module.

In the *REASONER* module, PORTIA exploits its knowledge about the user in order to compute the degree of importance of the various -rational and emotional- goals to the user, and infer the goal/goals on which focus the persuasion strategy. Then PORTIA builds a representation of the user's mental state: This enables to apply a what-if reasoning form to evaluate the persuasive power of different strategies to the user, and select the most promising strategy to induce in the user the intention to do a certain action in a given domain or to repair to its possible failure. To simulate the reasoning followed by the Persuader, a complex Belief Network is dynamically built by chaining forward several elementary belief networks.

After the reasoning on the user's mental state, in the ARGUER module, PORTIA has to construct the arguments to express the strategy selected as the most promising to the user. For this reason, PORTIA explores the complex Belief Network and decides the items to mention, their presentation order and the rhetorical relations among them. Also, she has to decide whether to include an appeal to cognitive inconsistency as a form of encouragement to a more consistent behavior. That is, PORTIA has to translate the complex Belief

Network into a coherent discourse plan. The discourse plan is dynamically built by combining the elementary argumentation plans that represent the elementary beliefs networks included in the Belief Network. The discourse plan may be employed to generate either a persuasion message or a dialog simulation between PORTIA and the user. In the first case, PORTIA translates the discourse plan into a text plan by applying some pruning rules, and generates a natural language message used as an attempt to persuade user (monologic viewpoint). In the second case, PORTIA uses discourse plan to reply to user's reactions at suggestion received (dialogical viewpoint). In both cases, outcome is rendered through a simple surface generation phase and conveyed by an ECA, called Valentina, which plays the role of a 'competent friend'. Valentina is a talking-head female character with a realistic and pleasant aspect, which shows consistent facial expressions. Subjects involved in the pilot experiment have expressed a globally positive evaluation of Valentina itself that also perceived as more persuasive than simple text.

Although the encouraging results and the contribution given by system like PORTIA to the persuasive intelligent interfaces, I think we are quite far from generating and recognizing something that has some resemblance with the richness of human persuasion messages and reactions, like the following - extracted from the corpus of persuasion messages (see Chapter 4) - in which there is more than one appeal to emotion and also irony:

*"My beloved Maria,
I know you are discouraged by the weak results of physical activity: making sport is good but whets the appetite. Diet is a necessary evil. I have a suggestion for you: rather than looking at TV ads on 'cycling for heart', 'healthy sets' and so on, with those burly and all-perfect pin-ups who make you feel a real rubbish, why don't you fish out the Artusi which is in you? Don't raise your eyebrows: kitchen is not your site of election, neither is it to me. But,*

here is the sagacity of the mature woman :-), you have your creative intelligence on your side. Do invent trendy dishes and menus. And if your husband rejects them, do invite him to address himself to the burly pin-ups. A wonderful dish of carrots with apple vinegar and supreme of asparagus, and it's done! What would you ask more to life? A bear hug. Ross"

8.1 Structure of the Thesis

In Chapter 2 after a brief introduction on the concept related to persuasion and emotion, I discussed the relevant role of emotions in persuasion. Then, I presented a brief state of the art of the different computational approaches of computer science.

In Chapter 3 and Chapter 4 I described theoretical and empirical background: in addition to the theories about argumentation and persuasion I grounded my work on the results of three experimental studies. Therefore, in Chapter 3 I investigated on two main aspects: according to the distinction between the phases of reasoning and planning, I introduced, on one hand, an overview of persuasion models -focusing on a-rational theory of persuasion-, and on the other one, an overview of the argumentation models and rhetorical theories. In Chapter 4 I presented the three experimental studies and the results of their analysis. The first study was aimed at collecting a corpus of persuasion messages with the intent to investigate on the strategies adopted by humans in producing a persuasive text. The corpus analysis proved that among the various sorts of persuasion strategies adopted by the subjects involved in the study, purely rational strategies were employed infrequently. In addition, subjects did not consider a single strategy sufficiently strong per se and they attempted to increase the overall effectiveness of the message by combining more than one strategy appropriately. The second was an evaluation study aimed at comparing the persuasion strength of some of the strategies identified in the first study.

Consistently with the corpus analysis, evaluation study proved that purely rational argumentation was not seen as an effective method to persuade, and that combine emotional issues was considered to be a more promising strategy. The third study was aimed at collecting a corpus of WoZ dialogues with the intent to define a restricted set of user's reaction to the persuasive ECA's suggestion. Although the ECA adopted a purely rational strategy during the dialog, subjects involved in the study introduced various emotional elements in their reactions, both as linguistic and acoustic sign. The results of the three studies were, in my view, evidence in favor of the a-rational persuasion: they proved that a-rational element may be founded both in persuasion strategies as so as in the user's reactions.

In Chapter 5 and in Chapter 6 I described the approach followed in modeling context and user-adapted persuasion, and the PORTIA prototype, the user-adapted persuasion system built to test the persuasion model proposed in the Healthy Eating domain.

Finally, in Chapter 7 I described the first experimental study towards assessing of the effectiveness of Portia. Evaluating the effectiveness of persuasion system is not easy and therefore, before planning a general experimental study that considers all the variables involved and their correlation, I performed a pilot experiment to investigate whether a message produce by PORTIA and conveyed through an ECA may be considered more persuasive then the same presented through a simple text. Results proved that subjects expressed a globally positive evaluation as concerning the perception of the ECA itself. Overall the study showed that while no significant differences occur between ECA and text in the evaluation of the information quality of the message, ECA was perceived as more persuasive. Contrarily, the recalling degree was higher for the text-based message than for the ECA. These results will be important in designing the general experiment.

8.2 Discussion

I am aware of the limits of my work, some of which stem from weaknesses in the a-rational theory, and others are due to including in the model only the attitudes of the Receiver.

Persuasion process is influenced by the relationship between Persuader and Receiver. It is well known that determinants of effectiveness of a persuasion process are not only the message features, but also the Source and the Receiver's features [101]. Source features are not absolute, but relative to the Receiver: a source may be more or less 'credible', 'likable', similar, 'attractive' to different Receivers. On the other hand (and maybe also because of this) Receivers may be biased towards a persuasion attempt, being skeptical, defensive or hostile, either in general or towards a particular Persuader [1]. This kind of 'resistance' to persuasion influences the Receiver's response to persuasion attempts, which may include different mixtures of rational and emotional components [33].

Again, the Persuader's attitudes, as well as his emotional state, should also be considered in the persuasion process. If a persuasion move aims at influencing the Receiver's attitude, it has been demonstrated that the Persuader's attitudes are influenced, in their turn, by the success or failure of their persuasion attempts: this is known as a referral-backfire effect, in which a persuasion failure engenders a lower susceptibility to persuasion, possibly due to problems of self-esteem or of social relation's threatening [53].

Also, the emotional strategy has a number of possible drawbacks inherent in the a-rational theory.

Emotion may characterize an unpleasant experience that may favor some form of the Receiver's resistance. As said in [96] the experience of a

negative emotion may raise emotion control processes which are very likely when the receiver has low self-esteem, or is very anxious. Yet, persuasion through arousal of emotions may fail if the Receiver detects or suspects that the Persuader is playing with her emotions: The Receiver perceives a threat to freedom. Too, the relationship between emotions and goals is not unique: an emotion may arouse more than one goal depending on the context as well as personality factors. For example, the Persuader may arouse the Receiver's shame about her shape in order to generate the Receiver's goal of saving face and induce, as a means for it, the intention to have a good appearance. Unluckily the experience of shame may be evaluated in a positively but also in a negatively way, and then generate the intention, respectively, to have a good appearance (so as to obtaining more positive evaluations of oneself from others), or to avoid social interaction (so as to avoid others' evaluation).

Such considerations highlight the need to consider a model of the Persuaders, which includes, inter alia, the knowledge of the basic components of emotions and their interrelations, as well as of Receiver's dispositions to certain emotion.

Finally, as already said, the model considers the Persuader's perspective, that is, the Persuader's plan to influence the Receiver that is not necessarily the actual effect on the Receiver's mental state. Therefore, may happen that a communicative act may produce, in different address, either a cognitive or an emotional activation of a goal, as well as, a given belief may arouse different emotions which, in turn generate and activate different goal.

8.2 Future research

According to the points discussed in the previous paragraph, future research may be oriented toward different issues. For example,

- To extend the knowledge base to a Persuader model in order to provide intelligent interfaces with the ability to have a personality, and to show their emotions. This includes a deep study about the influence of the relationship between the Persuader and the Receiver on the persuasion process.
- To extend the knowledge base with a model of emotions in order to reason on one hand on the basic components of emotions and their interrelations, and, on the other one, on the Receiver's dispositions to experience a given emotion. This should allow selecting the most appropriate goal activation strategy (either rational or emotional) to a given context.
- To study in deep the impact of different belief induction strategies on the persuasion process, and the variables related to them, in order to select the most appropriate to a given context.
- To enrich the PORTIA's knowledge base with new instance of strategies: The main difficulty in progressing with my work was to find psychological theories on which to ground PORTIA's knowledge base.
- Lastly, the domain-independence of PORTIA makes it potentially useful in different fields, ranging from sensitization campaigns on medical and social aspects (like family planning or stop smoking) to online distribution of products and e-commerce. For example, PORTIA may be used to support interactive advertising in online shopping or telephone marketing (to subscribe telephone, energy, gas and other contracts). In the first case, it might be integrated into an online shopping server in order to increase the user propensity towards the offered products and the communication effectiveness. In the second one, PORTIA might support the call-center operators by suggesting them a persuasive strategy to

employ in their telephone work. In a far future, PORTIA might become part an embodied training agent for new call-sell operators in a virtual environment. But this is only a perspective!

Although I focused my work only on generation aspect of persuasion, recognizing and interpreting the user's reactions (not only the type of reaction, but also the emotional reaction) is a fundamental, especially in dialog perspective [91, 100]. This merits a separate research project.

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Appendix A

The corpus collection study

Participants were introduced in the study through a brief description to the purpose of the experiment

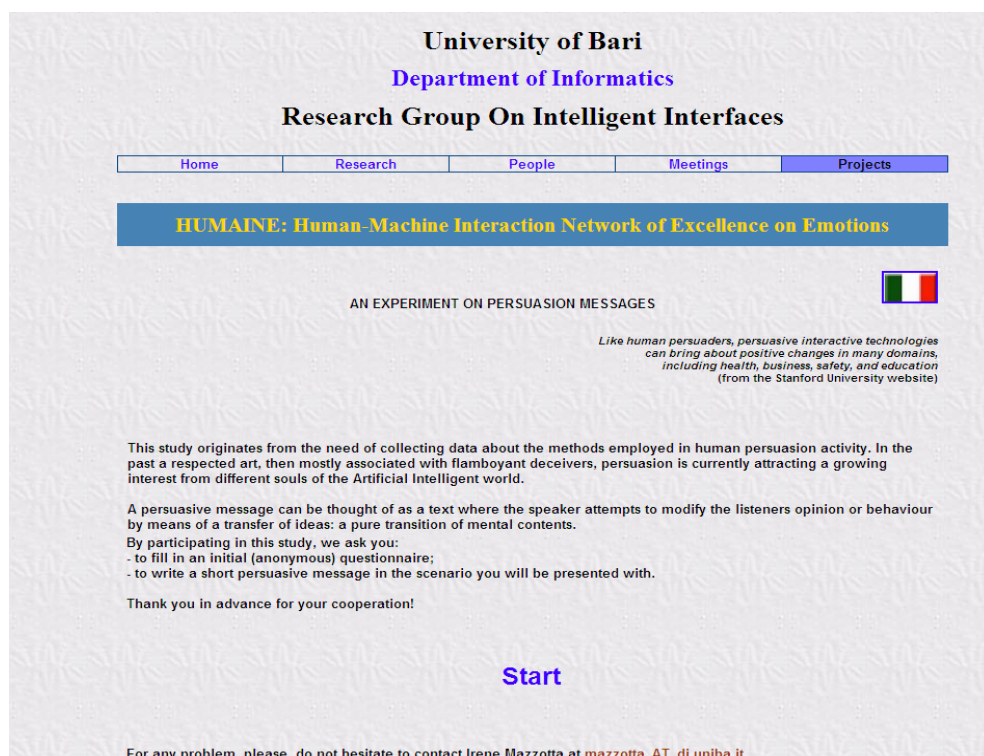


Figure A1: A screenshot of the Introduction

Participants filled out the PRE-TEST QUESTIONNAIRE aimed at assessing their level of knowledge, habits, and interest for healthy eating, in addition to their culture background.

Are you interested in information about diet?
☒ not at all ☐ a little ☐ somewhat ☐ very much

Do you think that following a correct diet is important?
☒ not important ☐ a little ☐ quite important ☐ very important

Do you think that your diet is correct?
☒ certainly not ☐ probably not ☐ probably yes ☐ yes

In which proportion the following food groups are included in your diet?
(1=none, 2=small, 3=moderate, 4=big)

Grains (rice, cereals, bread, pasta etc.)
☒ 1 ☐ 2 ☐ 3 ☐ 4

Foods rich in proteins (meat, fish, beans, poultry, eggs etc)
☒ 1 ☐ 2 ☐ 3 ☐ 4

Vegetables and Fruits
☒ 1 ☐ 2 ☐ 3 ☐ 4

Fats and Sweets
☒ 1 ☐ 2 ☐ 3 ☐ 4

How old are you?

Sex
☒ M ☐ F

What's your background?

Undergraduate student in

Other

Figure A2: A screenshot of the Pre-Test Questionnaire

Participants wrote their short persuasive message according to the scenario displayed

SCENARIO:

Grace, one of your best friends, is a 25 year old girl who follows a wrong diet. She does not eat much fruits and vegetables while tends to overeat meat, sweets and pasta.

Try to persuade her to eat more fruits and vegetables and, in doing so, don't forget that Grace is famous for her obstinacy!!!

You know the following facts: eliminating fruits and vegetables from the diet may have detrimental effects on your figure. They are good sources of vitamin A and C, and a deficiency these vitamins can lead to poor skin and hair, as vitamin C tonifies and rehydrates them. Fruits and vegetables contain minerals like calcium, whose shortage increases the risk of weak bones and teeths and slack muscles.

In addition consider that health is very important for Grace: she likes sports, undergoes periodical check ups and looks at TV programs about health care. Grace would have enough free time to cook vegetables and delicious fruit dishes.

Please, use this information to write a text (from 5 to 10 lines) to argue about your thesis.

Write your message to Grace in the window below:

Send

Reset

Figure A3: An example of Scenario

Appendix B

The evaluation study

Participants were introduced in the study through a brief description to the purpose of the experiment.

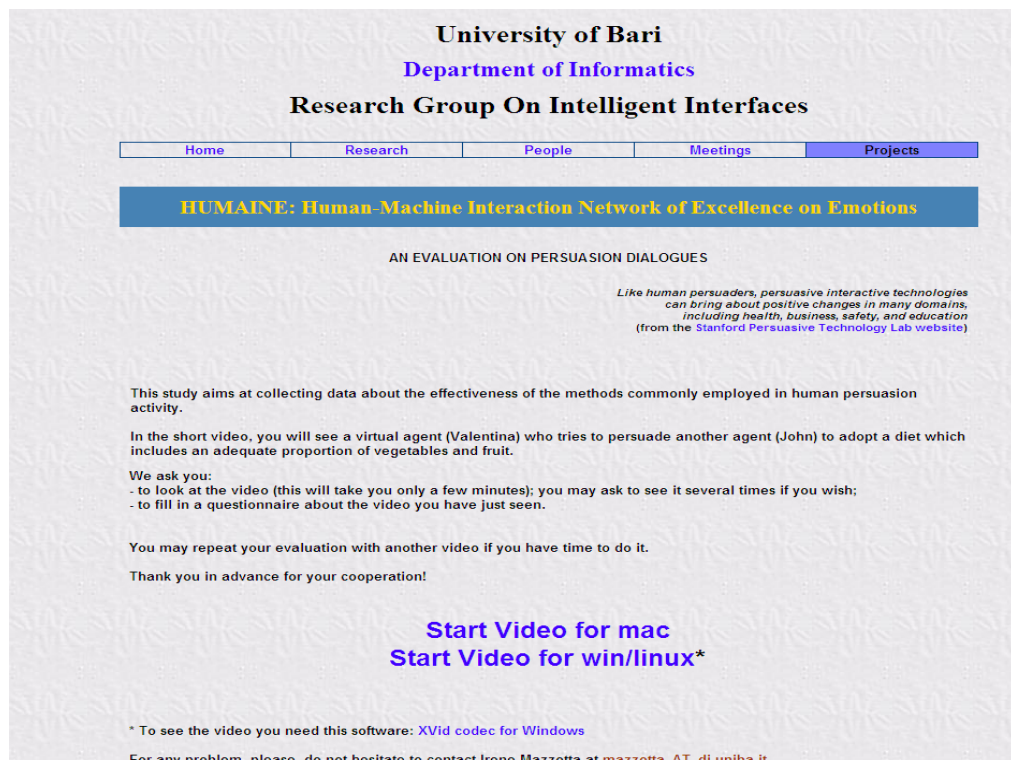


Figure B1: A screenshot of the Introduction

Participant watched a video of a virtual dialogue between two embodied agents and then filled out the POST-TEST QUESTIONNAIRE.

The screenshot shows a web-based questionnaire titled "Questionnaire". It includes a "Your name" text field, followed by three numbered questions: 1. Age (dropdown menu with "18-30" selected), 2. Gender (dropdown menu with "F" selected), and 3. Background (dropdown menu with "Computer science" selected and an "Other (please, specify)" text field). Below these is a paragraph asking the user to judge two aspects of a dialogue: "a. the characters' *performance*: their expressiveness, gestures, understandability of speech, etc;" and "b. the *content* of the dialogue." This is followed by a request to keep these aspects distinct in evaluation. Then are three more questions: 4. How did you like the characters' performance? (radio buttons for "very little", "little", "much", "very much", with "very little" selected and a "Why?" text field below); 5. Focusing now on the content, if you were in John's shoes, would you be persuaded by Alice's words? (radio buttons for "very little", "little", "much", "very much", with "very little" selected and a "Why? (please, specify)" text field below); and 6. Would you have changed anything of what Alice said? (radio buttons for "yes", "no", with "yes" selected, followed by "If yes, what would you have changed? (please, specify)" and "Why? (please, specify)" text fields). At the bottom is a "Place and date" text field, a "THANKS!" message, and a "Send" button.

Questionnaire

Your name

1. Age

2. Gender

3. Background Other (please, specify)

We ask to judge two distinct aspect of the dialogue you have just witnessed:

a. the characters' *performance*: their expressiveness, gestures, understandability of speech, etc;
b. the *content* of the dialogue.

Please try to keep those two aspects distinct in your evaluation.

4. How did you like the characters' performance?
☒ very little ☐ little ☐ much ☐ very much
Why?

5. Focusing now on the content, if you were in John's shoes, would you be persuaded by Alice's words?
☒ very little ☐ little ☐ much ☐ very much
Why? (please, specify)

6. Would you have changed anything of what Alice said?
☒ yes ☐ no
If yes, what would you have changed? (please, specify)
Why? (please, specify)

Place and date

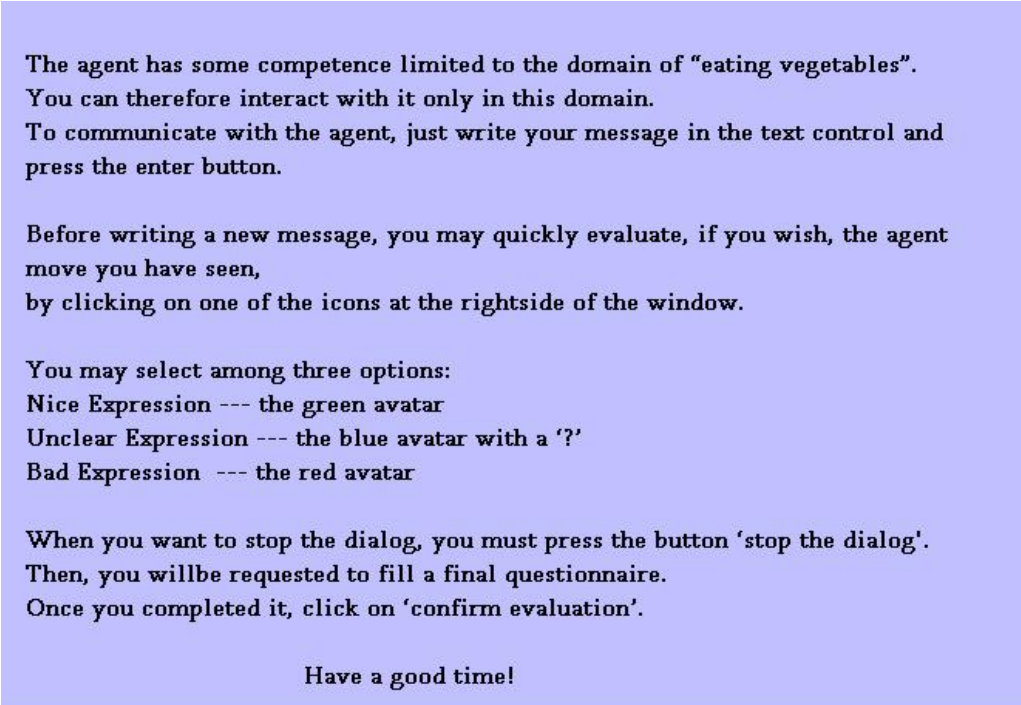
THANKS!

Figure B2: A screenshot of the Post-Test Questionnaire

Appendix C

The WoZ study

Participants were introduced in the study through a initial scenario describing the application domain and the dialogue goal.



The agent has some competence limited to the domain of "eating vegetables".
You can therefore interact with it only in this domain.
To communicate with the agent, just write your message in the text control and press the enter button.

Before writing a new message, you may quickly evaluate, if you wish, the agent move you have seen,
by clicking on one of the icons at the rightside of the window.

You may select among three options:
Nice Expression --- the green avatar
Unclear Expression --- the blue avatar with a '?'
Bad Expression --- the red avatar

When you want to stop the dialog, you must press the button 'stop the dialog'.
Then, you willbe requested to fill a final questionnaire.
Once you completed it, click on 'confirm evaluation'.

Have a good time!

Figure C1: A screenshot of the Introduction

Participants filled out a PRE-TEST QUESTIONNAIRE aimed to assessing their knowledge, and their interest to know about healthy diet.

1)	Do you think to know what is a healthy diet?
	1-----2-----3-----4-----5-----6
	certainly not certainly
2)	Do you think that your diet is correct?
	1-----2-----3-----4-----5-----6
	certainly not certainly
3)	Do you think that following a correct diet is important?
	1-----2-----3-----4-----5-----6
	certainly not certainly
4)	Are you interested in information about diet?
	1-----2-----3-----4-----5-----6
	certainly not certainly
Age	18-30 31-50 50
Gender	M F
What is your Background? _____	

Figure C2: The pre-test questionnaire

Participant interacted with the ECA, and then filled out the POST-TEST QUESTIONNAIRE to evaluate both the quality of the dialogue and the ECA.

Not at all Extremely

1) How credible do you think the dialog was?

2) How easy do you think that the agent's messages were to understand?

3) How satisfied are you with the information provided by the agent?

4) How persuasive do you think the agent's suggestions were?

5) How trustworthy do you think the agent was?

6) How helpful do you believe the agent was?

7) How intelligent do you believe the agent was?

8) How credible do you believe the agent was?

9) How likable do you believe the agent was?

10) How competent do you believe the agent was?

Insert your comments

Confirm the Evaluations

Figure C3: A screenshot of the Post-Test Questionnaire

Appendix D

The Experimental Evaluation

After receiving a short explanation describing the purpose of the experiment, participants were invited to fill out the pre-test. This enabled to collect data about them, including gender, background, level of knowledge on healthy eating, and facts about their life style and personality traits. The purposes of the pre-test questionnaire were threefold:

- a) To exclude that possible differences obtained in the post-test were due to difference in the healthy eating knowledge.
- b) To give to the participants the illusion to evaluate a user-adapted system: in fact, participants were told the results of the pre-test questionnaire would have been used to generate a personalized message (actually, the message was generated according to the assumptions about the hypothetical user described above).
- c) To know data about the subject gender in order to select the type of message accordingly.

1) Are you interested in information about diet?
1 2 3 4 5
not at all very much

2) Do you think that following a correct diet is important?
1 2 3 4 5
not at all very much

3) Do you think that your diet is correct?
1 2 3 4 5
not at all very much

4) In which proportion the following food groups are included in your diet?

a) Grains (rice, cereals, bread, pasta etc.)
1 2 3 4 5
none big

b) Foods rich in proteins (meat, fish, beans, poultry, eggs etc)
1 2 3 4 5
none big

c) Vegetables and Fruits
1 2 3 4 5
none big

d) Fats and Sweets
1 2 3 4 5
none big

5) Give me about you (you can sign more than one)

☐ I play sport regularly
☐ I make periodical check ups
☐ I often look at TV programs about health care
☐ I am ever on diet
☐ I like to wear beautiful dresses
☐ I feel comfortable around people
☐ I often feel blue
☐ I have some time free during the day
☐ I like cooking and do it with good results

6) Age _____

7) Sex M ☐ F ☐

8) What's your background? (Please, sign only one)

Undergraduate Student ☐ Degree ☐ PhD/PhD Student ☐

in _____

Figure D1: The pre-test questionnaire

After receiving the persuasive message (through ECA or simple text), participant received the post-test questionnaire and filled out it.

The post-test questionnaire enabled to evaluate how the persuasion message was perceived as effective in terms of rating of the *information quality* (questions 1), 2), and 3)), *perception of the persuasion strength* (questions 4), 5), and 6)), and *degree of recalling* (questions 7), 8), and 9)). The following is the post-test questionnaire to evaluate the male version of the persuasive message.

-----POST-TEST-QUESTIONNAIRE -----

- 1) How satisfied were you of the information received?

1	2	3	4	5
not at all				very much
- 2) How helpful was the information received?

1	2	3	4	5
not at all				very much
- 3) How easy did you think the information received was to understand?

1	2	3	4	5
not at all				very much
- 4) How persuasive did you think the information received was?

1	2	3	4	5
not at all				very much
- 5) How reliable did you think the information received was?

1	2	3	4	5
not at all				very much
- 6) How valid did you think the information received was?

1	2	3	4	5
not at all				very much
- 7) Which of the following words was mentioned in the message? (Please, circle the word you recall)

a)	Vitamin A	Vitamin B	Vitamin C	Vitamin E
b)	magnesium	calcium	potassium	sodium
c)	EFSA	FDA	CFSAN	WHO
d)	blood	heart	stomach	bones

- 8) Based on the information received, you may be more beautiful and healthy if you increase in your diet the quantity of (please, sign only one):
- a) meat and fish
 - b) fruit and vegetables
 - c) grains and fiber
 - d) fats and sweets
- 9) Based on the information received, these aliments are important for strong (please, mark only one):
- a) teeth
 - b) skin
 - c) hair
 - d) muscles
-

Finally, participants involved in the ECA condition of the experiment received a second post-test questionnaire to evaluate the *perception toward the ECA* itself.

-----ST-TEST-QUESTIONNAIRE for ECA perception-----

Now, think about the conversational agent without consider the information provide.

- a) How intelligent did you think the conversational agent was?
- | | | | | |
|------------|---|---|---|-----------|
| 1 | 2 | 3 | 4 | 5 |
| not at all | | | | very much |
- b) How believable did you think the conversational agent was?
- | | | | | |
|------------|---|---|---|-----------|
| 1 | 2 | 3 | 4 | 5 |
| not at all | | | | very much |

