MASTER THESIS

COMPUTATIONAL MODELLING OF SUSPECT BEHAVIOUR IN POLICE INTERVIEWS

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Foreword

The topic of simulating a police interview first got my attention during the elective course *Conversational Agents*, a course in which we discussed agents that can have conversations with humans. During this course we were shown different applications of conversational agents and how they are used in training simulations. One of those examples was a training exercise for soldiers to make correct decisions in non-standard situations found in local culture, something that sparked my curiosity. The course focused heavily on the stance theory by Leary which in turn further grabbed my attention. After two weeks I realised this was the direction I wanted to go with my master thesis and asked the teaching staff Rieks op den Akker and Merijn Bruijnes to become my supervisors for my Research Topics. After a successful conclusion of both the research topics and conversational agents courses we decided we would continue together by means of this Master Thesis. During this thesis I have performed a literature study on social behavioural influencing factors, police interviews and interrogations, deceit detection and more. After that I created a software system that interprets abstract factors that describe a question posed by a police officer and in turn models a response that a believable suspect could give to such a question. I have conducted an experiment to see if the model actually represents a believable suspect and finished by discussing the results, the model and future work that should assist us in completing an actual tutoring system for the Dutch police.

Contents

Chapter 1

Introduction

Proper use of interview techniques during police interviews is an important way for police officers to uncover the truth about a crime or even get a confession of guilt. These techniques usually mean that police officers speak with suspects in such a way that they cooperate and share valuable information. This is not unlike behaviour we, as humans, show in our day to day activities where we try to change the behaviour of other people towards something that is more beneficial to our own needs [35]. Currently, police officers are often taught interview theories and techniques and are trained in the practical use of these techniques through the use of actors. These actors are recruited to play the role of suspects and cadets are able to practise on them, but there is not enough time to do this repeatedly and often. This is both a costly and time inefficient method for practical training. After some practise with actors most follow-up training is through watching others interview actors. The need for repeated training is shown by Lamb et al. in her study on the effects of intensive training and ongoing supervision for high quality investigative interviews [27]. This means the police needs the means to continuously train their cadets (and even detectives) in investigative interviewing. Creating a system that allows an Embodied Conversational Agent (ECA) to take on the role of a suspect during a police interview can help with this problem. It allows for a training simulation that every cadet can take and through its use, gain practical experience in the field of suspect interviewing.

A simulation system of this magnitude requires a wide variety of parts to create the whole. A graphical representation of the suspect, a realistically sounding text to speech conversion to allow the suspect to say things to the police and at the same time, an efficient speech to text conversion to allow the system to work with the input that a police officer provides. These are some examples of technical parts that need to be build and implemented in such a system. These factors present the observable workings of the simulation, but evenly important are the internal mental workings of the simulation. How does the suspect decide what to say and when to say it? How do we generate the social behaviour that we expect a suspect to show during such a police interview? The possibility of using human psychology constructs to define and/or shape behaviour for virtual characters has been studied by McRorie et al. [30] and shows us its potential. Being able to automatically generate this social behaviour is an important factor

in building a virtual agent that is meant to interact with humans [45]. Building such a model to imitate human behaviour during a police interview can be used to create an agent that is more believable to humans [40]. This brings us to the focus of this thesis and the questions I wish to answer:

How should we model the social behaviour that a suspect shows during a police interview?

Does such a model generate realistic social behaviour?

In this thesis I will provide answers to the above questions. I will answer the first question through the use of information gained from literature on different aspects that influence social behaviour. To answer the second question I will perform a user study in order to evaluate the model (hereafter named **response model**) and through that answer the question whether the response model generates realistic behaviour (meaning behaviour we as humans would experience as normal when performed by another human). This work is a continuation of [52] and performed in combination with [8] where we took a different approach of finding factors that influence social behaviour. I will shortly explain the two different methods we used for finding theories on social behaviours that are important in our simulation system. After this I will explain the place of the response model in the entire police interview simulation. After this I shall give a further outline of the thesis.

1.1 Theory-Driven Factor Gathering Complemented by a Holistic Approach

As stated above, this work is a continuation of a previously written paper that focused on the **stance theory** of Leary [28] that is explained in more detail in Section 3.1. In my previous work I looked at different aspects that influence the stance someone takes. This information was the basis for my search on more factors that influence human behaviour in an interview set-up. These aspects had, apart from being related to the stance of someone, also relations to other behavioural factors that are important when trying to determine the behaviour for a suspect. Other theories were found by following the police manual for Dutch police officers in training [3]. This manual describes several theories that are explained to cadets and that have influence on how a suspect might respond. Other theories were found by looking at similar studies about police interview simulations [29,33] and studies about convict deception and lying behaviour [11, 25, 26, 47, 48]. All this led to a great source of information on how and why suspects might behave the way they do. However, due to the previous involvement in Leary's theory [52] and the use of the police manual, we felt we might have been steering ourselves into a certain direction. This would put us at risk of missing some other important factors. In order to ensure we included as much behavioural influencing theories that play a role in investigative interviewing into our response model, we performed a separate study to gather more information [8].

In [8] we try to do the opposite of what I had already done in [52] and continued doing during this thesis. Rather than look for theories, we examined a large amount of videos on police interview trainings with actors (taken from the *Dutch Police Interview Training Corpus* (DPIT Corpus) [2, 8]). We looked at what concepts people use to describe what is going on in a police interview when they experience/observe it. This information was discussed within the group to ensure different terminology was not used for the same phenomena. We narrowed and clustered this information and finally compared the results to existing theories to see if these theories adequately describe the concepts we observed in the interview videos. The results from this study were compared with the theories already found and if new information was found, this was added to my reasoning behind suspect behaviour for the response model.

1.2 Response Model Within the Simulation

The response model, which is the focus of this thesis, is part of the interview simulation system that is being developed for the police. It is important to understand the difference between these two and where the response model is placed within the simulation. Throughout the thesis I will make remarks about theories, information and factors that are usually of importance to my response model but sometimes of importance to the entire simulation. Figure 1.1 (next page) gives a clear view on what the response model will be and what its function within the entire simulation will be. A police officer will eventually be able to speak in natural language and perform natural behaviour. This language and behaviour will have to be recognised and converted into abstract factors which are required for the functioning of the response model. The recognition and conversion of natural language and natural behaviour is outside the scope of my study. Theory on how the processing of social signals can be done and how they can be turned into factors we can use is discussed in [34, 46]. Our response model will work with the factors that signal processing would deliver. These factors are discussed in more detail in chapter 3. These factors will be used to determine the response behaviour of the suspect agent, which in turn is expressed in abstract factors as well. These factors will need conversion back to natural language and natural behaviour. This last step once more falls outside the scope of this study. Examples of how this behaviour could be realized based on for instance BML (Behavioural Markup Language) is provided in [55, 56]. A different example of rule-based generation of animated conversation is given in [9]. An example of showing the behaviour for different personalities is given in [30]. To get a better understanding of how a question-answer pair between a police officer on the one hand and a suspect on the other is annotated in factors for the response model, several example question-answer pairs are shown in the Appendix, Section 8.1. This example shows natural language as input and output and the abstract factors in-between, that form a representation of the natural language for the response model to work with. Note that these factors will be further explained throughout this thesis (Chapter 2 and Chapter 3).

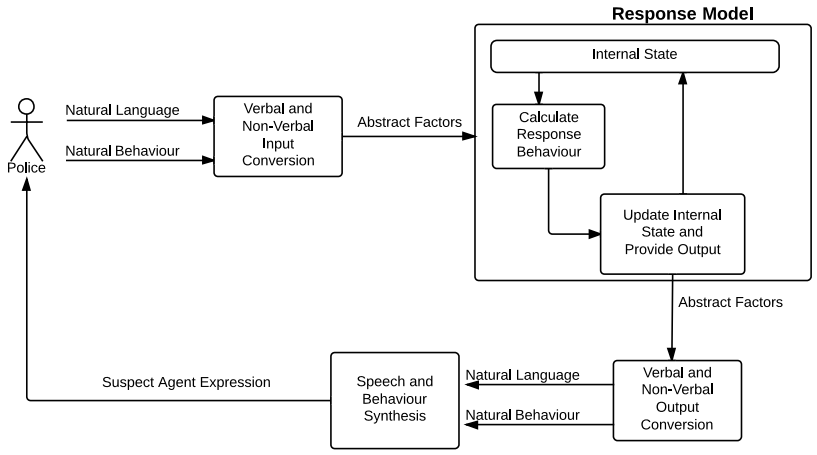

Figure 1.1: An overview of the police interview simulation and the response model within the simulation.

1.3 Thesis Outline

In this thesis I describe the different steps that led to the working response model that gives a suspect behavioural output based on both initial suspect factors and the police questioning method. In Chapter 2 I first describe some related work that was performed in the police training simulation field. This is followed by an explanation on how a police interview (in the Netherlands) is performed. The chapter ends with a suggestion on how to model the beliefs a suspect has about the interview can be realized and how this, together with the scenario for a crime (type of crime, amount of evidence etc.) is related to how the interview develops. All this is done to explain the course an investigative interview takes and what is important to the police. All factors that I found to be important for describing the behaviour a suspect shows are reported in Chapter 3. Chapter 4 describes the actual response model that is developed. It explains the general idea of the system, the different parts that make up the whole response model and the calculations performed in order to generate an output statement from the suspect. An experiment was conducted to validate the response model and get feedback from users about the generated output. This is described in Chapter 5. The results of this experiment and a discussion of the response model can be found in Chapter 6. I conclude with some thoughts about future work related to this response model and the whole police interview simulation in Chapter 7.

Chapter 2

Police Interview Training

In this chapter I will explain the basis for the creation of a police interview simulation system. I will start by shortly discussing two studies that created a similar system, an interview/interrogation training simulation for police officers. After this I will take a closer look at how police interviews are held in the Netherlands and what kind of things play an important role in these interviews. I will finish by describing the importance of having a representation of the beliefs that the suspect has about evidence and how a clear scenario about a case and all its details is required to train officers. By combining the knowledge of other studies on investigative interviewing, the current study material for police interviews for the Dutch police academy and our own general idea of how an interview could be represented in a scenario style, we try to provide an ample basis to start our search for social factors, derivative from a police utterance, influencing the behaviour of a suspect in an investigative interview.

2.1 Related Work

Before starting to work on our own suspect model, I looked at two different interview simulation studies that developed an entire system for simulating suspect (and victim) interviewing. The study discussed in Section 2.1.1 was funded by the FBI (in 1996) and the study discussed in Section 2.1.2 was funded by the Army Research Laboratory (ARL) in 2011, to be used by the United States Army Criminal Investigation Command (USACIDC) Military Police Investigators.

2.1.1 Interview and Interrogation Training

In a study performed by Olsen [33], a police interview and interrogation simulation system was developed that could be used to train officers in interviewing a suspect suspected of stealing $43,000 from an ATM. The suspect is a male loan officer who had the opportunity to take the money. The system works with this single case and is used to teach students to build rapport while maintaining professionalism, listen to verbal cues and detect important changes in both verbal and non-verbal behaviour. A list of four hundred predefined questions were made available for the police officer to use, but questions are only available

when they make sense. This means that questions about information that has not been made available by the suspect are unavailable until this information has been revealed. The student can first read background information about the suspect and then conduct an interview. Students are free to ask what they want (within the confines of the predefined questions). The student works through the interview and is given the opportunity to make mistakes at every decision. Every run with the system provides different responses. Suspects in this system are either innocent, guilty motivated by revenge or guilty motivated by financial pressure. There is **rapport** between the police and the suspect (ranging from 0-9) which may be built through the use of supportive statements. Suspects can either be angry at the police officer or at a random other outside source. Anger at the officer is always rated as bad whereas anger at an outside source can be used to build rapport. There is also a **mood** value which can be either anger, denial or compliance. This mood is affected by the entire question history and the influence of the last question on the mood (the influence of the last question is the biggest on this). Suspect responses are generated based on the question and the suspect's internal state (what will the suspect respond) and behaviour codes, which state the body language and facial expressions while speaking the utterance (how will this response be shown by the simulation). The predefined questions for police trainees to use have been carefully planned and directed by the authors and are scripted as seen in Figure 2.1.

Question/Statement/ Response	Question Code	Mood Value	Information Value	Rapport Value	Key words
What do you think should happen to whoever took the missing money?	37448	3 4 4	9	4	Diagnostic, Punishment, Need help

Figure 2.1: A predefined question as scripted by [33].

The question code is used by the system to identify this exact question. The *mood value* is a value for each of the three moods that the suspect can currently be in. These values range from 0 to 9. Some questions are good for when a suspect is compliant but bad when a suspect is angry or in denial(the three numbers indicate the three different moods a suspect can currently be in. The first represents anger, the second denial and the third compliance. If the value for the first is high, this means this question is more likely to lead to a positive response (and positive change in mood) if the suspect is currently being angry). This value increase or decreases the *mood score* (which is based on history, rapport etc. and kept in the internal state, as described above). The mood score ranges from -5 to 5 (which means the value of 0 to 9 for the mood value is converted into a score between -5 and 5). A negative mood score represents a poor question selection. The information value shows how much information this question could lead to. A rapport value is added to increase or decrease rapport between suspect and officer. When this score is high, the subject is more likely to provide valuable information, compared to when this is low. To such a question, there is a series of possible responses which require 12 pieces of information total in order to decide the response. Such a response is scripted as seen in Figure 2.2.

						Likelihood Codes					
Reply Code Compliance	Response	Guilt	Mood	Rapport	Cluster	Guilty Anger	Guilty Denial	Compliance	Innocent Anger	Innocent Denial	
37448-10 35378-20	The person should go to jail for a long time.	111	101	0111	H4, E6, A9, L1	2	2	1	9	8	8

Figure 2.2: A predefined reply as scripted by [33].

The reply code compliance shows to which question this response can be given (in the example, note that the reply can be given to the question in Figure 2.1). The guilt indicates whether the suspect would respond to the question (1) if they are innocent, guilty for revenge, guilty for financial reasons. 111 in this example means that for all guilt types this response is possible (100 would indicate only an innocent person would use this response). The same goes for the mood (this reply can be given by a compliant, denial or angry suspect if 111, 101 indicates only by compliant or angry mood). The rapport code indicates whether the response would be given with a level 1,2,3 or 4 rapport score. In this example (0111) the response would not be given with a level 1 rapport, but will be given with higher rapport. The cluster codes stand for the way the response is non verbally provided. The other 6 factors indicate how likely the response is based on the mood and guilt of the suspect (values ranging from 0 to 9). The study concludes with stating that through the use of some simple branching logic a good level of interactivity is reached. Their use of rapport is something we found in our own study to be of importance as well [8] and the addition of a mood seems logical in adding an extra dimension on how the suspect would respond and why.

2.1.2 Finding the Truth

A different study was conducted by Luciew et al. [29], about interpretation of non-verbal behaviour by police officers during an interview or interrogation. This study focused on building an interview and interrogation immersive learning simulation, specifically to train police officers in *interviewing* children who were victims of sexual abuse and *interrogating* suspects on that matter (so in fact two prototype systems were developed). The difference in interview and interrogation here is that by interview they mean talking to a victim or witness, while an interrogation is talking to a suspect with intend of proving his guilt. The study focused heavily on kinesics (the interpretation of body motion communication), parts of that being body language, facial expressions and proxemics (the reaction of someone with relation to the immediate surrounding area, such as personal space, social space and public space), all factors that should be included in a final training simulation system for police interviews, to make it more realistic and vivid.

The instructional design of both interview and interrogation systems were basically identical. Three paths were designed separately (green, yellow and red) and all began as a separate script with unique animations, events and outcomes. For the child victim interview, the green path was designed for the learner to move through the optimum scenario in which the interviewer has made all the

right decisions. The yellow path was designed to move the learner into some tangles whereas the red path was designed to be a halting path of strong resistance, maybe even hostility towards the learner. If the learner moves (based on poor decision making) deeply into the red path, there could be a dramatic behavioural breakdown of the child and with that an abrupt end to the scenario. The three paths run parallel of one another and the leaner can, by poor or good decision making, drop down a path or go up a path. The interrogation simulation starts with the police asking some non-threatening questions to the suspect that support a baseline of the suspect's response tendencies. After this the police will more intensively discuss the case. Throughout the simulation the learner is tasked to look for non-verbal signs. At certain points during the interrogation (and interview), decisions need to be made by the learner. These decisions have indicators for the green, yellow and red paths (not visible to the learner, but attached in the inner working of the system). Based on these decisions, the path might change during the next situation where such a change is possible. The study does not clearly reveal how the scenario and decisions themselves were decided and the focus lies heavily on the interpretation of non-verbal actions by victims and suspects and how the learner interprets them and reacts to them. Though this is an important part of the final simulation system we are building, it is less important for the response model I am creating. The user of this system provides some input but the output is mainly non-verbal output, whereas the focus of my study is mainly on response decision making itself and not on how a response should be portrayed in natural language and behaviour (based on the data our model provides, another model could of course pick the best behavioural output fitting that response). Even though the study of kinesics is not directly related to my response model, it does provide good insight on what kind of visual representations for behaviour we should use for our suspect at a later stage in our simulation development. The idea behind a multi layered path system (in this study three) is something to consider when deciding what kind of scenario building system we wish to create.

The above two studies provide a decent starting point for theories and information about the interpersonal behavioural sciences and the criminology sciences. The simulations described above give rise to ideas on how our own system could or should work and what kind of factors we need to keep in mind when designing our suspect response model; factors like rapport building and a suspect's mood. Aside from adding to our ideas on what factors influence the behaviour of a suspect, they also provide suggestions on how we could decide on our output definitions. For instance, lies and truths are triggers for different verbal and non-verbal behaviour and so is anger and avoidance behaviour. The final determination of these outputs will influence how other parts of the system will (eventually) represent them.

Apart from these studies, little other studies are available on this exact topic. The difficulty with a training system like the one we are working on now is that it consists of so many pieces that even when you focus your attention on a small part of it (in my case, the suspect response modelling), you still need to base your ideas and results on some of the other parts (what kind of input can I expect to receive, how will I need to provide output in order for others to use this efficiently, etc.). This makes it impossible to not look at the other parts

that the system will need to have. In the following section, I will take a look at the different aspects that are important during a police interview that might be relevant for my suspect modelling.

2.2 The Interview

To get familiar with police interviews I followed the book "Handleiding Verhoor" [3] to find how an interview is initiated, maintained and finished. What goals do police officers have when they interview a potential suspect, what kind of behaviour are they taught to show, are there different roles they can take and how does all this, combined, create a working interview between police and suspect? In Section 2.2.1 I will explain the layout of the police interview. How does an interview start? What happens after the initiation stage? How does the interview continue and eventually end? The three main stages of the police interview are explained and also the goals for these three stages are discussed.

2.2.1 Phases of Interview

When a suspect is apprehended and brought in for questioning, the detective who interviews the suspect will have his first interaction with the suspect. This stage of the interview is called the **"First contact"**. The police officer will have read about the suspect beforehand, gained knowledge on his past, priors, current situation etc. The officer will have made an evidence matrix, or "bewijsmatrix" in Dutch, which summarizes information about the case that the officers already have (evidence and/or tactical clues) and what kind of information they still need from the suspect. When the officer enters the interview room, the first contact begins. During this phase, the officer introduces himself to the suspect, explains his role and the position of the suspect and tells him why he has been arrested. His rights will be read and he will be explained that the interview is being recorded, both audio and audio-visual. He will be asked if he needs any medical attention and after this he is shortly explained how the rest of the interview shall go. The first contact usually fluently moves to the next stage, the person related interview.

Person related interview:
The person related interview is usually initiated by explaining what the use of this part of the interview is. An example of how the police could do this would be: *"I'm going to ask you some questions about yourself and your situation now, to gain a better insight in who you are and how you stand in life."* After this, questioning begins with a focus on non-sensitive questions, like name, place of residence etc. All of this information is used to confirm available information about the suspect or if the information was not yet available, to add this new information. Since the suspect might be innocent it is important to stay as neutral and objective as possible during the questioning. As the person related interview progresses, the sensitivity of topics that the officer questions about increases. It is important for the officers to normalize tension levels, which means that they do not start with threatening topics (See Section 3.5) but try to build towards such topics by asking low threatening topics first and get acquainted with the suspect. This is also called building a working relation

with the suspect, which is done by showing interest and keeping tension low if possible. Eventually, the goal of the officer will be to ensure that the suspect is ready to confess or at least build an increase in willingness to confess. The behaviour of the suspect should be indicative for this and if possible, the officer will also try to build tactical clues during this part of the interview to use later during the case related interview. Examples of gaining such tactical clues is asking whether the suspect has a car and if he is the only one who drives it (or has driven it for the last week). These seem like some random person related questions, but if the police has evidence that the suspect's car has been seen at the crime scene, answering these questions truthfully (yes I have a car with that license number and I am the only one who uses it) has provided a tactical clue to confront the suspect with in a later stage of the interview. Keeping it casual and non-threatening to the suspect allows for this line of questioning even in the person related interview.

It is possible that suspects are not willing to talk about certain topics. This could be due to the sensitive nature of the question or due to personality traits of the suspect. If officers keep on talking about the topic it is possible that a suspect shuts down or becomes aggressive. Officers are trained to drop the topic and try to re-establish the contact and working relation but at the same time to at least determine the reason for this unwillingness. An example of determining this unwillingness could be: *"I understand you don't wish to talk about your drug habits. Might I ask why it troubles you to talk about this?"*. Apart from getting information to verify or add to their own information about the suspect, the person related interview is also used to determine how the suspect responses to different approaches. For instance, how does the suspect respond to authority? Does he take initiative or does he wait for you to lead him? When the suspect is ready to talk about the case (either due to the police deciding enough rapport has been build, enough person related information had been gathered or the suspect states he wishes to talk about the case), the police officer starts with the case related part of the interview.

Case related interview:
The case related part of the interview usually seamlessly follows the personal related part of the interview, for instance when the officer changes to subject to a more guilt indicating topic (for instance, *"Were you at the gas station last night?"*. The goal of this part of the interview is to gain new information and insight in the case and eventually get a confession from the suspect. Gaining information that links the suspect to the crime is valuable as well, even without a confession such information could still be used in a case against the suspect in court.

There are three main interview techniques taught by the Dutch police: the "direct stacking method", the "standard interview" and the "question and answer method". The direct stacking method and the question and answer method include aspects from the standard interrogation but differ in several ways:

> **Direct Stacking Method:** The direct stacking method is suggested to be used when evidence alone is enough for a conviction, when time for the interrogation is short or when there is high expectancy of the suspect

to confess. This method entails that all evidence is given and used to confront the suspect hoping for a quick confession.

Question and Answer Method: The question and answer method is used when the suspect does not want to talk at all or about the case anymore. It is crucial that officers then ask questions about each piece of evidence they have and note the reactions of the suspect. Even a silent suspect might give away some hints or clues and these might in turn be used to get him to talk again.

Standard interview: The standard interview method is used in most scenarios. This is the case when there is at least some evidence against the suspect and the suspect is willing to talk. Officers make use of different types of evidence, evidence that gives a direct relation between crime and suspect, evidence that gives an indirect relation and evidence that gives no clear relation. The officers are trained to ask open questions without giving away evidence. This is directly related to the SUE (Strategic Use of Evidence) technique used in British interviews where officers are trained to strategically use evidence in order to detect deception at a higher rate [25, 26]. When a statement by the suspect is in accordance with evidence, no confrontation is required on that specific topic. If there is a discrepancy, for instance when a suspect states he was not somewhere while the police has video footage of the suspect at the location, a confrontation follows.

The police work with pressure, meaning they try to 'surround' the suspect by letting him make false statements that contradicts evidence and at some point confront him with this evidence. The more time and surrounding evidence is present, the more pressure is present and the more effective the confrontation will be. This means that the police gets the suspect to admit to certain things piece by piece. For instance, the police makes the suspect admit that he was present at the crime scene or that he used a phone near the location of where money was stolen. It is possible that during such interviews the goal of gaining information/confession fails. If this occurs, the officer can choose to keep discussing this subject, continue to the next or find more evidence. The last part will not be included in our simulation, since this would mean we not only have an interview simulation but also an evidence gathering part focused on some crime scene.

2.3 Scenario and Suspect Beliefs

The response model will be applied within different scenarios that describe a committed crime, evidence for the police and potential questions and answers. Such a scenario would be the basis for topics that can be discussed, types of sentences that could be selected, correct (positive response from the suspect is generated) and incorrect (negative response from the suspect is generated) paths that could be taken etc. When this scenario is played, the suspect will have continues changes in his beliefs about the evidence that is held against him. These beliefs play a role in his determination to lie about a fact or, if he believes the evidence is too strong to deny, his admittance of that fact. As described in the police manual, officers are trained to surround a suspect with

evidence, providing more evidence piece by piece. This is based upon topics and natural language, but these beliefs will have to play a role when determining the suspect response in our response model, so we need to form an idea about how these beliefs could be determined outside the response model and include a simplification within the response model, that can easily be replaced with a belief model in the final simulation. A suggestion for how such a belief system could look and how aspects that are relevant to the decision making of the suspect can be represented are given here.

Every police interview is different. This difference is of course partially due to the difference in suspect, but also due to the different nature of the crime committed. If we model a suspect that has stolen money from a local store, there might be different lies and truths available to him than when comparing the same suspect type to a case where he committed a murder. This means that clear scenarios need to be written in order for the total system to function correctly. The police will be given pieces of evidence, dependent on the scenario that is being played and the suspect has certain information that the police wishes to know, dependent on the scenario. To give an example of why this is important I give a very small example scenario:

A local gas station has been robbed and the suspect's car has been caught on camera while parking at the gas station. The suspect went inside the store to use the phone inside and stole money from the counter while he was inside. The actual act of stealing money has not been seen or caught on tape and is the confession information that the police wants to know and something only the suspect can provide. The suspect has however been seen by witnesses near and inside the gas station, as was his car. The suspect has debts which is known to the police. The scenario specific facts that are known to the police are not always known to the suspect. For instance, the suspect does not know his car was caught on camera. The way he handles questions about his whereabouts might differ depending on what he believes the police to know.

This example shows that the suspect agent needs to be able to deal with different situations concerning the same evidence: one in which the police surrounds him by keeping evidence from him and one where the evidence is immediately presented to him. Difference between questions with evidence backing it or without evidence backing it will have to be made and an idea needs to be developed about how these situations can be illustrated for the suspect. It is also ideal for a training simulation if there is a way for the trainee to find out what kinds of information he might have missed after a session or what actions has resulted in the admitting of a fact by the suspect. We propose the final simulation to maintain a Bayesian representation for the beliefs of the suspect on guilt indicative matters, allowing for probabilities on whether he will likely tell the truth or a lie. Depending on the scenario, a **Bayesian network** can be formed around evidence and guilt indicating factors that the suspect response model can (in the final simulation) use to identify these threats and have the suspect respond to them accordingly. A Bayesian network is a probabilistic representation that can be used to model decision making in uncertain situations, in our case decision making for the suspect agent. An example of such a Bayesian network for a scenario in which the suspect has debts, stole money

from a gas station and used a phone inside the station can be found in Figure 2.3.

This figure shows a Bayesian network for both beliefs and actions. Circle nodes represent evidence that the suspect has beliefs about, these can be either true or false. Diamond nodes represent actions that the suspect has either performed or not. For instance, the suspect has observes evidence nodes prior to the AdmitCarPresent when new evidence is brought up. The probability that his beliefs about this evidence and that the police actually has this evidence was low or perhaps 0 when the police had not yet brought it up, but increases (to a maximum of 1) when the police brings it up during the interview. This increase in probability in the child nodes allows for the action admit car to be triggered, leading to an admittance of this fact in the actual interview speech. At the start of the interview, the suspect will most likely believe most evidence information to be absent, but scenarios could be made in which the suspect already believes some incriminating facts are known (he saw a witness see him). For this example there is no need to provide actual values to all nodes, but to understand what this network represents we start by looking at the central node *'Confess'*. If surrounding evidence nodes that point at this node are observed and found true (meaning the suspect believes the police has this evidence gathered against him), the suspect will confess if asked about this directly. The value for this node is dependent on all nodes with an incoming edge to the confess node. The chance that he confesses is written as:
$p(Confess|TruthSuspectPresence, TruthPresenceInside, TruthDebts)$.
The difference between TruthSuspectPresence and TruthPresenceInside in this case are that even if the suspect was present at the gas station area, that does not mean he was in fact inside the kiosk where the money was stolen. These are two different facts, though his presence inside cannot be the case without his presence also being the case. An example of how these chances could relate is given in Table 2.1.

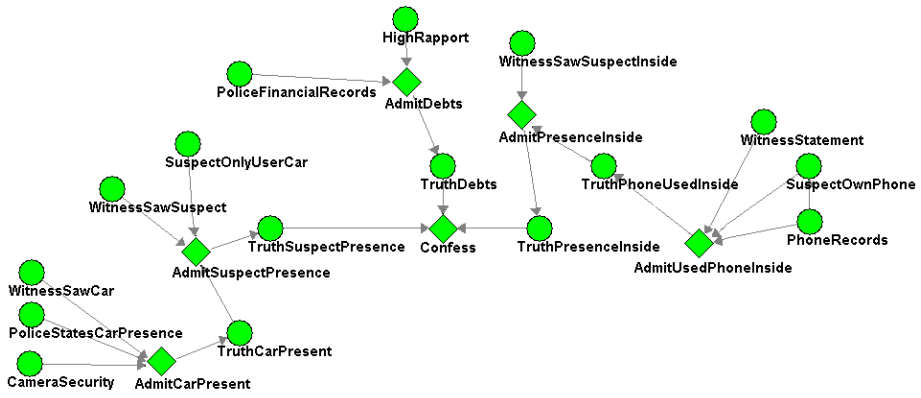

Figure 2.3: A simple Bayesian network representation, showing the beliefs (circle nodes) of the suspect on evidence and potential actions (diamond nodes).

Table 2.1: An example for the truth value of the action 'Confess'. (T.P.I = TruthPresenceInside, T.D. = TruthDebts and T.S.P. = TruthSuspectPresence.)

T.P.I.	**T.D.**	**T.S.P.**	**p(Confess = true)**
True	True	True	0.9
True	True	False	0 (impossible)
True	False	True	0.5
True	False	False	0 (impossible)
False	True	True	0.3
False	True	False	0.0
False	False	True	0.1
False	False	False	0.0

The evidence factors are based on the small scenario described above. The network represents the likelihood that the suspect will give (or has given) a truthful answer about the topic in question. Debts for instance is related to the fact that the suspect has debts, which are his motive for committing the theft. Giving a truthful answer about debts (admitting he has debts) will occur depending on whether the police has brought up financial records and whether a high rapport is present between police and suspect or not. If the suspect agent admits to having debts, his beliefs about telling the truth about this are also updated to true, since he knows he has admitted this fact. This is done to allow for a difference in beliefs and actions (since actions have a direct influence on the speech act of the suspect during the interview, while beliefs are not known to the police). His beliefs about something that he has performed however will need to be updated, hence this is done by connecting the action nodes to a follow-up belief node. This ensures for instance that the belief that he has admitted that his car was present influences the action of admitting that he himself was present at the crime scene. The fact that he was inside and was present at the location are further relevant to increase the likelihood that he will confess. These factors in turn can be appointed as true or false, depending on the nodes that point to them.

These beliefs about the current situation of the network are based on the scenario and the evidence that is provided by the police. A trainee can decide to ask the suspect (during the interview) about these facts, for instance about his car being present or the fact that he used the phone inside the building. If this occurs, the response model might decide that there is hardly enough evidence and that the suspect would deny these facts. This could be a result of the belief that the TruthCarPresence node for instance is still false. For example, the trainee asks the suspect about his car: *"Your car has been seen at the crime scene."* This statement updates the network, the node PoliceStatesCarPresence is observed and found to be true. This updates the network to the situation in Figure 2.4.

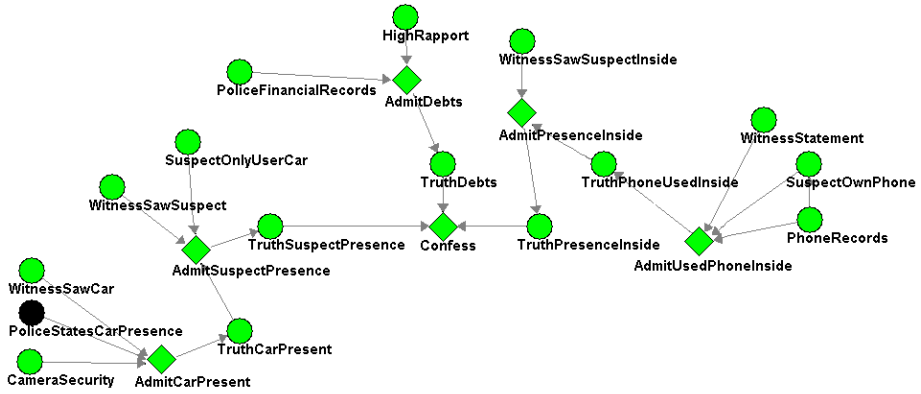

Figure 2.4: The Bayesian network after observing the 'PoliceStatesCarPresence'.

The probability that AdmitCarPresent is now triggered due to this one simple statement is low (these chances are set manually). For example:
$p(AdmitCarPresent|PoliceStatesCarPresence = t, WitnessSawCar = f, CameraSecurity = f) = 0.0$.
The suspect has no reason to be truthful about the presence of his car so he would deny to these allegations. *"Impossible, it never left the parking lot at my home."* The police might now add that a witness has seen the car of the suspect. This would increase the likelihood of the suspect to be truthful about this topic. However, there might still be enough doubt (*"The witness must have made a mistake."*). The new probability could be:
$p(AdmitCarPresent|PoliceStatesCarPresence = t, WitnessSawCar = t, CameraSecurity = f) = 0.3$.
The suspect is still likely to lie about his car presence and since other factors that might influence his truthfulness are (for this example) also not present, he denied again. The police now brings his final piece of evidence and states that camera security was present at the gas station and that an image of the suspect's car is clearly visible. This final statement leads to the update of the Bayesian network as shown in Figure 2.5 and results in the following probabilities:
$p(AdmitCarPresent|PoliceStatesCarPresence = t, WitnessSawCar = t, CameraSecurity = t) = 1.0$.
The action of admitting that his car was present at the crime scene will now be performed, after this question by the police has been posed and updated his beliefs. The suspect agent believes there is no point in denying it now. This means the network is updated and the node AdmitCarPresent to become true, which directly links to the belief TruthCarPresent that is also observed and found true after the suspect has admitted this guilt indicative fact. This questioning and providing of evidence by the police can be performed until the end of the interview. This is currently a suggestion on how evidence beliefs can be modelled in the final simulation system. Potential connections and influences on the response model will be discussed further in the future work section.

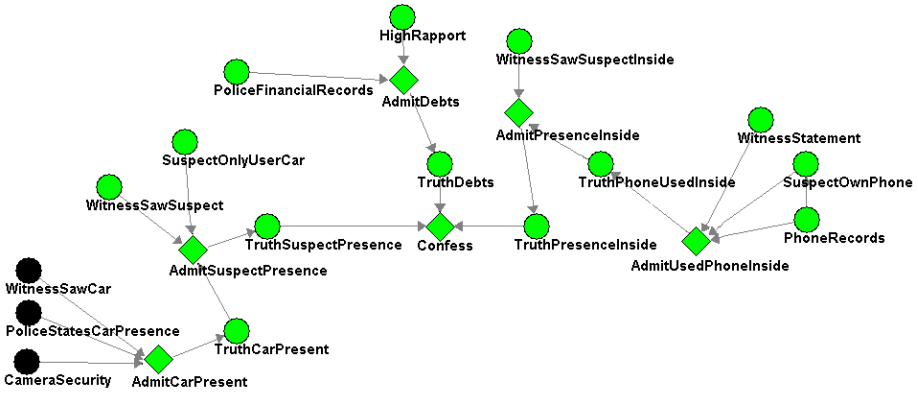

Figure 2.5: The Bayesian network after three nodes have been observed.

Chapter 3

Behaviour Influencing Factors

In this chapter I describe all factors that can influence the behaviour that the suspect shows during the police interview. These factors were determined by analysing the police video corpus [8], the manual for Dutch police interviews [3] and a separate literature study. The literature study provided factors that influence the behaviour of suspects, so it describes how a human would act under the same circumstances, influenced by these factors that play a role. It also provided the actions suspects take in an interview. This chapter is fully devoted to factors that are of direct influence on the type of behaviour that needs to be performed by our suspect agent in order to be received as a realistic suspect in a police interview. The actual behaviour that will be performed, both verbally and non-verbally, is not part of the response model but a crucial part in the final simulation. This will be discussed in the future work chapter.

3.1 Interpersonal Stance

"Defining yourself by your taste is easier than defining yourself by any genuine stance on something." - *Noah Baumbach*

One of the main theories that the Dutch police work with is the theory on interpersonal **stance** by Leary [28]. To give a clear definition of interpersonal stance, Scherer described it as "It is characteristic of an affective style that spontaneously develops or is strategically employed in the interaction with a person or a group of persons, colouring the interpersonal exchange in that situation (e.g. being polite, distant, cold, warm, supportive, contemptuous)" [38]. Leary found that two people who interact with one another take a certain stance to one another. These stances are represented in a rose, which is illustrated in Figure 3.1A. Two dimensions make up this rose, representing a dimension of affect (x-axis) and power (y-axis). Other studies make use of this same principle but use slightly different names, such as the Interpersonal Checklist [15] and the interpersonal circumplex [36, 37].

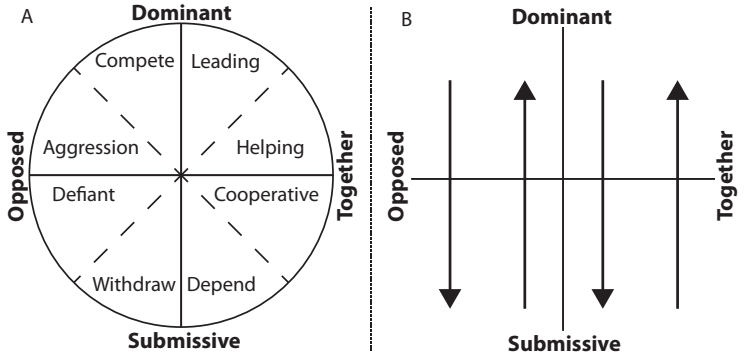

Figure 3.1: A: Leary's rose, represented by a horizontal affect axis and a vertical power axis. The rose can be divided into eight octants that each correspond to a stance. B: The behaviour-inviting relation between the quadrants according to Leary's theory [28] (Figures courtesy of [8]).

3.1.1 Theory

The model of interpersonal stance models human interaction on two orthogonal axes, the previously called affect and power axes [12, 28]. The names for these axes differ slightly between studies and sometimes the horizontal affect axis is called the competitiveness axis, the togetherness axis or the together-opposed axis. The power axis on the other hand is sometimes called the dominance axis or the above-below axis. The circumplex consists of eight octants that each define a stance: Leading, Helping, Co-operative, Dependent, Withdrawn, Defiant, Aggressive and Competitive. To simplify the model, the octants can be reduced to quadrants of Friendy (dominant together), Dependent (submissive together), Withdrawn (submissive opposed) and Aggressive (dominant opposed).

To better understand the meaning of these different stances, Wiggins et al. used an item-analytic procedure to create a list of English adverbs describing the eight stances, called the revised interpersonal adverb scale [57]. Rouckhout and Schaft did the same with Dutch adverbs [36]. Leary suggests that during interaction between humans, the stance that someone takes on the scale invites the other to take a stance based on that, meaning that the two conversational partners influence one another during their interaction. Positioning on the horizontal half of the rose invites the interlocutor to take that same horizontal half as a stance, whereas the vertical half invites the interlocutor to take the opposite vertical half. This means that together behaviour invites together behaviour and opposed behaviour invites opposed behaviour, whereas a dominant stance invites the interlocutor to be submissive and vice versa. This behaviour is illustrated in Figure 3.1B. According to the theory on stance, this change in dynamic does not occur immediately but gradually over the course of the interaction. This means that if you want someone to become submissive, this is not achieved by being dominant during one utterance, but during several utterances after one another.

One of the main problems with the interpersonal stance theory is recognizing

stances in an utterance. Even after some training, a group of human annotators has difficulty to reach a high agreement on stance recognition and the problem is even bigger with automatic recognition [43,44]. Stance is something that is also not only described by *what* is being said but especially about *how* something is said. In written dialogue this makes it even more difficult to correctly recognize and annotate this.

3.1.2 Influence

So what role should stance taking have in the interview of a suspect by a police officer? First of all, both our suspect and police need to be in a stance at any given moment during the interview. The behaviour of the suspect needs to be modelled, so if stance is to play an important role in the response model, this too needs to be modelled. The stance of the police officer will have to be interpreted from the expression that he provides. This means that an expression will need to be evaluated and based on that expression, a stance will be interpreted. Every utterance that the police will make will need to be labelled with a stance that in turn can be used to influence the stance that the suspect will take. This also happens during the current training interviews that police trainees have with actors. Some actors play an angry suspect that just wants to be understood. When the police trainees approach these suspects with a friendly stance and continue to do so, even if the suspect remains aggressive at first, this usually leads to a shift in stance where the suspect finally takes a friendly together stance. Whenever the police responds with aggression or defiance however, this only fuels the aggression in the suspect leading to a more hostile and dominant stance. Note however, that there might be a difference in stance as interpreted by the system and as meant by the police officer! An officer might say something, believing he is being friendly, while the system interprets this as something other than friendly.

I already suggested that basing a stance on the stance of the other person alone is probably not the most correct way to model stance [52], so other factors that will be described below may also influence this stance. In turn, after calculating the stance that a suspect will take to answer the question that the police officer poses, this stance will influence the actual response. If the suspect is taking an aggressive stance, his response will need to be aggressive as well. If he is taking a submissive stance, his response might be to avoid talking all together or give very short answers.

3.2 Personality

"We should take care not to make the intellect our god; it has, of course, powerful muscles, but no personality." - *Albert Einstein.*

Other than the intellect, every person has his own **personality**. Some people are more friendly, outgoing and adventurous while others are more secluded, introverted and withdrawn. Such a difference in personality should also affect how different suspect agents would respond to the same question. In order for us to have an agent respond to a question we need to have a clear definition of

the suspect, meaning we need to describe his personality. This is also done in for instance [30]. We try to follow the lines of the interview guidelines of the Dutch police, so we can base the personality of a suspect on the stance theory described above and through the feelings of sensitivity to factors described below.

3.2.1 Theory

The main theory that was used in discovering personality traits was the book Personality and Interpersonal Behavior by Robert Freed Bales [4]. This choice was made based upon the fact that we try to model interpersonal behaviour for our suspect agent and this book approached personality from this angle. According to Bales, personalities can be scaled on 3 different axes, Upward vs. Downward, Positive vs. Negative and Forward vs. Backward. A person can have a personality described by either 1, 2 or 3 of these factors, but never a combination of opposites within the same axis (so UPB Upward Positive Backward personality is possible, but UDP Upward, Downward, Positive is not, due to upward and downward being each other's opposites.) The book lists methods of analysing a person to conclude what personality he/she has, but in our response model it would be sufficient to be able to allocate a personality type to the agent and have him act according to that personality. Acts of friendliness are always present in a personality that at least includes the positive direction, which means people with a positive personality trait tend to be more friendly in their behaviour towards others than negative personalities. The giving of information is usually described as a downward direction. Bales states that a sentence can be analysed to see its direction (called the *value-direction* of an act). This means that each sentence or utterance can be labelled with a certain direct. People with different personality types are more prone to have a certain value-direction for their speech acts than other people with a different personality type. These directions are the earlier mentioned upward/downward, positive/negative and forward/backward. In order to gain insight in the personality of someone, Bales suggests that three questions are asked about the person in question, concerning dominance, liking of speaker towards audience and alliance of speaker to conventional legitimate authority. These three questions with their respective values depending on the answer are as following:

> Is it your impression that the person making the statement wants to be in a dominant position in the group? (Yes leading to Upward and No leading to Downward).
>
> Do you feel that the person making the statement likes most people in the group? (Yes leading to Positive and No leading to Negative).
>
> Do you feel that the person making the statement feels himself to be allied with conventional legitimate authority? (Yes leading to Forward and No leading to Backward).

The first two questions are indicative for personality traits that can be directly linked to the stance theory described in Section 3.1. Is someone a dominant person and is someone kind hearted and friendly? Due to this overlap, these two personality traits are chosen as the foundation of a personality for our

suspect. The third dimension is more focused on problem solving in a larger group setting. Forward people are not friendly or unfriendly, not dominant or submissive, but mostly fixated on getting a task done. This dimension does not offer much use in our interview simulation and cannot be combined with the stance theory we use as basis. This dimension is therefore not used in the portraying of a personality in our model. By combining the other two personality traits for one personality, we get a combination of four different personality types which are represented by the four quadrants of the rose of Leary. Defining a personality through the use of the interpersonal stance classification is also done by Gurtman [23]. In his work, "Exploring personality with the interpersonal circumplex", Gurtman tries to define personalities inside the circumplex. Such a personality is what we call a preferred stance [52], a positioning on the circumplex that the person prefers to take if possible. Such a preference means that it could be more difficult to get someone into a stance that is very different from this preference. An example of two personalities defined by a stance is shown in Figure 3.2.

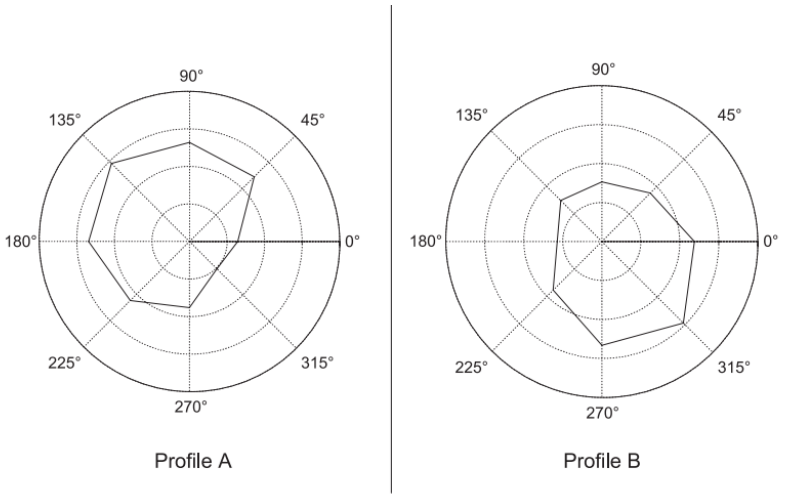

Figure 3.2: Two examples of personalities defined by the interpersonal circumplex. Profile A shows an aggressive personality whereas Profile B shows a dependent personality. [23].

A preferred stance is not the only part of the personality. Things like how sensitive someone is to the building of rapport or different types of pressuring techniques (both discussed in following sections) are important when defining a personality. All this will need to be combined to create a personality for our suspect.

3.2.2 Influence

The personality of a suspect should influence his behaviour. Things like his preferred stance influence how fast the suspect would turn towards a certain stance. If for instance a suspect with an aggressive personality type is being interviewed and the police officer makes an aggressive statement, the result will

be a quick increase in opposed behaviour, since the suspect prefers to be opposed. If the same statement were made to someone with a friendly personality type, this increase in opposed behaviour would not be so big. If the police officer shows dominant behaviour to someone who prefers to be submissive, this will also lead to an increase in togetherness, since the suspect can be in his preferred submissive state. Personality traits may also influence the way the speech utterance of the suspect is performed. An aggressive personality type might be more prone to make unfriendly replies compared to a friendly personality type. Apart from the influence on stance, different sensitivities to rapport and pressuring techniques will influence the effect that these things have on the suspect. If a police officer is extensively building rapport with someone who is sensitive to this, the suspect will be more prone to tell the truth and remain friendly and helpful, whereas someone who does not care much about rapport would not be moved by these gestures from the police. The same goes for pressure building. Submissive introverts are more prone to internal pressuring, the increase of guilt and shame, and would be prone to admit to certain things if they are pressured about these guilt related matters in this fashion. All of this means that a police officer could try different approaches to figure out what works best with the suspect he currently faces. If building rapport is useless, there is no need to spend an excessive amount of time on building rapport. If external pressure has no effect whatsoever, the police should try different approaches.

3.3 Rapport

"You want to work with people who you like and have an easy rapport with."
- *Mike White*

Building a bond is an important tool for people to get along with one another. This bond is also defined as **rapport** and can also be described as being in sync with another person. As Mike White understandably states, you want to work with people you have an easy rapport with. In Section 2.2 I already pointed out that one of the goals for police trainees is to build and maintain a good work relation with the suspect. One of the important factors that stipulate such a working relation is rapport.

3.3.1 Theory

Tickle-Degnen and Rosenthal provided a more clear identification for rapport while focusing on the interaction process as a whole [42]. They identified three components that signify rapport: *mutual attention, positivity* and *coordination*. Mutual attention is the degree of involvement or engagement that two interacting individuals experience. Paying attention to what the other party says or has said previously builds rapport through the factor of mutual attention. Positivity is defined as caring behaviour and friendliness, meaning you provide positive feedback on something the other person has said in order to build rapport. Finally, coordination means the synchronization of the two speakers, the factor that stipulates the being in sync with one another and have a clear shared goal. These three factors are all ways of building rapport, but positivity is something that is more important at the beginning of the conversation, whereas coordina-

tion becomes more and more important over time. This is illustrated in Figure 3.3.

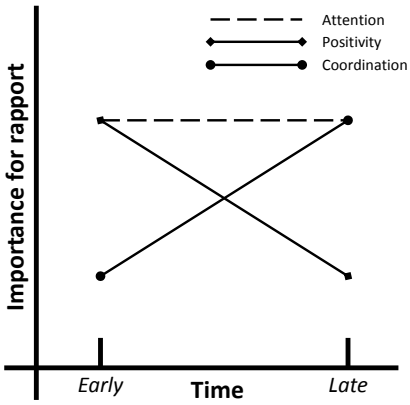

Figure 3.3: Importance for rapport for Attention, Positivity and Coordination over time [42].

Several studies looked at the importance of rapport building in police interviews in order to find out if building rapport is really as essential as suggested [1, 10, 51]. Collins et al. found that building rapport can seriously affect the quality and quantity of information provided by both witnesses and suspects and that lack of rapport has the potential to turn a cooperative witness into an uncooperative one. They also found that 'neutral behaviour', meaning no rapport was built but also no negative attitude was maintained, was considered to be rude or abrupt, showing that disinterest or a lack of enthusiasm can be interpreted as a highly negative interviewer attitude [10]. The study by Collins et al. was mainly focused on witness recall, but the study performed by Walsh and Bull was more directed at suspect interviewing [51]. They examined the PEACE model used by British police officers (Preparation, Explaining and engaging, Account from the suspect, Closure and thereafter Evaluation) and how rapport building needs to be started as soon as possible but also maintained throughout the interview. It was found that many police officers overlook opportunities to build rapport, which already occurred at the beginning of the interview. This missed opportunity was during the *delivers caution* stage, where a suspect was explained his rights and the outline of the interview. Rather then continually checking with the suspect if he understood and had any questions, the entire caution was delivered in a single block, missing out on rapport building opportunities. The study found that skilled rapport building during the engage and explain phase and account phase lead the more favourable outcomes of the interview. Finally, the study also showed the fact that rapport can be lost if not maintained throughout the second part of the interview and that this still leads to an unfavourable outcome of the interview.

3.3.2 Influence

That rapport is important to build and maintain should be clear. Suspects who feel there is a certain amount of rapport between them and the police are more forthcoming with information and more positive towards the police. This needs to be modelled in their behaviour, especially if they are sensitive to rapport. If rapport is built but not maintained, the rapport between suspect and police should slowly deteriorate unless it is built and maintained again. The building of rapport through the use of positivity should have more effect at the beginning of the interview (during the person related interview) and coordination should have a higher effect during the second part of the interview (the case related interview). Attention should always have an equal influence on the building of rapport.

3.4 Strategy

"However beautiful the strategy, you should occasionally look at the results." - *Winston Churchill*

Interviewing a suspect who is unwilling to talk often means it might be necessary to stop the conventional question-answer method and apply a **strategy** to get the suspect to talk about something he/she does not want to talk about. The Dutch police bases the strategies that their interviewers can apply on the work of Giebels [16]. Giebels has developed a table of ten strategies that police officers use in hostage negotiation situations that also apply to other sectors of police work, like suspect interviewing.

3.4.1 Theory

In her study on hostage negotiation situations, Giebels proposes a frame focused on the interpersonal process of mutual influencing in negotiations, with behavioural changes as goal [16]. This frame is called the "tafel van tien", literally translated the "table of ten". This frame proposes 10 tactics that are used in hostage negotiations between police and kidnappers, in order for the police to come to a safe solution where no blood is shed and the hostages are saved. The study of Giebels focuses on one-time events in which behavioural change is the main focus. This is the same focus that police officers want to achieve in police interviews. An overview of these ten strategies is given in Table 3.1. These ten strategies are subdivided into two main strategies: relational strategies and substantive strategies. Relational strategies are employed to improve the relation between the two parties whereas substantive strategies are used to focus on the message being conveyed. Being kind, equal and credible are the relational strategies and are used to improve the relation between the two parties. The other seven strategies are substantive strategies, meant to get the suspect to open up about certain topics. Relational strategies might have the same effect eventually, a friendly and at ease suspect might reveal information he might not have shared if he had remained unfriendly.

Table 3.1: The ten strategies representing Giebels's table of ten [16].

Strategy	Short explanation
Being kind	Friendly, emphatically, helpful
Being equal	Cooperation, shared experience
Being credible	Show of control, reliability
Emotional Appeal	Using suspect's emotions
Legitimating	Refer to agreements (laws/rules)
Rational convincing	Using arguments and logic
Trade	Give and take
Intimidation	Threatening, personal accusations
Direct pressure	Neutrally keeping pressure (steadfast)
Imposing restrictions	Time limits, restricting something

Being kind means reacting emphatically and showing understanding towards the other, giving something without asking anything in return. Being equal is done by sharing own experiences. Being credible means that you show the other party that you are in the position- and have the means to -handle this situation. It also means you are reliable, by for instance following up on arrangements made. An emotional appeal occurs when someone refers to the reward (respect, positive feeling etc.) the other will receive upon following the proposed solution for a problem. It also means referring to important people in the suspect's life to gain emotional advantage. Legitimating is an indirect form of influencing in which a party refers to external matters such as the law or moral guidelines. In convincing, one party tries to convince the other party of the importance of changing their behaviour, through the use of arguments or pointing out discrepancies between things a person has said. Trading refers to negotiating in a limited sense, praising and offering, giving and taking. Intimidation refers to behavioural changes through use of force. Direct pressure is more neutral and usually means repeating what you want over and over again. Legitimating, convincing, intimidation and direct pressure are seen as forcing behaviours [18]. Imposing restrictions usually means connecting a time limit to an offer or demand. In a different study, Giebels found that forcing behaviours might work counter-productive if the party that suffers the forcing behaviour is already frustrated, agitated or aggressive. In such cases the strategy might lead to conflict escalation [17].

3.4.2 Influence

When a police trainee tries to apply a certain strategy on our suspect agent, it is important that the system recognizes this action. Recognizing these strategies means we can allow our suspect agent to show positive responses to correctly applied strategies and negative responses to incorrectly applied strategies. Positive strategies such as being kind and being equal would improve the togetherness of a suspect and might have a bigger effect on personalities of a kind nature. Emotional appeal would be a very effective strategy if employed with suspects that are sensitive to feelings of guilt and shame and overall submissive personalties. Strategies like intimidation are not supposed to be used during interviews, but an officer in training should be allowed to make the mistake of intimidating

the suspect. This would most often have a negative effect on the togetherness of the suspect.

3.5 Politeness and Topic Threat

"In truth, politeness is artificial good humour, it covers the natural want of it, and ends by rendering habitual a substitute nearly equivalent to the real virtue." - *Thomas Jefferson*

Face is a person's public self image, something he wishes to protect and tries to avoid losing [19]. In order for someone to take the face of someone else in consideration when asking a question, certain **politeness** strategies can be applied to avoid the interlocutor to lose said face. Brown and Levinson state face consists of the desire for autonomy (the need to be free) and approval (the need to be approved) [7]. Not only does politeness relate to preventing the loss of face, but also incites people to respond honestly and positively to questions about topics with a certain **topic threat** (a term of our own after a small side study on the effects of questioning strategies in relation to different types of topics) [53].

3.5.1 Theory

Given the desire to maintain their own and other's face, agents should base their social stance on three socially determined variables: *social distance, power* and *ranking of imposition* [7, 49]. The first is how familiar the hearer and speaker are with one another, but also depends on social class and status. The second is the power that the speaker has over the hearer and comes from many sources, but often arises from the ability of the speaker to control access to goods that the hearer wants. The final relies on the fact that all agents' basic desires include the desire for autonomy and approval. In their paper on generating politeness, Gupta et al. refer directly to Brown and Levinson's theory on face, describing positive face, the desire that some of the speaker's and hearer's goals and desires are shared by other speakers, and negative face, the want of a person that his action be unimpeded by others [7, 22]. They speak of Face Threatening Acts (FTAs) and that the threat of a linguistic form can be predicted by the three variables named above. They discuss several strategies employed to state something that might be face threatening, but in such a way that the hearer does not feel as if he loses face. These strategies are part of one of four main politeness strategies.

Direct Being straight to the point: "Tell me what you did yesterday."

Approval oriented Taking the other's wants into account: "Would you like to tell me what you did yesterday?"

Autonomy oriented Not hindering the other's autonomy: "If it's not inconvenient to you, could you tell me what you did yesterday?"

Off record Being indirect or vague about one's own wants: "I don't seem to have written down what you did yesterday."

Approval and autonomy oriented strategies are more polite than direct strategies and usually lead to a more positive response from the interlocutor. Off record strategies are even more polite, but are often statements that can also be chosen to be ignored. In a side study performed (during an elective course, Conversational Agents), we tried to find if the threat that a certain topic has also influences the forthcoming of an interlocutor and if so, if the applied politeness strategy has some effect on this [53]. We found that we could indeed identify certain topics as almost not threatening (pets, hobbies), others as medium threatening (friends, description of character) and others as very threatening (drug usage, childhood, debts). After this, we found that the higher threatening topics were almost only answered after some positive politeness strategy was applied, whereas lower threatening topics were also answered if direct strategies were used. This led us to the belief that the topic of every question has a certain threatening value attached to it and that higher threatening topics should be asked in a more polite manner and probably after some rapport and positive stance is built (as is proposed by the police interview manual).

3.5.2 Influence

The theories on face, politeness and topic threat show that questioning can be done in different ways and that the applied questioning strategy can influence whether someone experiences a threat to their face or not. Our suspect will have to be able to respond differently to different politeness strategies and, perhaps just as important, to different threatening topics. We need to make a distinction between the levels of threat of different topics and combine the information of the applied politeness with the threat of the topic to base how our suspect will respond to this. As mentioned above, the police interview manual suggests waiting with threatening topics until some rapport has been built. This means we need to take this into account when having the suspect respond to threatening topics. Depending on the positivity in his stance, the amount of rapport built and the applied politeness strategy, the suspect would respond differently.

3.6 Pressure and Evidence Beliefs

"Pressure is something you feel when you don't know what the hell you're doing." - *Payton Manning*

At the time during the interview that the course changes to the case related part of the interview, topics that are illustrative for the guilt of the suspect are brought up by the police. **Pressuring** and evidence usually coerce the suspect into confessing to his crime. But are there different ways of pressuring and how important is the amount of evidence? Gudjonsson tried to find answers to this, as well as find out if suspects who confessed due to a certain pressuring technique were more likely to fall back into the negative habits of crime they had commuted in the first place [20, 21].

3.6.1 Theory

Gudjonsson found that convicted criminals usually confess to the police due to one predominating factor out of a set of three factors (even though the overall reason is due to several factors). These predominating factors are **External Pressure, Internal Pressure** and Proof (which we will call **Evidence Beliefs**). Over 70% of the convicted criminals stated that if the police had not apprehended them or pressured them, either directly or through evidence, they would have never confessed to the crime and the police would have been left with far fewer confessions [21]. The most common reason for confessions is the perception of an overwhelming amount of evidence against the suspect. Feelings of guilt and correct pressuring of these feelings by the police was rated the second best reason for criminals to confess. It differed per criminal however whether they even experienced feelings of guilt or shame and when this was not the case, internal pressure was not the reason for confessing [20]. It was clear that the feeling of guilt alone was not enough for suspects to confess. They needed to be confronted with both evidence and emotional appeals by the police officers (a way of pressuring on the internal feelings) in order for them to confess. External pressuring by the police was found to be most effective with suspect of property offences, younger suspects and suspects who had never been interviewed by the police before. All this lead Gudjonsson to conclude that confessions seem related to the type of offence and to attitudinal and personality factors.

3.6.2 Influence

In order for our suspect to deny in a believable fashion and for him to eventually tell the truth and confess (since it is a training simulation where we want to trainee to be able to succeed) we are going to need a way to deal with guilt related topics and how to answer them. The theory on these three reasons for confessions provides an ample basis for dealing with exactly that. We already have different personalities for the suspects and these personalities can be connected to the type of pressuring that is effective on them. For instance, submissive personalities are usually more prone to feelings of guilt [47] and would therefore be more sensitive to internal pressure. Police can use strategies like emotional appeal to increase the internal pressure that is experienced. We also need to keep track of how much evidence is presented by the police in order for suspects to form a belief about this evidence. As stated in Section 2.3, using a network to provide probabilities on the beliefs on this evidence for the suspect, and the chance that he would admit guilt related topics could proof a great way to model this in the final simulation. For our response model, we have to keep it slightly simpler though, since we are not going to work with natural language and thus, also not with topics directly relating to evidence. It should be modelled somewhat simpler. The belief in evidence will increase with each new piece of evidence provided by the police (which can be provided as a factor), but also when a suspect admits to one of these pieces of evidence (since that means he knows that the police now has certainty on for instance his whereabouts at the time of the crime).

3.7 Frame

"Greater than scene is situation. Greater than situation is implication. Greater than all of these is a single, entire human being, who will never be confined in any frame." - *Eudora Welty*

When a conversation takes place between a waiter and his customer, the level of intimacy and trust of that conversation will likely be significantly lower than compared between the customer and his wife, who he is dining with. The relation between the customer and waiter is strictly business, distant and formal, whereas the whispering conversation between the husband and wife is intimate, close and informal. Such a difference can be described to the differences in **frame** between the two.

3.7.1 Theory

The notion of frame was first introduced by Bateson in 1955 as he studied the behaviour of monkeys in different situations [5]. Bateson stated that no communication could be interpreted without a meta-message about what was actually going on, that is, what the current frame of the interaction between the monkeys was. During a play frame, all monkeys knew that certain behaviours were accepted (such as biting) which would otherwise be interpreted as a hostile act. In later years, Fillmore elaborated on this idea, focusing more on frames in human interaction, rather than framing in the animal kingdom. Fillmore stated that a frame is "a system of linguistic choices associated with a scene, where a scene is any kind of coherent segment of human actions" [14]. According to Tannen, conversational frames are repositories for social cultural norms of how to do different types of conversation, such as storytelling, teasing, and small talk [41].

A frame tells us something about what we can and cannot say in that particular frame. The frame that is currently active allows us to decide which assumptions we can make, scripts we take (what we can do), and constraints we have (what we should not do). In his work on framing and interpersonal stances in relational agents, Bickmore talks about framing, a setting in which a conversation takes place [6]. A conversation always takes place within a frame and that frame dictates topics that can be taken for granted, are reportable or excluded. Within the frame of a conversation between two friends, topics like ones love life might be discussed, while this topic might be excluded in a conversation between two strangers at a bus stop. This means that when a certain frame is active, the same stance can be interpreted differently than it would in another frame. Just like biting was accepted by monkeys during the play frame, aggressive stance is an accepted stance during a video game, when for instance someone is losing and shows his frustration about this.

3.7.2 Influence

Within our police interview simulation, we can maintain two different frames that were described in Section 2.2, the person related frame and the case related frame. It is important to make the distinction between these two frames

for a number of reasons. First of all, rapport building and maintaining are done differently throughout the interview. Building rapport through the use of positivity is more effective at the beginning of the interview (and thus during the person related frame) whereas maintaining rapport through the use of co-ordination is more effective towards the end of the interview (during the case related frame). Politeness rules might differ for both frames as well. When talk switches from personal talk to more case related talk, more direct questioning is accepted by the suspect. It would also be convenient to discourage the asking of guilt indicating questions during the person related frame by having suspects respond aggressively and negatively when this occurs.

Summary

Before we move onto the modelling of the communicative behaviour of our suspect agent, it might prove useful to give a quick summary of all information we have gathered throughout this and the previous chapters. Different theories have been explained and their use for our response model has been given. Table 3.2 gives a clear overview of these theories and how they could influence the behaviour that our suspect will show. If we look at Section 8.1 in the Appendix again, the reasoning for choosing certain values for the abstract factors in the question frame should now be clear.

Table 3.2: An overview of the factors that will influence the behaviour of the suspect in our respone model.

Section & Theory	**Influence**
2.1.1: Mood	Suspect has a mood that shows whether he is compliant or aggressive. Internal states and police utterances will influence this mood.
3.1: Stance	The stance as interpreted from the police officer will influence the suspect stance and mood. Suspect will have a stance that influences how he responds.
3.2: Personality	Suspect has a personality that will influence how his stance changes based on a given police sentence. This influences how easy mood changes and how fast rapport is build.
3.3: Rapport	Rapport will need to be build between police and suspect. This rapport will be stored and updated for every utterance.
3.4: Strategy	Strategies employed by the police will be recognized and influence the stance, mood and response of the suspect.
3.5: Politeness	The politeness of a police utterance will influence how well the question is received and influences stance and mood.
3.5: Topic threat	The threat of a topic will influence whether a suspect lies, becomes aggressive or is truthful. This depends on stance, mood, rapport and personality.
3.6: Pressure	Internal and External pressuring techniques can be applied by police and will affect the honesty of the suspect with regard to guilt related topics.
3.6: Evidence beliefs	The beliefs the suspect agent has about the amount of evidence against him will influence whether he will confess at a certain point or not.
3.7: Frame	The difference between the person related interview and case related interview will influence how the suspect responds to different topics in different parts of the interview.

Chapter 4

Modelling Communicative Behaviour

We looked at the different theories that describe the behaviour that police officers show during a police interview and how this influences the behaviour that the suspect shows. In this chapter I will provide all factors that are implemented into our response model and how, by combining and calculations, the response of the suspect is given. Before this could be done however, we had to limit our software in several ways. First of all, the implementation of our suspect response model is based on abstract factors and attributes from social sciences and criminology sciences only. This means that we do not use literal sentences, but look at a more abstract level in which we base our response on input variables, meaning no speech recognition, speech-to-text or text-to-speech transformation is made. Second of all, we reduced the police interview to a Question-Answer format. This simplifies the model in such a way that for each question, an answer can be calculated based on that question alone. This prohibits the system from generating interruptions and backchannels (see [13] for more on backchannels) and other speech acts, but lets us focus on the message being conveyed and how the response is based purely on that information.

An overview of the system is given in Figure 4.1 on the next page. The flow from an interview goes from police officer to suspect and back to police officer, but our system first has to initiate a personality for the suspect. This is explained in Section 4.1.1. After this is done, the police officer can pose a question. The information that describes this question are explained in Section 4.1.2. After this is done, the system requests information from the Interpersonal Status and Suspect Stance and updates this information. This is explained in Section 4.1.3. Finally, based on the new status and stance, the system provides an Answer Frame that the suspect gives to the police. This is explained in Section 4.1.4. How all of this is done internally in the software implementation is discussed in Section 4.2. The software included to this thesis contains javadoc as well to describe everything that occurs.

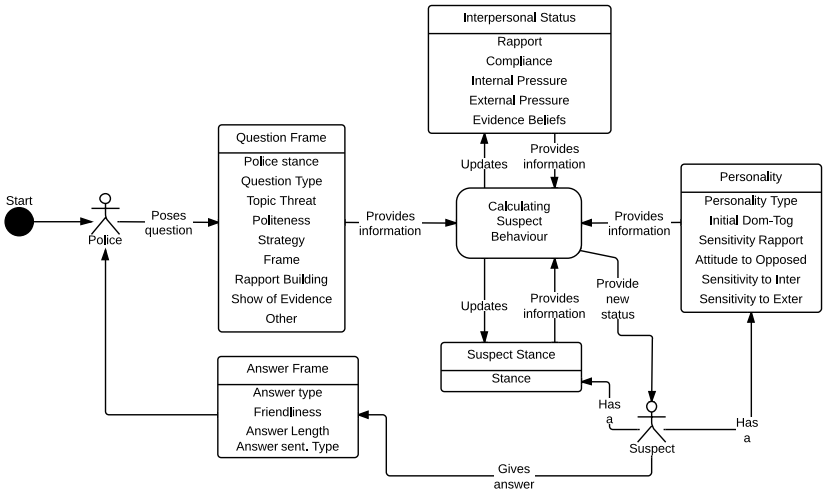

Figure 4.1: The flow of an interview and the general architecture of the response model.

4.1 Interview Flow

In this section the different steps that the response model goes through during the interview will be explained. This flow (as shown in Figure 4.1) is step by step illustrated by the visual representation of the software as shown in Figure 4.2, to make it more understandable. The four main stages that represent the flow are the initiation stage, where the personality for a suspect is set, followed by the questioning phase, where the police question is set. After this the interpersonal status and stance update is performed, followed by the generation of the answer frame. After all this is done, the process returns to step two (the personality is set for an entire interview).

4.1.1 Personality

Before the interview can commence, a personality needs to be set. This is done during the initiation stage, which is also represented in the visual representation as shown in Figure 4.2A, labelled *Initiation*. This personality will be one of the four quadrants of the Rose of Leary. These represent the two personality factors described in [4] as dominance and friendliness. After this is done, an initial stance needs to be set. This is usually dependent on the scenario that is being played. What kind of suspect do we want to portray and how does he feel right after his arrest? Maybe he has been apprehended quietly and brought in without problems, making him submissive at the start. Or maybe a lot of aggression was used and the suspect feels very angry right now. This needs to be initiated. After this is done, his sensitivity towards rapport needs to be given a value between 0 and 100. Someone who is very sensitive to rapport will be more forthcoming with information and more positive overall if rapport has been built or is being built. The attitude towards opposed behaviour is a measurement for linking the likelihood of the suspect showing aggression and aggressive behaviour and how aggressive he becomes from an aggressive approach by the police. Finally, values

need to be given for his sensitivity to internal and external pressure, which will be important when calculating his response on certain allegations. The 'Preset Character' tab is used to select a suspect that was predefined in the code. We used this ourselves during the experiment discussed in Chapter 5. These pre-set characters come with all variables already set. The Human player box is not used in my thesis, but is added in order for a human user to provide the output for the suspect. This could be useful if we want to code answer sentences and give them certain values that we currently provide as output.

4.1.2 Question Frame

The question frame is based on all information that can be present inside the question that is being posed. So rather than an actual question, the question frame is a description of the question. Figure 4.2B illustrates how the variables for the question frame are selected in our simulation, labelled *Police Factors*. The stance of the police officer is the first variable that needs to be provided and is once more, one of the four quadrants of Leary's Rose. If rapport is built during the question, it needs to be provided which of the three types of rapport building is performed (this can be more than one). After this, the question type needs to be given. We have based our question types on the work of Snook et al. [39], who performed a field study of police questioning practices of suspects. The question type can be:

> **Open:** The open question type expects an open telling or account from the suspect (*"Tell me about yesterday."*).
>
> **Yes/No:** The yes/no question type is a question to which a yes or no answer is expected (*"Were you at the gas station yesterday?"*).
>
> **Probing:** The probing question type is a question about a single specific topic (*"Who else was there?"*).
>
> **Leading:** The leading question type includes a suggestion towards the answer (*"You were at the gas station, weren't you?"*).
>
> **Forced choice:** The forced choice question type forces the answer to be one of the suggested options (*"Did you punch or kick him?"*).
>
> **Statement:** The statement question type can be a declaration or other statement (*"I think you were at the gas station yesterday"*)

After this, a topic threat is set, which can be either **Low, Medium, High** or **Guilt Indication**. The first three are about random topics, but the fourth is when the question is posed about something that is directly linked to the crime (for instance, being present at the crime scene, car seen at the crime scene, murder weapon found etc.). One of the four politeness strategies needs to be given as input as well. The frame needs to be provided, which can be either the person related or case related frame. Strategy can contain either none or one of the strategies from the table of ten that we felt was relevant for police interview training. After this, the amount of new evidence needs to be provided. Finally, some other factors can optionally be provided to indicate that the question about the topic is repeated, that a lie is confronted or that the

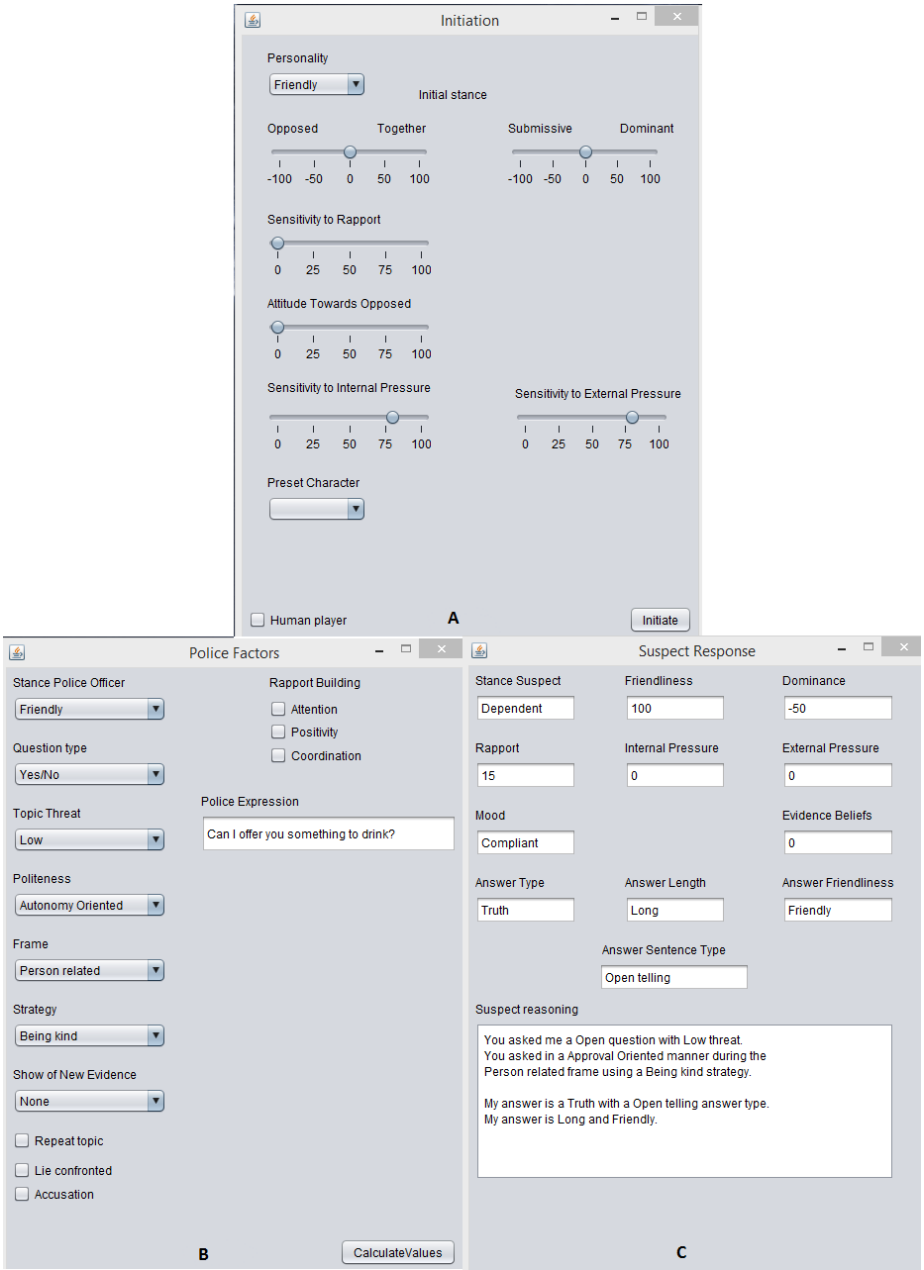

Figure 4.2: The visual representations of the police interview simulation. A: The initiation of the simulation by setting a personality. B: The setting of all question related variables in the question frame. C: The generated output for the suspect as given in the interpersonal status and answer frame.

suspect is actually accused. These three unique options are meant for increases in pressure or to get an actual confession about the crime. See Section 8.1 in the Appendix for examples of how a question frame could be determined based on a natural language question from the police.

4.1.3 Interpersonal Status

Our response model provides both an update in the interpersonal status and generates an answer frame. The factors that are provided in the interpersonal status will be given in this subsection and will be illustrated by the visual representation of our simulation. The stance is kept within the interpersonal status, both as a quadrant of Leary's Rose as by actual values for friendliness and dominance. This is illustrated in the first row of Figure 4.2C, labelled *Suspect Response*. The interpersonal status also provides information on several variables that play a role between the police officer and suspect. First of all, the interpersonal status contains the rapport that is currently built between suspect and officer. Secondly, it keeps track of the compliance (or mood) that the suspect is currently showing towards the police. This can be either compliant or aggressive. The interpersonal status also shows the amount of internal and external pressure the suspect is currently experiencing and also shows the beliefs the suspect has about the amount of evidence that has currently been presented (as mentioned earlier, this could be done by keeping track of his beliefs in a manner as suggested in Section 2.3. In our model however, this will be based on the new evidence provided in the question frame). See Section 8.1 in the Appendix for examples of how a question could affect these values.

4.1.4 Answer Frame

The answer frame consists of four variables that describe the answer that the suspect provides, given a police question, personality and interpersonal status. The answer type can be one of four:

> **Truth:** The truth answer type is given when the suspect wishes to respond truthfully (*"Yes, I paid for gas inside the gas station."*)
>
> **Lie:** The lie answer type is given when the suspect wishes to lie (*"No, I wasn't there, he must've been mistaken."*).
>
> **Avoid:** The avoid answer type is given when the suspect wishes to avoid the question (*"I don't know..."*).
>
> **Aggression:** The aggression answer type is given when the suspect wishes to respond aggressively (*"Piss off, copper!"*).

The answer length provides a description of how long the answer is. This can be either **Long, Short, One word** or **Nothing** (nothing meaning the suspect says nothing, for instance when he shrugs or looks tauntingly). The answer friendliness describes how kind the answer is formulated. This can be either **Friendly, Neutral** or **Unfriendly**. Finally, the answer sentence type describes what type of sentence the answer is, which can be compared to the question type in the question frame. The possible answer sentence types are:

Open telling: The open telling answer sentence type is an open telling or account from the suspect (*"I went to the market, bought some apples, went home, did some laundry, watched some tv, cooked a meal and went to work after that. Came home from the night shift and went immediately to bed."*).

Counter question: The counter question answer sentence type is used when responding by asking a question (*"Are you married?"*).

Aggressive expression: The aggressive expression answer sentence type is used for an aggressive response (*"Piss off, copper!"*).

Yes/No: The yes/no answer sentence type is used when answering with a yes or no (*"Yes I was at the gas station."*).

Play dumb: The play dumb answer sentence type is used when the suspect plays dumb (*"I don't know"*).

Probing answer: The probing answer sentence type is used when answering about a single topic (*"There was no one else."*)

Ignore: The ignore answer sentence type is used when ignoring the police question altogether.

These answer sentence type options were based as a response on the question types by Snook et al. [39]. These four variables are illustrated in the fourth and fifth rows of Figure 4.2C. See Section 8.1 in the Appendix for examples of how the interpersonal status can affect the answer frame values and how an answer frame could be converted into an actual natural language answer.

4.2 Software Implementation

In this section the software that was built for this thesis is discussed. The first part will focus on the classes that were made to represent and calculate values. After that, the calculations that are made to update the interpersonal status and answer frame are discussed.

4.2.1 Class overview

The software that was built to simulate the suspect behaviour is programmed in Java and makes use of javabeans in order to give a visual representation as shown in Figure 4.2. The main class ModelFrame is the class that draws all JFrames that make up the visual representation of the software. In this frame all buttons and sliders are made, including their size, locations and names. Whenever a button is pressed, the action performed method for that button is called in the ModelFrame class. When the initiation button is pressed, all personality traits are set to the Suspect class, the initiation window disappears and the police factors window becomes active. Now all factors for the question frame can be set. When the calculate values button is pressed, the QuestionFrame class is updated with all information from the police factors window and so is the police class itself (containing information like his stance). If no human player or random suspect (see Experiment for more information on this) is selected,

the calculator class is now called to perform all sorts of calculations. These are described in more detail below. The calculator class gets all its information from the Suspect class, the Police class, the Situation class (that contains all information on the interpersonal status) and the QuestionFrame class. When all calculations have been made and all variables in the suspect and situation class have been updated, the answer frame class is updated with the four variables that define the answer the suspect will give. After this all values in the third window, the suspect response window are updated. The lowest text field in the suspect response is updated with an overview of what information was inserted in the question frame and what answer frame factors the suspect provides in return. This is simply a few sentences describing the in and output in order for participants in the experiment (Chapter 5) to quickly see how the suspect responds and why. After this the police factor window becomes active again, allowing for the user to perform another interaction. Apart from getting and setting values, the system also writes all input and output data to an excel file that is generated based on the time and location of the Jar file running. This allows for an easy gathering of data for the interactions with the system.

4.2.2 Calculation class

The calculator class consists of methods that are called from the ModelFrame class in a specific order. The order allows for rapport and stance to be updated first, before updating pressure and evidence beliefs and before deciding on the answer frame content. This is done to ensure that the answer frame's content is based on a new situation and stance which was formed after the police question has been posed. In order to do so, it will first retrieve all information available about the current situation (after the previous answer), which means the current rapport between police and suspect, the current state of compliance of the suspect, his internal and external pressure, his beliefs about the amount of evidence against him, his current stance and all his personality traits. An overview of the methods within the calculator class and the order in which they are called is given in Figure 4.3. This figure also shows which classes provide information as input for the methods (the squares surrounding the calculator field) and which class is updated with the generated output. More details on what input is used per method is shown in Figures 4.4, 4.5 and 4.6 and is explained in more detail below. Two of the most important and complex methods are provided in the Appendix, Section 8.2.

The input and output per method for the first four methods that are called are given in Figure 4.4. The first method to be called is the *calculateRapport()* method, which calculates the rapport between the police and suspect by taking the old rapport and increase it if a new rapport building action was performed or decrease it if this was not the case. The increase is based on the type of rapport building action (Coordination, Attention and/or Positivity) and the frame (person or case related). The reason for this is that some forms of rapport building are more effective during the first part of the interview while others are more effective during the second part (see Section 3.3 and [42]). Decline of rapport occurs if no rapport is being built. This deterioration is low, since we expect a lot of interactions will not include rapport building. This decline is bigger if no rapport is built during the person related frame than compared to

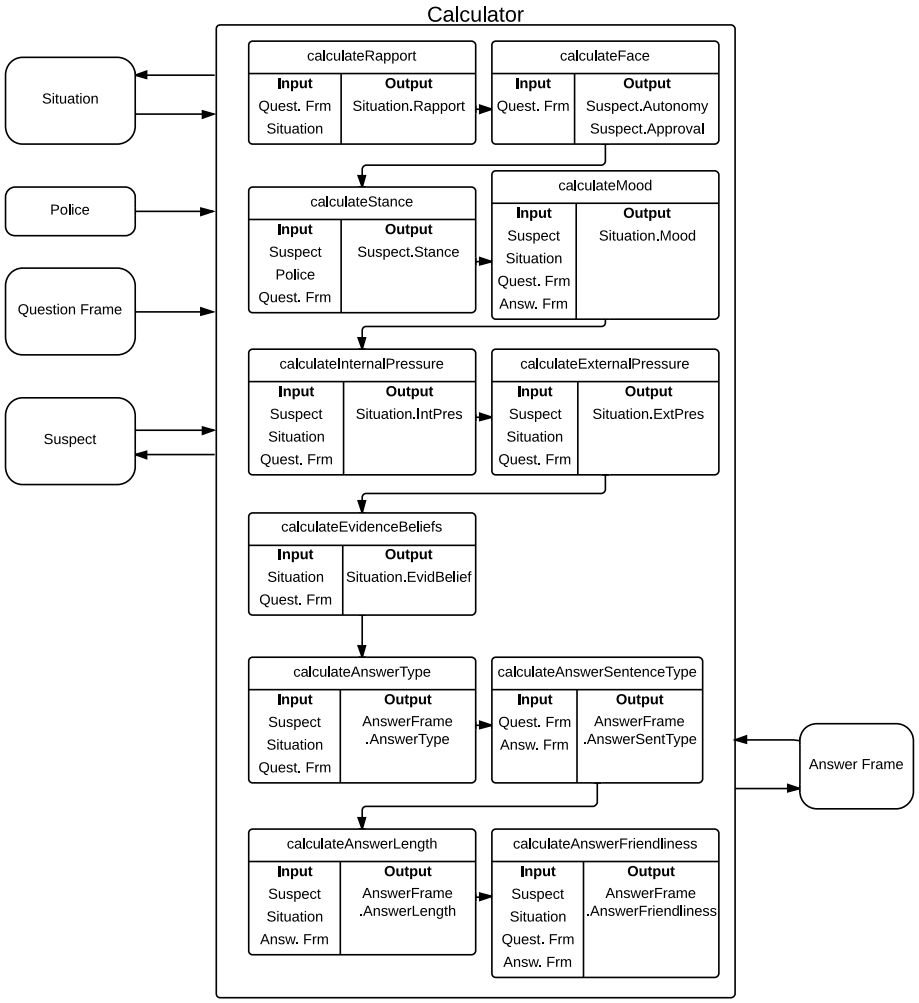

Figure 4.3: An overview of the order in which the calculator methods are called. On the left and right side of the calculator class are the classes that either provide information the methods within the calculator class use, or both provide and receive information.

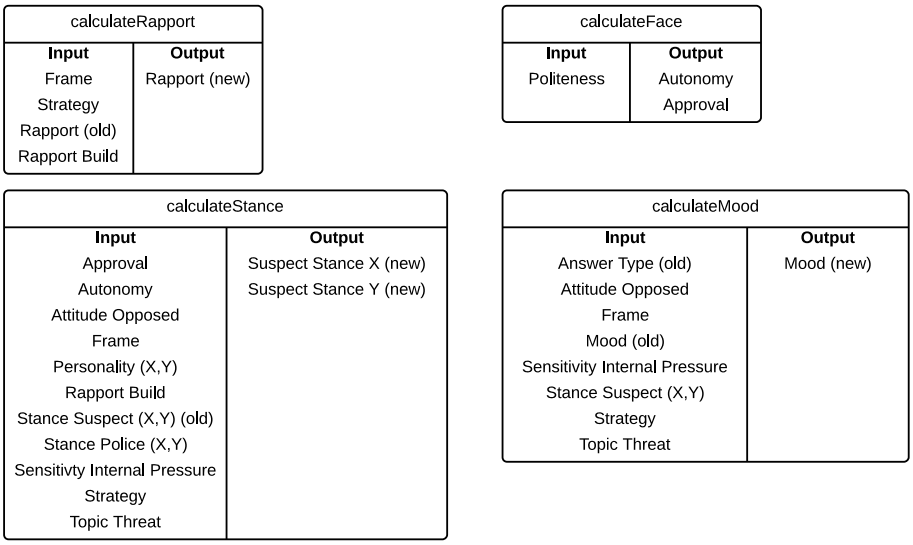

Figure 4.4: An overview of the input factors that are crucial in running the methods to calculate Rapport, Face, Stance and Mood.

the case related frame. If the police use an intimidating strategy, the rapport will decrease greatly as well.

After this the *calculateFace()* method is called to set feelings of approval and autonomy, based on the politeness of the questioning. These values are simply set to either -1 when direct questioning is used, +1 to approval and 0 to autonomy when an approval oriented question is asked, the opposite when an autonomy oriented question is asked and both to +1 when an off record question is asked. These values will influence the stance in the next step.

The new stance for the suspect is calculated when the *calculateStance()* method is called. This is done by looking at the old stance, the preferred stance, rapport building, topic threat, politeness and applied strategies. Since this is a large and important method for our model, this method is provided in the Appendix, Section 8.2.1 (decelerations of variables and constants etc. are left out and can be found in the actual code). Some increases/decreases are larger depending on the sensitivity to those factors (like sensitivity to rapport, opposed behaviour, pressure etc.). The model looks at the frame that is active (person related or the case related). Based on the frame a rapport effect is calculated, which in turn is based on whether rapport is being build in the current question and the sensitivity to rapport. The 'togetherness' of the suspect increases if the police officer takes a dominance stance that is opposite from the preferred dominance stance of the suspect (moving the suspect towards a Friendly or Dependent stance). The 'togetherness' increases if rapport is being build, the topic is not threatening, the strategy is Being Kind, Being Equal, or Emotional Appeal. The 'dominance' of the suspect increases if the police officer uses a threatening topic, strategy or stance.

Table 4.1: An overview of the calculations for the increase or decrease of the suspect's mood. The table shows the factor that influences the mood value, whether it leads to an increase of the positive or negative value and on what the amount of increase or decrease depends.

Factor	**Positive or Negative**	**Dependency**
Previous Mood	$+/--$	Compliant / Aggressive mood.
Intimidating	$-/--$	Non-aggressive personality / Aggressive personality.
Being Kind or Being Equal	$+/++$	Aggressive personalities / Non-aggressive personality.
Emotional Appeal	$+/++$	Sensitivity to internal pressure / Dependent personality.
Direct Pressure	$-/+$	During personal related and previously avoided or aggressive / During case related and previously lied.
Stance	$++/--$	Stance on together side / Stance on aggressive side.

The *calculateMood()* method updates the compliance of the suspect. This update is based on the previous state of compliance, the new stance of the suspect and the optional strategy that might have been employed by the police. A positiveness value and a negativeness value are kept and increased throughout the method. At the end, the two are compared and the largest value determines the new mood of the suspect, compliant or aggressive. These factors and whether they increase the positiveness or negativeness value are summarized in Table 4.1. If the previous mood was compliant, the positiveness value is increased, otherwise the negativeness value is increased. Negative strategies like intimidating will increase negativeness either a lot (when the personality of the suspect is aggressive) or by a smaller amount. Kind strategies will increase positiveness by a larger amount if the personality is not aggressive, or slightly if this is not the case. Emotional appeal will have a large impact on submissive personalities (introverts who experience more feelings of guilt and shame [47]) and a large impact on suspects with a sensitivity to internal pressure. Direct pressure or repeating of a question will lead to negativeness if the previous answer (which was to that question that is now repeated) was during the person related frame and was avoided or aggressively responded to. If the previous answer was during the case related frame and a lie however, this will lead to compliance (since the trainee is correct by not dropping this topic yet). A negative stance will add to the negativeness whereas a positive stance will increase the positiveness. After all this, the negativeness and positiveness are compared and based on the highest value the compliance will be either aggressive or compliant.

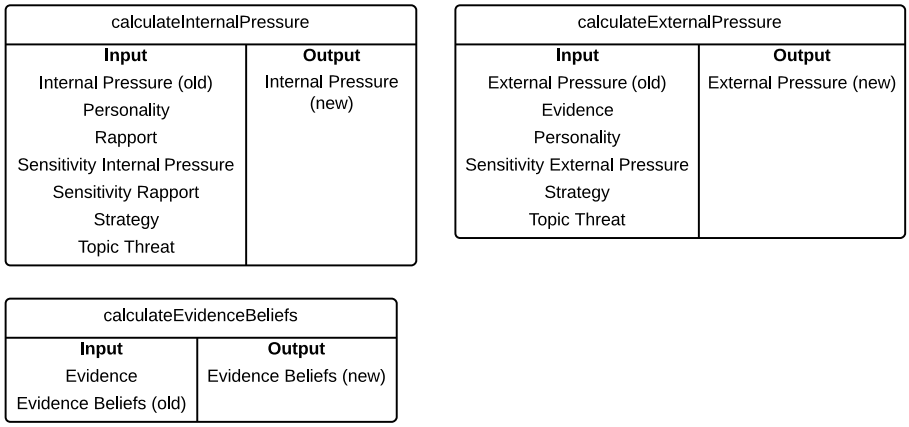

Figure 4.5: An overview of the input factors that are crucial in running the methods to calculate Internal Pressure, External Pressure, and Evidence Beliefs.

When rapport, face, stance and mood have been calculated the internal and external pressure and the suspect's beliefs on the amount of evidence against him are calculated in the methods *calculateInternalPressure(), calculateExternalPressure* and *calculateEvidenceBeliefs()*. The input and output provided and generated per method are given in Figure 4.5. Based on strategies, sensitivity and optional fields like 'lie confronted' and 'question repeated', the pressure values will increase or remain the same. These pressure values are indicative for the pressure the suspect is experiencing about the particular topic that is being discussed. Whenever a suspect tells the truth about these topics, the pressure is dropped to zero again (since the pressure is built in order for police to get a truthful answer, rather than a lie). The suspect's evidence beliefs will be updated if new evidence has been provided by the police (this belief will also increase whenever a suspect tells the truth about a guilt indicative topic).

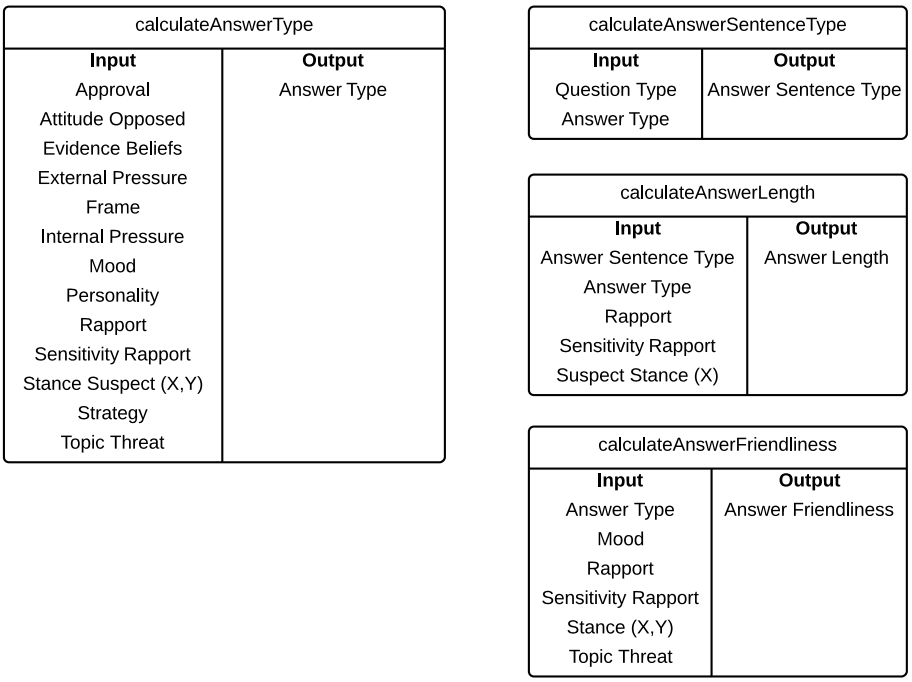

Figure 4.6: An overview of the input factors that are crucial in running the methods to calculate the Answer Type, Answer Sentence Type, Answer Length and Answer Friendliness.

After all these suspect and interpersonal status traits have been updated, the actual response from the suspect is calculated. The output from these methods updates the answer frame. This frame contains four attributes that describe the way the answer of the suspect is given. An overview of the four methods that are called in order to fill this frame and their respective input values is provided in Figure 4.6. First the answer type is calculated by calling the method *calculateAnswerType()*. The outcome of this method is based on a large amount of data: approval, pressure values, stance, evidence beliefs, rapport, threat, mood, frame and of course the sensitivity for these attributes. Since this is also one of the most important methods of the model, the method is provided in the Appendix, Section 8.2.2. An aggressive mood will always result in an aggressive answer type. If this is not the case, we look at the frame. Within a frame, we look at how high the topic threat is. If this threat is high, more togetherness and/or rapport is required for the suspect to respond truthfully. Based on attitude towards opposed and personality, the suspect might decide to avoid or lie. If the stance is aggressive and the personality is aggressive, the answer type will also be aggressive. For lower values of topic threat, the threshold values of togetherness and/or rapport in order to respond truthfully will be lower as well. Guilt indication topic threat within the personal related frame will always be met with either aggression or avoidance. Whenever the case related frame is active, guilt indication will have a different calculation. It will be dependent on the amount of pressure that has been built against the suspect, his stance and also the strategy that is employed.

After the answer type, the answer sentence type is calculated by calling the *calculateAnswerSentenceType()* method. The output of this method is based on the answer type and the question type. For instance, if an open question was posed by the police, the suspect will give an open telling answer sentence type if he answers truthful or is lying, but asks a counter question if he wants to avoid the question. A yes/no question will be answered with yes or no if truth or lie is told, but a play dumb reaction is given when the question is avoided. This is done for each question type that is available (see Section 8.2.3 for all possibilities). Currently, all question types have a maximum of four different answer sentence types attached to them, based on the answer type. In the future we might make more combinations, based on the scenario and/or topic of the question.

The method *calculateAnswerLength()* will provide the length of the answer, which is based on the answer type, answer sentence type, rapport and stance. For instance, when a truthful open telling is given while the rapport between officer and suspect is high, the length is long, because a lot of truthful information is provided. When this is a lie however, this length is short, since a trademark of lying is short answers with as little information as possible, lowering the risk of being caught [11, 47]. The length can also be short when no rapport between the suspect and officer exists or when his stance is not positive enough.

Finally, the friendliness of the answer is calculated in the *calculateAnswerFriendliness* method. The output of this method is based on stance, mood, rapport and answer type, together with the potential topic threat. High threats require a more positive stance and rapport effect to still be answered friendly compared to lower threats, while guilt indicative questions are answered neutrally or unfriendly.

Chapter 5

Experiment

In this chapter I will discuss the experiment that was held to evaluate the model. The rationale behind this evaluation is as following: Suppose we describe different personas in terms of personality traits and sensitivity to some other factors that influence their behaviour in a police interview. We implement these personas, which are based on characters from our existing police interview corpus, in our response model. If the response model captures these different traits correctly, participants should be able to successfully identify who they are interacting with, based on the behaviour that the suspect agent shows.
Participants of the experiment will take on the role of police trainees and describe questions they wish to ask the suspect. They describe these questions by means of the abstract factors that were discussed in the previous chapters. The suspect will provide an output response in same terminology, based on the response model. This evaluation required the participants of the experiments to become familiar with the abstract factors (stance, rapport, threat, etc.) that were used to direct the behaviour of the suspect. By letting the users choose all these factors themselves, we could rule out noise created when a participant selects a certain sentence and thinks that the sentence is for instance aggressive and with a high topic threat, while someone else might consider the same sentence as defiant with low topic threat. By letting the participants select the values for stance and topic threat themselves, they could describe the exact core features of the question.

5.1 Participants and Procedures

A total of 48 participants (42 male, mean age 24.8 with SD 3.7) volunteered to take part in the study. Participants had to use the system I created through the use of the visual representation given in Figure 4.2. The task for the participants was to interact with the simulated suspect in order to form an hypothesis about who they were actually interviewing. The participants were thus unaware of which suspect was initiated at the first step of the interview and they had to decide on who this was, based on their own experience with the simulated suspect. Three suspect personas were created, based on suspects from the DPIT-corpus [2, 8]. The initiation values for our three persona's (personality, initial stance, sensitivity to rapport, attitude to opposed behaviour and sensitivity to

both internal and external pressure) are given in Table 5.1. Each persona was introduced in a small text:

> **Van Bron:** Mr. van Bron is known to the police. He has several drug related prior arrests and some for nuisance and not following police instructions. Van Bron is known as a difficult person to deal with. He comes from a past of abuse and negligence and has grown up in foster families and boarding houses. He isn't a friendly person and feels comfortable in situation where he can boss people around with harsh words and aggression. He has been brought in for questioning about a fight with his neighbour and his arrest didn't go smoothly at all.
>
> **Remerink van Bergen:** Mr. Remerink van Bergen is upper class and finds status and personal appearance important. Under normal circumstances Remerink van Bergen is a kind and helpful individual, especially when he is treated with respect. However, if this is not the case he can cause problems/annoyance. He is taken in for questioning about money that has disappeared at his country club and is angry about the way he was arrested in front of all his neighbours. He feels his image has been harmed by the way he was taken in.
>
> **Huls:** Mr. Huls is a kind person who has gotten himself into a difficult situation. He has increasing debts and although he does have job, this work does not provide a solid income. This makes him feel like a failure towards his family. He is well-spoken and an emotional person who finds feelings of others important and who isn't unfamiliar with feelings of guilt towards other he might have hurt. Huls is brought in for questioning about money that disappeared at a gas station. He came with the police without any problems.

Table 5.1: The values set for the three individual suspect personas.

	van Bron	**Remerink van Bergen**	**Huls**
Personality	Aggressive	Friendly	Dependent
Stance together	-80	-20	80
Stance dominant	80	50	-20
Sens. rapport	10	70	90
Att. opposed	90	60	15
Sens. int. pres.	75	50	90
Sens. ext. pres.	0	50	80

Before the participants would enter the room where the actual simulation took place, they were greeted and instructed on their task. They would receive two forms, one giving the description of the three suspects as given above and another form with elaborate explanation of the factors in the mental model (e.g. stance) and the aspects of the contributions of both the police and suspect (e.g. an aggressive stance). Each factor was explained and illustrated with several examples. The list of explanations is given in the Appendix, Section 8.3. Participants were encouraged to ask questions if something was unclear to them.

Choice of suspect 1: □ van Bron
□ Remerink
□ Huls

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I am sure of my choice of suspect					
I found the suspect reacted realistically					
I found the factors I had to set for the police clear					
I found the factors that described the behavior of the suspect clear.					
Before the experiment I was familiar with Rapport.					
Before the experiment I was familiar with Stance.					
Before the experiment I was familiar with Face threat.					
I quickly became familiar with the functioning of the system.					

Figure 5.1: The short questionnaire participants had to fill out after their interview with the suspect.

Once everything was clear they were allowed inside the experiment room where two pc's were available, allowing two participants to participate in the experiment simultaneously. When a participant filled out the abstract factors values and pressed calculate values, the suspect's response model calculated its next state based on these factors and displayed this state. This was then repeated to give the participant a feeling for the flow of a conversation with this persona. During the experiment the explanation of the factors and the descriptions of the personas continued to be available for reference.

Participants interacted two times with the system. Each participant interacted once with one of the three personas and once with a random suspect response generator (not based on a persona or mental model). The order of real suspect - random suspect was distributed evenly over the 48 participants. After three utterances followed by replies, the simulation showed a pop-up window in which the participant was asked to guess who he was interviewing. After this the participant was free to continue interviewing the suspect until a maximum of eight utterances. Examples of different interactions (in this case, an interaction is the entire input/output dialogue between user and system) can be found in the Appendix, Section 8.4. For each interview, the participant had to fill out a questionnaire after they were done, which is shown in Figure 5.1. The confidence in their choice and how they rated the interaction on realism were collected on a 5-point Likert scale (1=totally, 5=totally not). Finally, the participants were asked to report their familiarity with the concepts and terms used in the experiment.

5.2 Results

A total of 39 (81.25%) participants guessed correctly with which persona they were interacting after a maximum of eight utterances. The van Bron suspect was recognized correctly 100% of the times, suspect Remerink van Bergen was recognized correctly 68.75% of the times and suspect Huls was recognized correctly 75% of the times. Comparing the correct and incorrect guesses showed that the difference in confidence for the participants who were correct compared to the participants who were incorrect is 4.41 (SD = 0.59) compared to 3.67 (SD = 1.11). This difference was weakly significant ($Z = -2.001, p < 0.1$) (see Section 8.5). The realism rating was practically similar (3.90 SD = 0.50 compared to 3.89 SD = 0.60). The amount of utterances that users had with the system when they were correct was 5.38 utterances compared to 5.89 utterances when they were incorrect. Analysis of interactions that lead to an incorrect guess showed that it occurred four times that Huls was misinterpreted as Remerink, three times that Remerink was misinterpreted as Huls and two times that Remerink was misinterpreted as van Bron. Discussion of these results can be found in Section 6.1 and an example of the interaction of one of these incorrect guesses is given in Section 8.4.

Before we can compare the results between random output results and actual suspect results we need to look at the order in which the two interactions were performed by the participants. Does it matter if they first get a random output followed by an actual suspect output or first get an actual suspect output followed by a random output? In order to check this we compared the certainty and realism ratings of the random output groups, based on the order in which they were presented to the participant (either first or second). We found that participants who rated the certainty of the random output in their first round rated this with an average of 3.63 (SD = 0.77) compared to an average of 3.29 (SD = 0.75) if the random output was generated in the second round. This difference was not significant. The difference in realism when rating between random in the first or second round was 3.54 (SD = 0.88) compared to 3.17 (SD = 0.87). This difference was not significant either (see Section 8.5), which means we can assume that the order in which the random output was given to the participant had no influence on how they rated the random or suspect.

In the interactions where the responses of the system were random we expected that each of the personas would be chosen an equal number of times (33% of the times, meaning 16 times per persona in this experiment). However, Remerink was chosen as the persona in 62.5% of the rounds (30 times), van Bron was chosen 20.8% of the times (10), and Huls 16.7% of the time (8). This means that the random output was seen as Remerink in a significant amount of the cases (0.33 is far outside the significance interval when 30 of the 48 guesses is Remerink). This interval is: $\text{SI}(p < 0.05) = [0.625 - 0.138, 0.625 + 0.138]$.

The average certainty level for interactions with personas was significantly higher 4.27 (SD = 0.76) compared to 3.46 (SD = 0.77) for the random interactions ($Z = -4.2, p < 0.001$). The average level of realism for personas was significantly higher 3.90 (SD = 0.52) compared to 3.35 for random rounds (SD = 0.89) ($Z = -3.7, p < 0.001$). The average amount of utterances the participants used

when facing a persona was significantly lower 5.48 (SD = 2.13) compared to 6.25 (SD = 1.95) utterances when facing a random output ($Z = -2.3, p < 0.05$) (see Section 8.5).

After the experiment, we informally asked participants about their experiences during the experiment. People who interviewed the random suspect first reported that they started doubting their decision on the first suspect after they had interacted with the second suspect. They felt more certain about the second suspect. They also felt the first to be more random after they had interviewed the second. They reported the second suspect met their expectations of one of the three suspects. Some participants struggled with the feeling that when they had chosen a suspect for the random output they felt they could not pick that suspect again at their second run. They felt this way because the output was different from the first and they did feel some sort of certainty on their first choice. This led to some people mistakenly choosing Huls at their second run with the system, when in fact they were interviewing Remerink (but they had already pointed out Remerink as the suspect in the first, random, interview).

People tended to base their decision on parts of the output generated by the suspect rather than look at all the output. They tried to rationalize 'weird random output' and actively tried to find reasons to consider it as correct and realistic. This caused an overestimation of how realistic they found the random suspects, as well as how certain they were of their choice of suspect when the suspect was in fact a random generated output. These results are discussed in more detail in the following section.

Chapter 6

Discussion

In this chapter I will first shortly discuss the results from the user experiment described in the previous chapter. After this I will further discuss the response model.

6.1 Experiment

Having 81,25% of the participant successfully recognize what suspect they are currently interviewing is a positive signal, since this is clearly higher than the chance at guessing it correctly (33,33%). It seems that even with a small amount of utterances, our participants are able to identify the personality type that is being portrayed by our simulation. The realism score of 3.9 on average that participants gave when interviewing an actual suspect, which was significantly higher than that of the random output, shows that the short term behaviour that the suspect shows is found realistic enough by the participants and more realistic than the behaviour of randomly generated output. The fact that participants were also significantly more certain about their choice when basing this choice on an actual suspect shows that the response model generated output that the participants expect from a suspect, whereas the randomly generated output leaves participant uncertain about their guess. If we look between the correctly and incorrectly guessed suspects we see that even if the participants who guessed incorrectly were significantly less certain of their choice (which means the output might have been confusing or the input unclear), they still felt the suspect to be realistic, significantly more so than compared to the random output generated.

Most participants were able to recognize the correct suspect and were confident in their choice, but it is perhaps more interesting to see why 18.75% of the participants were not able to do this successfully. Since the number of participants this amounts to was only 9, I looked into the interactions that these participants had with the system to try and get a better understanding what went wrong. I also paid extra attention when interviewing these participants after the experiment to see if perhaps they gave a clear indication as to why they guessed incorrectly. As already mentioned in the previous chapter, some participants who guessed wrong, did so when the real suspect was initiated dur-

ing their second run and that suspect was the same as the one they had already chosen during their first interaction run. The fact that the participants were so determined that they had guessed the first suspect correctly (even though there was no correctly during the random run, but of course they were not aware of this) made them choose a different (and incorrect) suspect at their second run. This accounted for three of the nine incorrect cases.

Some participants mistook behaviour that Huls showed as Remerink behaviour. The reasoning for this is that the participants felt the suspect agent responded too aggressively to some factor input, which they did not expect the Huls suspect to do. This was the case when they initiated a guilt indication topic threat while being in the person related frame. This frame is meant for the beginning of the interview and should be about light topics. Trainees should try to avoid talking about guilt indicative topics during the person related part of the interview, because suspects might shut down completely if this is done too early during the interview. To refrain trainees from talking about the case in this frame, the model keeps this in mind whenever a guilt indication threat is detected by having suspect agents respond aggressively towards these kinds of questions during the person related interview. In our experiment, this meant that everyone, including Huls, would react aggressively to guilt indications during the person related frame. People felt this to be more in line with Remerink, which is understandable, since he too would react in this way. However, by only looking at that fact when deciding on who the suspect was, they made an incorrect guess. This accounted for two of the nine incorrect cases.

In some cases the participants asked one friendly question, followed by an aggressive question, while interviewing Remerink. The behaviour shown is slightly friendly, followed by aggression. After this, the participants switches to a more friendly questioning style again and Remerink follows suit. The participants remains asking friendly questions and Remerink remains friendly as well. The participants seem to think that this is evident of behaviour shown by Huls, while they do not take into account that Remerink would also remain friendly. This shows that the model provides understandable and logic responses for the suspect, but that participants forget to check his response to other questioning styles. This accounted for three of the nine incorrect cases.

One participant who guessed incorrectly used only three utterances and all three were case related (even though we explained the differences in frame and that the interview supposedly started at the beginning of a real interview). The responses were lies and avoidance (suspect Huls) while continuously taking a dependent stance (turning closer and closer to withdrawn with each utterance). Rather than guessing Huls, the participant guessed Remerink, which we could not really account for.

Another odd thing we found was that even though participants felt the suspect was showing odd behaviour (and even realised it, since several participants mentioned that the suspect was sometimes both aggressive and friendly at the same time) the participants still filled out the realism level of the suspect at 3 or 4, rather than 1 or 2. Some participants seemed to look only at a part of the output generated in the suspect field and not the whole picture, so even when

two parts of the response description were counter intuitive, the participants felt it to be realistic enough. It also occurred that participants tried to rationalize the behaviour that the random output produced. For instance, the participant thought they were interviewing Remerink, made a hypothesis and choose several factors for the next question to confirm this hypothesis. They believed that if the suspect would be Remerink, a certain response could be expected. If half of the response values did not show anything they expected, but the other half did, they would think that the correct half was more important and probably indicative to the fact that they were right about their idea of suspect. This phenomena is known in literature as a *confirmation bias*, the seeking or interpreting of evidence in ways that are partial to existing beliefs, expectations or a hypothesis in hand [31, 32, 54]. This is of course understandable, since the participants were told that one of the three suspects would be interviewed, so they always tried to rationalize the output to fit at least one of the suspects. Apparently the description of Remerink was the best justification for seemingly random output.

6.2 Response Model

The response model was built to simulate the interaction over an entire police interview. The theories that are applied within the model are applied in such a way that reactions from the suspect are usually not suddenly the exact opposite from what has been occurring the past utterances. This means that someone who has taken a maximum together and dominance stance (being in the Friendly quadrant) will not take a fully withdrawn stance after one utterance (fully negative on together and fully negative on dominance). This however does not mean that a friendly response is given to fully aggressive and negative approach by the police. By making a distinction between the stance of the suspect and the mood he is in, we can keep the theory of stance (that states a stance is usually maintained at least over a certain period of time) while still responding negatively to negative police utterances, by changing our mood to aggressive. Furthermore, the model allows the building of rapport to have a visible positive effect on the long run, by allowing a high rapport rating to ensure more positive results in answer results. Someone who is not highly together, but more neutral, will still respond positively to for instance a high threatening question, if they feel like the rapport between them and the police is at a high point. Still, a combination of positive stance and rapport will have the most positive effect, even on the long run. Using sensitivity towards things like rapport and opposed behaviour allows for a more dynamic creation of a suspect to fit the scenario the police wish to change. Do they want students to learn that there are also aggressive suspects that will almost never respond positively, no matter what you do? Just set up a personality that is aggressive, high on opposed behaviour, low on sensitivity to rapport and low on sensitivity to the two pressure types.

By having a distinction between two types of pressures, the system can deal with different approaches that the police can take to acquire a confession or new information about the crime. The building of a scenario is less restrictive if the system can already deal with several different types of scenario parts, like an emotional part or a pressuring part. In such a scenario, there can be

again different suspect personalities to train the police in learning that one approach might work on someone whereas it will be ineffective against someone else. Using evidence to enable the correct use of 'lie confrontation' also helps with providing a more dynamic interview. Suspects will often lie about guilt indicative topics when they are guilty, but if a scenario is built that includes evidence for the police, trainees can surround the suspect by forcing him to either tell the truth or tell a lie that they can contradict. Contradicting such a lie will lead to an increase in pressure and belief of evidence, leading to a more truthful response after this confrontation. This is exactly what the Dutch police teaches their students, encircle a topic until the suspect can no longer lie about it due to the high amount of proof and pressure.

The problem with a model that can be used over a large amount of utterances is successfully validate that it works over so many utterances. Can we validate this right now? The short answer would be no, we cannot validate this right now. However, there are several things that need be mentioned as to why this is hard to do. First of all, the model currently functions through the use of abstract input and output and can be used like this in the final simulation software as well. The visible layer for users however will be full written sentences for questions and answers (that within them hold the abstract values that our model works with). In order to test an entire interview with this, we need to create a scenario, suspects and sentences befitting of the scenario. To test certain actions at the end stage of the interview with our response model would require a rerun of the entire interview over and over again (since past actions also have an effect), while continuously taking the responses of the model in consideration before posing the next question. For a Master Thesis all of this is simply too time consuming to do to validate, hence we validated at least a part of the model, the short term response modelling that shows the responses to the first few user utterances. Of course more utterances can be made and an entire interview is functional and modelled according to the theories described above and should therefore still provide a correct suspect behaviour output. A second problem lies with the fact that we simulate human behaviour and that such behaviour is hard to label as "incorrect behaviour". This is both an advantage and a disadvantage. Yes, the model shows responses that might seem like correct human behaviour, but does it also function according to the theories that police officers are taught? That is exactly what the model currently does. Wrong actions will be punished by a negative output and correct actions will be met with a positive output (maybe it takes several utterances, based on personality traits, but eventually positive actions will lead to positive results). This is exactly what we wanted our model to do, so even though it has not been validated through the use of hour long interview tests, the basic foundation which is based on all theory taught to police trainees is correctly modelled. It should provide an ample interview simulation that can be used to train police trainees to refrain from certain actions and perform other actions that lead to a positive outcome.

The software is written in Java, one of the more open and easy to change programming languages. The ModelFrame calls for all calculations in the Calculator class separately, meaning that new calculations can be added as simple as adding one call within the ModelFrame and adding a new calculation method

in the calculator class. If you want the response from the suspect to be influenced by this new calculation, the methods for the answer frame can be easily adjusted by adding the new information or changing the original code. This allows for an easy adjustment within the model itself. Some variables that are used within the calculation model are determined by own intuition, but can easily be altered. For instance, I use a -100 to 100 scale to represent the values for the togetherness and dominance of the stance of the suspect. It could be that this range is too small for some actions and that a range of -1000 to 1000 is more suitable. This can be changed without too much hassle in the code and the system could still function. If someone would want to use the response model but within a different visual representation, all separate classes that receive and provide information can be taken, including the calculator class. Rather than have the ModelFrame update the classes through the use of the fields as presented in our visual representation, a new class could be written to provide this information and to call for the calculator methods.

The system produces a log file for every interaction that is performed by the user. This means that every question frame and the corresponding interpersonal status and answer frame are documented for each question. For my thesis this was important to be able to look back at the data and find out why users made incorrect guesses or simply to see what kind of actions users preferred to take during the experiment. This backup however can be used for a far more interesting application, namely that of building a database filled with questions and answers. Users of the response model can already fill out a police expression in the question frame. During the experiment, this field was optional and was not used in the model calculations. This expression is saved however in the excel file, along with all other information. This means that a combination of expression and question frame factors can be saved, giving the option to build a database with sentences that have a value for things like question type, threat etc. attached to them. This will be a next step, described in the future work section below.

To conclude this discussion section, I look back at the beginning of my master thesis and the questions I asked myself there:

How should we model the social behaviour that a suspect shows during a police interview?

Does such a model provide realistic social behaviour?

During the course of my master thesis I have looked at a lot of different theories on police interviewing, social behaviour, lies and deceit and many more topics. Not everything was deemed relevant enough to include in my final suspect response modelling system, but it gave me a clear idea on how to build such a system and what things were important and what things were not. I have modelled social behaviour through the use of different factors that describe a question and by basing an answer frame on factors that are important for a suspect to show in a police interview. These factors were based on theories described in the Dutch police training manual [3] and factors found by our own study [8]. Those behaviour changing factors, supplemented with ideas from

the studies of [29, 33] gave a clear basis for my simulation system. To answer the question whether this model provides realistic social behaviour I can only point towards the results of my user experiment. Based on the scores given by participants of the experiment, this model shows behaviour that is more easily recognized as realistic behaviour compared to random output generations. This means that the characteristics of human behaviour are, at least according to our participants, modelled in a realistic fashion. We could ask ourselves if there are no better or simpler models that could provide the same certainty and realism ratings as this model did. Perhaps there are models that, if the same experiment was conducted, would result in the same or better results. We have no model to compare the model we created to. However, we can say that:

> **A:** Our model is based on scientific theories from behavioural sciences and criminological sciences that explain how someone should behave during a police interview.
>
> **B:** Our model makes a clear distinction between the factors that lead to certain behaviour, allowing for reasoning and pinpointing the source of a response. This in turn can be used to train police officers on certain aspects of an interview.
>
> **C:** Our model, in its current form based on these theories, provides a realistic suspect agent in a police interview.

The goal of this thesis was to look at factors that should drive a suspect agent in its response behaviour and to model this in a realistic fashion. This goal has been achieved throughout this thesis. We should also not forget that the final simulation is meant for police officers to train certain interview skills. They will need to learn how to approach different people in different ways to uncover the truth and detect lies. This response model provides differences in deceitful and honest behaviour, which in the final simulation can be met with verbal and non verbal cues to deceit. It also allows for different personality types that require different approaches in order to succeed, something that is also important for police officers in training. In the future, improvements and changed might be necessary to improve the quality of the suspect response or to allow functionality inside the entire simulation system. Potential improvements are discussed in the next section.

Chapter 7

Future Work

Since this thesis was part of a much bigger project, there are many different things that still need to be done. Some things are related directly to the behavioural model that is described in this thesis, whereas others are related in a different way. In this chapter I will discuss several future work ideas that are related to how the behaviour that the suspect agent shows should be calculated and how the behaviour should be presented visually and vocally.

7.1 Response Model Calculations

Currently, a suspect is modelled according to several personality traits that we deemed important enough for a first behavioural model. The behaviour is based on factors of an abstract level. In the future, we might wish to look at some more traits and how they influence the course of an interview. For instance, we have not looked at the difference between male and female suspects and as a result, based our experiment on three male characters. It could be that females have a different response pattern to factors we currently include. For instance, there might be topics that are more threatening to males than to females. If we wish to portray different suspects, we might want to do some research on whether this influences behaviour in a police interview at all.

In the study performed by Luciew et al. [29], non-verbal behaviour by the police officer was taken into account when deciding how the suspect should respond. One of the prime factors that they looked at for this influence on the suspect was proxemics, the reaction of an individual in relation to the immediate surrounding area including the animate or inanimate objects within that area [24]. This means that the suspect can respond differently if the police is in their social space (a space generally between 3.6 meters and 1.2 meters away from the person), compared to when the police is within their personal space (between 0.45 meters and 1.2 meters) or even intimate space (closer than 0.45 meters). This could be perceived as more threatening or more pressuring (according to the theory, it builds an extra amount of stress). If a police officer enters this comfort zone of a suspect, the general biological reactions is stress, which officers can use in their interview techniques [29]. In a future simulation it would be interesting to add such a choice to the domain, having another factor influence

the reasoning behind the response from the suspect.

If police officers are going to train for an actual police interview, they are going to need to train their speech as well. Sometimes, something meant kindly can sound angry, intimidating or judgemental. This intonation and prosody can only be measured and used if some form of speech recognition is used. In future studies, there needs to be a group of people working on speech recognition and determining valuable information like prosody and intonation and send this information to the mental model that can then use this information to help base its reaction on. Backchannels and interruptions need to be added to the system before calculations can be made. These are part of the speech recognition as well but provide an extra stream of information for the mental model. Backchannels are ways for the police officer to show he is paying attention to the suspect and understands what the suspect is telling. These could function as a way to build rapport (attention and positivity) and allow the suspect to have a more positive relationship with the police. Interruptions on the other hand can lead to several results. For instance, if the suspect is someone who is not used to being interrupted, this might lead to an act of aggression from the suspect, whereas it might sometimes be better to interrupt a suspect that is telling a large story that contains no valuable information whatsoever. Sometimes interruptions are used when the suspect tells something that the police knows to be incorrect and wishes to correct. All these different types of interruptions have different motives and should also have different response results from the suspect, something that we should work on in the future.

Finally, we need to build a scenario (situation of crime, details of evidence, description of suspect and its personality traits etc.) and corpus of police questions with an annotated semantic frame, containing the information used in the response model. This allows for an actual interview to be played. Adding this step in the future should not be too hard, especially since the current system provides an easy way to store sentences and factor values in one excel file already. If this is done for a scenario with a big corpus of possible questions, the ModelFrame can be adjusted to for instance a selection of question topics and question types and show a list of possible questions that the officer can ask about the selected topic with the selected question type. For instance, if a topic is selected about drug use and the open question type is selected, there might be some sentences like "Tell me about your drug use.", "Can you give me an account of your drug habits?", "I need you to tell me about your drug use, now!" etc. These sentences would have different politeness, stance and other factors attached to them, that can be sent to the calculator to provide new feedback. This would already start to resemble an actual interview. The beliefs a suspect has about his current situation and the influence that his beliefs on the evidence gathered against him have, which I suggested to be illustrated by use of a Bayesian network, need to function together with the response model. The response model bases its responses on behavioural factors, but facts like "You have been seen at the crime scene, both by witnesses and a camera" need to be responded to with honesty, since there is too much evidence to deny it. This means that a network that keeps track of the suspect's beliefs needs to be able to update the response model of this knowledge so that an appropriate answer can be formed.

7.2 Behavioural Output Generation

Currently, the model generates an output that is divided in two parts, the interpersonal status part and the answer frame part. The answer frame consists of four variables. The combination of these four variables leads to a description of the answer. Just like generating an actual natural language question, based on all question frame factors (as described above, in order to make a corpus of questions), the same needs to be done with building a corpus of actual natural language answers with information from the answer frame. One key factor here is that the answer from the answer frame needs to be linked directly to a question from the question frame. For instance, a yes/no answer sentence type cannot be given to a question that is posed as an open question (or maybe it can, answering "No" to the question, "tell us about your day yesterday" is in fact a correct possibility). All these possibilities need to be taken into account and a combination of answer frame options needs to be linked to each question that is posed. Currently, the answer frame is slightly limited. As given above, to an open question, one can either respond with an open telling (tell a short lie story or perhaps a long honest account), a counter question (an avoidance tactic) or by an aggressive expression. "No" in this example might fit the aggressive expression, if the friendliness is unfriendly, but since we make a distinction between aggressive expression and yes/no answer type, this is not entirely correct. The only way to correctly build a larger combination set of answer frame outputs for each question is by actually making question/answer pairs and see what kind of different answer types we find there and why they would occur. This was outside the scope of this thesis, but is certainly something to consider in the future.

One of the most important things (in my opinion) that the current simulation lacks is an actual visual representation of the suspect. The behaviour of the suspect is currently a mental model, that generates a description for an output. But this suspect output would include so much more information if non-verbal behaviour was shown as well. Looking away, crossing of the arms, raising of the brows, all these things are linked to behaviour humans show in certain situations. These are things that the police are trained to identify and take notes of, to maybe detect if someone is lying or not. During the literature study performed for this thesis I looked at several studies about cues to deception and behaviour of lies and deceit [11, 25, 26, 47, 48, 50]. These studies sometimes contradict each other, but the general line remains the same, people have an incorrect view of what kind of behaviour is an actual cue for lies. Hand, finger, leg and feet movement is considered to be an indication for deceit by social beliefs, while studies show the exact opposite, liars are usually too aware of these movements and refrain from showing them. Gaze aversion is another thing that people tend to connect to lie behaviour, while studies show that it is not determinative for either truth or lies. If we want to build a training simulation, we need to include these visual cues in order to train officers not to base conclusions about the suspect on incorrect cue recognition. For instance, a suspect could purposely averse his gaze when he tells something that is the truth. If police officers deem this to be a lie, they will later find out they were incorrect and be explained the reason behind it. In order to do so, we need to include a graphical representation of the suspect, including not only a head but an entire body.

Cues of lies and deceit are not only found in verbal and visual cues, but also in vocal cues [48]. According to the study performed by Vrij, a higher pitched voice, a larger latency period and longer pause durations are all indicators for deceitful behaviour. Hesitations, speech errors, increased speech rate and more pause frequencies are vocal cues that indicate neither truthful nor deceitful behaviour, but are generally believed to do so by humans. This incorrect belief should once more be reason for training in the simulation system, allowing both deceitful and truthful persons to make these errors or perform these vocal cues to teach police officers that they are not necessarily indicative for lies. In order to do so, we need a speech output generated by the system, based on these factors. This speech output should also include giving backchannels and interruptions, the same as a police officer should be able to do so as described above.

Acknowledgements

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Chapter 8

Appendices

8.1 Appendix A: Natural Language to Abstract Factors Example

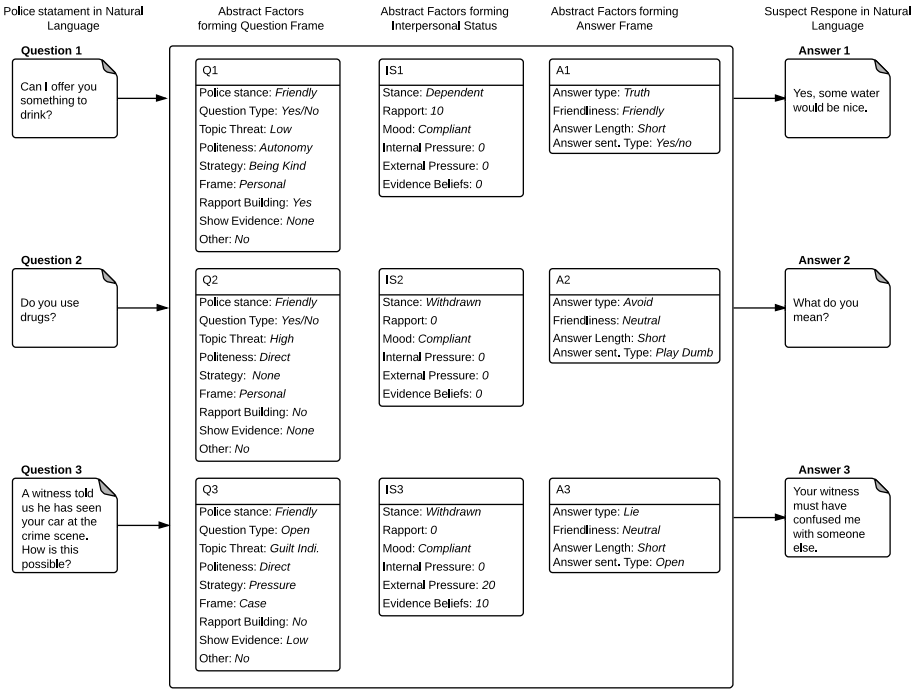

Figure 8.1: An example for three sentences as provided by an officer in Natural Language, as seen in our response model as a Question Frame. Through calculations an update of the Interpersonal Status is provided and an Answer Frame is made. This Answer Frame would than have to be converted into Natural Language again, providing a response from the suspect. In this example the three questions are not posed after one another but as separate questions to give an indication of how the model uses and provides abstract factors.

8.2 Appendix B: Calculation Methods

8.2.1 calculateStance()

```
// If a rapport building sentence has been given, this will influence
    the current stance change
       if((questionFrame.getRapportAttention()) ||
           questionFrame.getRapportCoordination() ||
           questionFrame.getRapportPositivity()){
          rapportBuild = true;
       }
       else{
          rapportBuild = false;
       }

       // First calculations are based on the frame of person related
           questioning
       if(frame.matches("Person related")){
          // If during this stage rapport has been build, it will
              influence 1/10 of the sensitivity to rapport building
          if(rapportBuild){
             rapportEffect = (suspect.getSensitivityToRapport()/10);
          }
          // Low threats don't require much politeness, but still
              direct approach has some negative effects on stance
          if(threat.matches("Low")){
             if(approval < 0){
                approvalEffect = -5;
             }
             else if(approval > 0){
                approvalEffect = 10;
             }

             if(autonomy < 0){
                autonomyEffect = 5;
             }
          }
          // Medium threats require slightly more politeness, but
              effects are also greater if this is done
          else if(threat.matches("Medium")){
              if(approval < 0){
                approvalEffect = -10;
             }
             else if(approval > 0){
                approvalEffect = 8;
             }

             if(autonomy < 0){
                autonomyEffect = 8;
             }
          }
          // High threats will have serious consequences if approached
              directly, but some positive effects if handled polite
```

```
    else if(threat.matches("High")){
         if(approval < 0){
            approvalEffect = -20;
        }
        else if(approval > 0){
            approvalEffect = 5;
        }

        if(autonomy < 0){
            autonomyEffect = 12;
        }
    }
    // Guilt indiciation during a person related questioning
         session is not done and will always have negative effects
    else if(threat.matches("Guilt Indication")){
        if(approval < 0){
            approvalEffect = -20;
        }
        else if(approval > 0){
            approvalEffect = -10;
        }

        if(autonomy < 0){
            autonomyEffect = 15;
        }
    }
}
// The else starts the case related part of the questioning
else {
    // During case related interview rapport is less important to
         be build
    if(rapportBuild){
        rapportEffect = (suspect.getSensitivityToRapport()/20);
    }
    // During case related interviewing direct questioning styles
         have less negative effects, but the same goes for polite
         questions
    if(threat.matches("Low")){
        if(approval < 0){
            approvalEffect = 0;
        }
        else if(approval > 0){
            approvalEffect = 1;
        }

        if(autonomy < 0){
            autonomyEffect = 5;
        }
    }

    else if(threat.matches("Medium")){
         if(approval < 0){
            approvalEffect = -5;
        }
```

```
        else if(approval > 0){
            approvalEffect = 4;
        }

        if(autonomy < 0){
            autonomyEffect = 7;
        }
    }

    else if(threat.matches("High")){
         if(approval < 0){
            approvalEffect = -7;
        }
        else if(approval > 0){
            approvalEffect = 6;
        }

        if(autonomy < 0){
            autonomyEffect = 10;
        }
    }
    else if(threat.matches("Guilt Indication")){
        if(approval < 0){
            approvalEffect = 0;
        }
        else if(approval > 0){
            approvalEffect = 10;
        }

        if(autonomy < 0){
            autonomyEffect = 10;
        }
    }
}

//Going through strategy options
//Intimidation has more negative effect on someone with a high
    attitude towards opposed.
//Being kind or equal has more effect on 'together' based
    personalities
//Emotional appeal has more effect on personalities with
    sensitivity to internal pressure
if(strategy.matches("Intimidating")){
    strategyEffect = ((attitudeOpposed * -50)/100);
}
else if(strategy.matches("Being kind") ||
     strategy.matches("Being equal")){
    if(personalityX > 0){
        strategyEffect = 10;
    }
    else{
        strategyEffect = 5;
    }
}
```

```
        else if(strategy.matches("Emotional appeal")){
            strategyEffect = ((sensIntPres*25)/100);
        }

        // If the police takes the opposed dominance stance from the
            personality standard dominance, this will increase the
            friendliness of the suspect
        // Otherwise it slightly reduces it

        if(policeStanceY != personalityY){
            mirroredDominance = 5;
        }
        else if(policeStanceY == personalityY){
            mirroredDominance = -5;
        }

        int calcX = (stanceX + (personalityX/persInfluenceX) +
            ((policeStanceX/policeInfluenceX)) + rapportEffect +
            approvalEffect + strategyEffect + mirroredDominance);
        int calcY = (stanceY + (personalityY/persInfluenceY) -
            ((policeStanceY/policeInfluenceY)) + autonomyEffect);
        // Update the suspect stance
        suspect.setStance(calcX,calcY);
```

8.2.2 calculateAnswerType()

```
// If the suspect is in an aggressive mood, this is enough reason for
    him to respond aggressive, since all reasoning behind aggressive
    behaviour is already done
       if(mood.matches("Aggressive")){
           answerType = "Aggressive";
       }
       // All other scenarios are played when the suspect is compliant.
           Compliant does not mean truthful, it means the
           question/answer mechanism is played
       else if(mood.matches("Compliant")){
           // The response will be different and calculated differently
               during the person related frame
           if(frame.matches("Person related")){
               // Threatening topics might be avoided or lied about, but
                   with enough positive factors answered truthfully as
                   well
               if(threat.matches("High")){
                   if((stanceX > 30 && rapportEffect > 35) || (stanceX >
                       0 && approval > 0 && rapportEffect > 20) ||
                       stanceX > 90){
                       answerType = "Truth";
                   }
                   else if((stanceX > 0 && attitudeOpposed < 50) ||
                       (!personality.equals(aggressive) && stanceY < 0)){
                       answerType = "Avoid";
                   }
```

```
    else if(stanceX > 0 && attitudeOpposed > 50 ||
        (personality.equals(friendly) && stanceX < 0) ||
        (!personality.equals(aggressive) && stanceX < 0
        && stanceX > -50)){
        answerType = "Lie";
    }
    else if((personality.equals(aggressive) && stanceX <
        0) || (!personality.equals(aggressive) && stanceX
        < -50 && stanceY > 0)){
        answerType = "Aggressive";
    }
}
else if(threat.matches("Medium")){
    if((stanceX > 10 && rapportEffect > 5) || (stanceX > 0
        && approval > 0) || stanceX > 70){
        answerType = "Truth";
    }
    else if((stanceX > 0 && attitudeOpposed < 50)){
        answerType = "Avoid";
    }
    else if((stanceX > 0 && attitudeOpposed > 50) ||
        (stanceX < 0 && stanceY < 50)){
        answerType = "Lie";
    }
    else if((stanceX < 0 && stanceY > 50) ||
        personality.equals(aggressive) && stanceX < 0){
        answerType = "Aggressive";
    }
}
else if(threat.matches("Low")){
    if(stanceX > -25 || (stanceX < -25 && approval > 0) ||
        (stanceX < -25 && rapportEffect > 10)){
        answerType = "Truth";
    }
    else if((stanceX < -25 && attitudeOpposed < 50)){
        answerType = "Avoid";
    }
    else if((stanceX < -25 && attitudeOpposed > 50)){
        answerType = "Lie";
    }
}
// If talk about the guilt indication occurs during the
    personal related interview nothing goods will come
    out of it
// If a positive stance is maintained and the person
    isn't aggressive by nature he will avoid the question
// All other cases will lead to aggression
else if(threat.matches("Guilt Indication")){
    if(questionFrame.getAccusation()){
        answerType = "Aggressive";
    }
    else if(stanceX > 0 &&
        !personality.equals(aggressive)){
       answerType = "Avoid";
```

```
        }
        else{
            answerType = "Aggressive";
        }
        stanceX -= 30;
        suspect.setStance(stanceX, stanceY);
    }
}
// During case related frame topics might be accessed easier
    and guilt indication question can now gain truthful
    answers
else if(frame.matches("Case related")){
   // Threatening topics might be avoided or lied about, but
       with enough positive factors answered truthfully as
       well
    if(threat.matches("High")){
        if((stanceX > 25 && rapportEffect > 30) || (stanceX >
            0 && approval > 0 && rapportEffect > 20) ||
            stanceX > 70){
            answerType = "Truth";
        }
        else if((stanceX > 0 && attitudeOpposed < 50) ||
            (!personality.equals(aggressive) && stanceY < 0)){
            answerType = "Avoid";
        }
        else if(stanceX > 0 && attitudeOpposed > 50 ||
            (personality.equals(friendly) && stanceX < 0) ||
            (!personality.equals(aggressive) && stanceX < 0
            && stanceX > -50)){
            answerType = "Lie";
        }
        else if((personality.equals(aggressive) && stanceX <
            0) || (!personality.equals(aggressive) && stanceX
            < -50 && stanceY > 0)){
            answerType = "Aggressive";
        }
    }
    else if(threat.matches("Medium")){
        if((stanceX > 10 && rapportEffect > 5) || (stanceX > 0
            && approval > 0) || stanceX > 70){
            answerType = "Truth";
        }
        else if((stanceX > 0 && attitudeOpposed < 50)){
            answerType = "Avoid";
        }
        else if((stanceX > 0 && attitudeOpposed > 50) ||
            (stanceX < 0 && stanceY < 50)){
            answerType = "Lie";
        }
        else if((stanceX < 0 && stanceY > 50) ||
            personality.equals(aggressive) && stanceX < 0){
            answerType = "Aggressive";
        }
    }
```

```
else if(threat.matches("Low")){
    if(stanceX > -25 || (stanceX < -25 && approval > 0) ||
        (stanceX < -25 && rapportEffect > 10)){
        answerType = "Truth";
    }
    else if((stanceX < -25 && attitudeOpposed < 50)){
        answerType = "Avoid";
    }
    else if((stanceX < -25 && attitudeOpposed > 50)){
        answerType = "Lie";
    }
}
// This part explains the suspect behaviour when
    confronted with guilt indicating questions
// Internal and external pressure are used and
    recalculated here as well as evidence beliefs
// Things like lie confronted, question repeat,
    sensitivity to guilt etc. are already calculated at
    intprescalculation
else if(threat.matches("Guilt Indication")){
    // If the actual accusation takes place, this part is
        run
   if(questionFrame.getAccusation()){
       if(evidbeliefs == 100){
        answerType = "Truth";
        }
       else if(evidbeliefs > 80 && ((intpres > intpresLim)
           || (extpres > extpresLim) || (((extpresLim -
           extpres) < 10) && strategy.matches("Rational
           convincing")))){
          answerType = "Truth";
        }
       else{
           answerType = "Lie";
        }
   }
    // If external pressure is below 20 a new guilt
        indiciating topic has been started. Suspect will
        always try to lie first.
    else if(extpres < 20){
        answerType = "Lie";
    }
    else if((extpres <= extpresLim) && (intpres <=
        intpresLim)){
        // If the limit is almost reached and a convincing
            argument is used and the suspect is in a
            together stance, he will tell the truth
        if(((extpresLim - extpres) < 10) &&
            strategy.matches("Rational convincing") &&
            stanceX > 0){
           answerType = "Truth";
        }
        else if(attitudeOpposed > 20 &&
            !stance.equals(aggressive)){
```

```
                    answerType = "Lie";
                }
                else if(attitudeOpposed < 21 &&
                     !stance.equals(aggressive)){
                    answerType = "Avoid";
                }
                else{
                    answerType = "Aggressive";
                }
            }
            // If the external or internal pressure have reached
                 the limit, truth will be told unless suspect is
                 aggressive
            else if(extpres > extpresLim || intpres > intpresLim){
                if(!stance.equals(aggressive)){
                    answerType = "Truth";
                }
                else{
                    answerType = "Aggressive";
                }
            }

           if(answerType.matches("Truth") && evidbeliefs != 100){
                situation.setExternalPressure(0);
                situation.setInternalPressure(0);
                evidbeliefs += 10;
                situation.setEvidenceBeliefs(evidbeliefs);
            }
         // End guilt indication
        }
        // End case related
    }
    // End Compliant
}
else{
    answerType = "Error";
}
answerFrame.setAnswerType(answerType);
```

8.2.3 calculateAnswerSentenceType()

```
if(quesSent.matches("Open")){
        if(answerType.matches("Truth") || answerType.matches("Lie")){
            answerSentenceType = "Open telling";
        }
        else if(answerType.matches("Avoid")){
            answerSentenceType = "Counter question";
        }
        else if(answerType.matches("Aggressive")){
            answerSentenceType = "Aggressive expression";
        }
}
```

```
else if(quesSent.matches("Yes/No")){
    if(answerType.matches("Truth") || answerType.matches("Lie")){
        answerSentenceType = "Yes/No";
    }
    else if(answerType.matches("Avoid")){
        answerSentenceType = "Play dumb";
    }
    else if(answerType.matches("Aggressive")){
        answerSentenceType = "Aggressive expression";
    }
}
else if(quesSent.matches("Probing")){
    if(answerType.matches("Truth") || answerType.matches("Lie")){
        answerSentenceType = "Probing answer";
    }
    else if(answerType.matches("Avoid")){
        answerSentenceType = "Play dumb";
    }
    else if(answerType.matches("Aggressive")){
        answerSentenceType = "Aggressive expression";
    }
}
else if(quesSent.matches("Leading")){
    if(answerType.matches("Truth") || answerType.matches("Lie")){
        answerSentenceType = "Yes/No";
    }
    else if(answerType.matches("Avoid")){
        answerSentenceType = "Play dumb";
    }
    else if(answerType.matches("Aggressive")){
        answerSentenceType = "Aggressive expression";
    }
}
else if(quesSent.matches("Forced Choice")){
    if(answerType.matches("Truth") || answerType.matches("Lie")){
        answerSentenceType = "Choice";
    }
    else if(answerType.matches("Avoid")){
        answerSentenceType = "Play dumb";
    }
    else if(answerType.matches("Aggressive")){
        answerSentenceType = "Aggressive expression";
    }
}
else if(quesSent.matches("Statement")){
    if(answerType.matches("Truth") || answerType.matches("Lie")){
        answerSentenceType = "Open telling";
    }
    else if(answerType.matches("Avoid")){
        answerSentenceType = "Ignore";
    }
    else if(answerType.matches("Aggressive")){
        answerSentenceType = "Aggressive expression";
    }
```

8.3 Appendix C: Experiment Information

The police factors that had to be set were explained as effective as possible, allowing for a quick understanding without spending too much time on all the reading. In order to use them correctly however, all options had to be mentioned and explained shortly through the use of an example. The suspect output was simply explained as shortly as possible.

Stance means what kind of attitude the police officer shows in his sentence towards the suspect. An officer can ask the same question in different manners, so how he wants to come across is important when taking a stance. The possible values and examples for each one are:
- Friendly: "Please tell me what you know about this."
- Aggressive: "Tell me what you know, now!"
- Withdrawn: "I don't really care what you tell me about it."
- Dependent: "Maybe you could tell me a little about it?"

Rapport means the feeling of being in sync with another person. Usually when two people speak they build rapport between one another by being positive, attentive and on the same line. Sentences can include rapport if they have one of the following:
- Attention: "So you said you were married. How do you feel about the marriage?"
- Positivity: "You have three cars? Wow that's fascinating!"
- Coordination: "Maybe we could talk about your past a bit, if you don't mind?"

Question type explains explains how the question the officer asks is posed and what kind of answer they invite. The possible values and examples for each one are:
- Open: "Tell me about yesterday."
- Yes/No: "Were you at the gas station yesterday?"
- Probing: "Who else was there?" (questioning about one specific topic)
- Leading: "You were at the gas station alone, right?" (question includes suggestion towards answer)
- Forced Choice: "Did you punch him or kick him?"
- Statement: "I think you were at the gas station yesterday."

Topic threat states how threatening the topic that is questioned about is to the suspect. This can range from low to high, or be about something that might indicate towards the guilt of the suspect (time of crime, location suspect during crime, fingerprints, etc.). **Note that every question you wish to ask that clearly has something to do with perhaps the guilt of the suspect is a guilt indication**. This includes questions about his whereabouts, his car at the crime scene, blood on his clothes, etc. Values and examples:
- Low: "Do you have any pets?"
- Medium: "How did the arrest go this morning?"
- High: "Do you use any drugs?"
- Guilt Indication: "Your car was spotted at the crime scene. Care to explain how that is possible?"

Politeness describes the politeness with which a question is posed. Values and examples:
- Direct: "Where were you yesterday?"
- Approval Oriented: "You would like to tell us where you were yesterday, wouldn't you?"
- Autonomy Oriented: "Can you tell us where you were yesterday?"
- Off Record: "We haven't talked about where you were yesterday yet."

Frame describes during what part of the interview the question is asked. Normally, first some general questions are asked during the first part of the interview and case related questions are asked during the second part.
- Person related: Ask general questions about the suspect.
- Case related: Ask case related questions. **Note that only guilt indication will actually be questions about things related directly to the case**. This means that if you ask a medium threatening question during the case related frame, it isnt necessarily directly about the crime committed.

Strategy describes the strategy that is employed. A question or statement can be posed using a certain strategy to increase the relationship between police and suspect or the increase the likelihood that the truth is being told. Values and examples:
- None: "Where were you yesterday?"
- Being kind: "I understand this might be tough on you, but we have to know if you have debts."
- Being equal: "I used some drugs when I was younger so I understand if you did so as well."
- Emotional appeal: "What would your wife think if she knew her husband stole money?"
- Intimidating: "You better tell us what you did there or I'll make sure you'll never see the light of day!"
- Direct pressure: "Did you use drugs? Are you sure you didn't use drugs? So no drugs are in your body now?"
- Rational convincing: "If you are the only one who uses your car and your car was seen at the gas station, how could you not have been there?"

Politeness describes the politeness with which a question is posed. Values and examples:
- Direct: "Where were you yesterday?"
- Approval Oriented: "You would like to tell us where you were yesterday, wouldn't you?"
- Autonomy Oriented: "Can you tell us where you were yesterday?"
- Off Record: "We haven't talked about where you were yesterday yet."

Show of New Evidence is used when the police provides a new piece of evidence to the suspect. For instance, when the police shows an image from a camera that recorded the suspect at the crime scene. This would mean a high value for new evidence, whereas stating that the suspect's car has been seen in the area might be low new evidence.

Repeat, confront and accusation: are three values that can be set when either one of them is performed. Accusation here means the final

accusation about the actual case (So stating, you were there! Is not an accusation, but asking so did you steal the money? when the case is about stolen money, is an accusation).
- Repeat topic: Asking the same question again (perhaps at a later stage)
- Lie confronted: "You say you used your own phone to call, but cameras registered you using the company phone."
- Accusation: "So did you kill the victim?"

Stance Suspect: This will provide you with the stance that the suspect is taking in his response to your question. You will also see an actual value for the friendliness (-100 to 100) and dominance (-100 to 100).
Rapport: In here the amount of rapport between you (as police) and the suspect is shown. (0 to 100)
Mood: This shows whether the suspect is currently (for the current answer he gives) in an aggressive mood towards you or in a compliant mood towards you. (Compliant or Aggressive)
Internal pressure: This shows how much internal pressure the suspect is currently experiencing. This pressure is related to internal feelings, feelings of guilt, remorse, etc. Some things can trigger a higher internal pressure. (0 to 100)
External pressure: This shows how much external pressure the suspect is currently experiencing. This pressure is directly related to the pressure the officer puts on the suspect during the interrogation. Facts, lie confrontations, rational convincing etc. all play a part here. (0 to 100)
Evidence beliefs: This shows how much evidence the suspect beliefs is currently shown by the police. (0 to 100)
Answer Sentence Type: This shows the type of answer the suspect gives in his response. (Open telling, counter question, aggressive expression, yes/no, play dumb, probing answer, ignore)
Answer Length: This shows how long the answer for the suspect will be. (Long, short, one-word)
Answer Friendliness: This shows how friendly the answer that the suspect generates is. (Friendly, neutral, unfriendly)
Answer type: This shows what type of answer the suspect gives. (Truth, avoid, lie, aggressive)
Suspect reasoning: This field will show some of the reasoning of the suspect. It will state how you asked something and how he responds to this.

8.4 Appendix D: Response Model Interaction Examples

Turn	Stance Police	Rapport Build	Quest. Type	Topic Threat	Politeness	Frame	Strategy	Show Evidence	Other
1	Friendly	Positivity	Open	Low	Autonomy	Person	Being kind	None	None
2	Friendly	Coordination	Open	Medium	Autonomy	Person	Emotional appeal	Low	None
3	Aggres.	None	Open	Medium	Direct	Person	Direct pressure	Low	None
4	Aggres.	None	Forced Choice	High	Direct	Person	Intimidate	Low	None
5	Aggres.	None	Yes/No	High	Direct	Case	Direct pressure	Low	None
6	Friendly	None	Open	Low	Direct	Case	Being equal	None	None
7	Friendly	None	Leading	High	Direct	Person	Emotional appeal	High	None
8	Friendly	None	Leading	High	Direct	Person	Emotional appeal	High	None

Figure 8.2: An example of the given input of a participant for the Remerink suspect.

Turn	Stance Suspect	Friendliness	Dominance	Rapport	Internal Pressure	External Pressure	Mood	Evidence Beliefs	Answer Type	Answer Length	Answer Friendliness	Answer Sent. Type
1	Friendly	7	40	20	0	0	Compliant	0	Truth	Short	Neutral	Open telling
2	Friendly	36	30	30	0	0	Compliant	5	Truth	Long	Friendly	Open telling
3	Friendly	16	28	25	0	0	Compliant	10	Truth	Short	Neutral	Open telling
4	Aggres.	-44	30	5	0	0	Aggressive	15	Aggressive	Short	Unfriendly	Aggres
5	Aggres.	-61	30	2	0	0	Aggressive	20	Aggressive	Short	Unfriendly	Aggres
6	Aggres.	-41	25	0	0	0	Aggressive	20	Aggressive	Short	Unfriendly	Aggres
7	Aggres.	-39	27	0	0	0	Aggressive	30	Aggressive	Short	Unfriendly	Aggres
8	Aggres.	-39	27	0	0	0	Aggressive	30	Aggressive	Short	Unfriendly	Aggres

Figure 8.3: The given output for the Remerink suspect after receiving the input from Figure 8.2. After three interactions the participant guessed the suspect was Huls, after eight interactions he changed that opinion to Remerink.

Turn	Stance Police	Rapport Build	Quest. Type	Topic Threat	Politeness	Frame	Strategy	Show Evidence	Other
1	Friendly	Positivity	Open	Low	Autonomy	Person	Being kind	None	None
2	Friendly	None	Yes/No	Low	Direct	Person	None	None	None
3	Depend.	None	Leading	Low	Autonomy	Person	Emotional appeal	None	None
4	Withdraw	None	Probing	Medium	Direct	Case	None	Low	None
5	Depend.	None	Probing	Medium	Direct	Case	Intimidate	Low	None
6	Depend.	None	Probing	Medium	Direct	Case	Intimidate	Low	None

Figure 8.4: An example of the given input of a participant for the Remerink suspect, where he mistakes Remerink for van Bron after six interactions.

Turn	Stance Suspect	Friendliness	Dominance	Rapport	Internal Pressure	External Pressure	Mood	Evidence Beliefs	Answer Type	Answer Length	Answer Friendliness	Answer Sent. Type
1	Friendly	7	40	20	0	0	Compliant	0	Truth	Short	Neutral	Open telling
2	Friendly	12	35	15	0	0	Compliant	0	Truth	One word	Neutral	Yes/No
3	Friendly	44	65	10	0	0	Compliant	0	Truth	Short	Friendly	Yes/No
4	Friendly	39	100	7	0	0	Compliant	5	Lie	One word	Friendly	Probing answer
5	Friendly	24	100	0	0	0	Compliant	10	Lie	One word	Neutral	Probing answer
6	Friendly	24	100	0	0	0	Compliant	10	Lie	One word	Neutral	Probing answer

Figure 8.5: The given output for the Remerink suspect after receiving the input from Figure 8.4. After three interactions the participant guessed the suspect was Remerink, but after six interactions he changed that opinion to van Bron, which was incorrect.

Turn	Stance Police	Rapport Build	Quest. Type	Topic Threat	Politeness	Frame	Strategy	Show Evidence	Other
1	Friendly	Positivity	Yes/No	Low	Approval	Person	Being equal	None	None
2	Friendly	Coordination	State.	Low	Autonomy	Case	Being equal	Low	None
3	Friendly	Coordination	Yes/No	Low	Approval	Case	Being kind	Low	None
4	Friendly	Coordination	Yes/No	Medium	Direct	Case	Rational convincing	Low	Lie Confronted
5	Friendly	None	Yes/No	Guilt Indicate	Direct	Case	Rational convincing	High	Accusation
6	Friendly	None	Yes/No	Guilt Indicate	Direct	Case	Intimidating	High	Accusation
7	Friendly	None	Yes/No	Guilt Indicate	Direct	Case	Direct pressure	None	Accusation
8	Friendly	None	Yes/No	Guilt Indicate	Direct	Case	Direct pressure	None	Accusation

Figure 8.6: An example of the given input of a participant for the random generated output.

Turn	Stance Suspect	Friendliness	Dominance	Rapport	Internal Pressure	External Pressure	Mood	Evidence Beliefs	Answer Type	Answer Length	Answer Friendliness	Answer Sent. Type
1	Friendly	74	92	89	47	66	Compliant	7	Aggressive	Long	Neutral	Aggres.
2	Withdrw.	-97	-74	32	81	62	Aggressive	14	Truth	Short	Unfriendly	Open
3	Aggres	-39	60	13	57	10	Aggressive	15	Lie	One word	Unfriendly	Yes/No
4	Withdrw.	-31	0	53	75	4	Aggressive	20	Avoid	One word	Friendly	Play dumb
5	Withdrw.	-76	-25	22	73	16	Aggressive	29	Avoid	One word	Friendly	Play dumb
6	Friendly	10	33	86	70	54	Compliant	37	Avoid	Short	Neutral	Play dumb
7	Aggres.	-65	94	98	50	69	Compliant	46	Truth	Short	Friendly	Yes/No
8	Aggres.	-65	94	98	50	69	Compliant	46	Truth	Short	Friendly	Yes/No

Figure 8.7: The given random output after receiving the input from Figure 8.6. After three interactions the participant guessed the suspect was Remerink. After eight interactions he still thought he was interviewing Remerink.

8.5 Appendix E: Experiment Results

Group Statistics

	Group	N	Mean	Std. Deviation	Std. Error Mean
Certainty	Correct	39	4,410	,5946	,0952
	Incorrec	9	3,667	1,1180	,3727

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Certainty	Equal variances assumed	8,375	,006	2,817	46	,007	,7436	,2640	,2123	1,2749
	Equal variances not assumed			1,933	9,070	,085	,7436	,3846	-,1255	1,6127

Figure 8.8: The results for performing an independent T test between the correctly guessed and incorrectly guesses suspects where we look at the certainty ratings of both guesses.

Group Statistics

	Run	N	Mean	Std. Deviation	Std. Error Mean
Certainty	First	24	3,6250	,76967	,15711
	Second	24	3,2917	,75060	,15322
Realism	First	24	3,5417	,88363	,18037
	Second	24	3,1667	,86811	,17720

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Certainty	Equal variances assumed	,469	,497	1,519	46	,136	,33333	,21945	-,10840	,77506
	Equal variances not assumed			1,519	45,971	,136	,33333	,21945	-,10840	,77507
Realism	Equal variances assumed	,040	,842	1,483	46	,145	,37500	,25285	-,13396	,88396
	Equal variances not assumed			1,483	45,986	,145	,37500	,25285	-,13397	,88397

Figure 8.9: The results for performing an independent T test between the results when the random output was given to the participant at the first run or second run. We look at the certainty ratings and the realism ratings in both situations.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	certainsuspect	4,2708	48	,76463	,11037
	certainrandom	3,4583	48	,77070	,11124
Pair 2	realsuspect	3,8958	48	,51528	,07437
	realrandom	3,3542	48	,88701	,12803
Pair 3	interactrionsuspect	5,4792	48	2,13372	,30798
	interactionrandom	6,2500	48	1,95154	,28168

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	certainsuspect & certainrandom	48	,002	,992
Pair 2	realsuspect & realrandom	48	,036	,809
Pair 3	interactrionsuspect & interactionrandom	48	,364	,011

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	certainsuspect - certainrandom	,81250	1,08483	,15658	,49750	1,12750	5,189	47	,000
Pair 2	realsuspect - realrandom	,54167	1,00970	,14574	,24848	,83485	3,717	47	,001
Pair 3	interactrionsuspect - interactionrandom	-,77083	2,30854	,33321	-1,44116	-,10050	-2,313	47	,025

Figure 8.10: The results for performing a paired T test between the random ouput results and the actual suspect results. We looked at the certainty ratings, realism ratings and average amount of interactions between the user and the system.

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