Social Signaling in Decision Making

by

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Abstract

Nonverbal communication is an important and often underestimated instrument in social interactions. The paralinguistic elements of speech, which are described in common speech as "tone of voice", are one channel of the nonverbal communication. They, together with conversational dynamics, are a very powerful measurement for interactions, without looking at the content of the conversation. A subset of these features, the social signaling measurements, are very useful when analyzing and quantifying conversation.
The goal of this thesis is to better understand the framework of social signaling. We applied the social signaling measurements to negotiations as well as to small group interactions. For negotiation we were able to predict up to 30% of the variance in individual outcome. The use of automated algorithms enables to build real-time feedback mechanisms that can then help users to improve and achieve their objectives.

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Contents

List of Figures

List of Tables

Chapter 1

Introduction

1.1 Thesis Objective

"Yesh arbaah matzavei metziut: Domem, Nefesh, Chai, Medaber; Dugmaot hem: sela, eitz, tzvi, ben-adam" "There are four states of being: silent, living, animated, and speaking; examples are: a rock, a tree, a deer, a human being." (Malbim)

This ancient proverb separates the world into four groups where each dominion is more developed then the previous one. The first category describes the inanimate world. The next higher level refers to everything that has the capability to grow. The third group covers the animal kingdom and the last category is the human race. Independently from the biological, scientific debate of what (if anything) separates humans from the animal world, this proverb emphasizes the ability to speak as the unique human feature. We can see that the ability to speak is a very powerful gift. Interestingly the proverb emphasizes speaking as the key characteristic, not language. While many people automatically associate the ability to speak with language, language is not the only aspect of verbal communication.

The field that traditionally studies human language is called linguistics. In linguistics, the focus is on the structure and content of language. But language is much more powerful. Another part of our vocal communication contains intonation, loudness, rhythm and other

prosodic features. In the traditional literature, we refer to these features as paralinguistic aspects of speech. The paralinguistic level serves two purposes. First, it helps to bring meaning into the flow of words: for example, adding emphasis on words, marking questions, or using pauses to underline the importance of a sentence. Second, it is used as a mean for direct or indirect nonverbal communication. We signal intentional states such as interest, worry or empathy.

But the term speaking is not only limited to the paralinguistic aspects of voice, it also refers to the interactional aspect of language. This aspect of speaking can be best described as conversational analysis. Not looking at the individual characteristics of a speaking person but on the dynamics between the interacting dyad or group.

The different aspects of speaking described above, the paralinguistic features and the conversational measurements, can be described as social signaling. We understand social signals in this context as unconscious and not full indicating signals. Social signaling also shifts the focus from the micro perspective of paralinguistic analysis to a slightly longer time frame. Social signaling is not constrained to one particular tone, a gesture or a smile: it is a general tendency. The idea behind social signaling is that people show, possibly even on several communicative channels in parallel, what goes on in their minds.

In most private and business conversations people exchange information, sometimes uninteresting, boring information; other times crucial and time constrained information. There are other kinds of conversations where people not only exchange information but also make decisions. Particularly interesting are the interactions where a decision is made at the end of the conversation. In these cases, the decision might be directly influenced by the previous interaction. The outcome of this conversation is based not only on the information exchanged but also on the interaction between the participants.

It is well established that non-verbal communication is an important factor in how people are perceived and also on how well they can do. But how much is encapsulated in the conversational dynamics and tone of voice? How well can an outcome or a decision be predicted by social signaling. To what degree is social signaling a means of personal

style? Does a person have his/her own constant social signals or are the signals purely an interactive measure that always depends on all the people involved in a conversation.

With the algorithms and technology developed in the human dynamics research group, we now have the capability to extract all the underlying speech features automatically. Instead of hand coding the different behavior and speech characteristics, we can use machine learning algorithms, which can perform the task more accurately and much faster. In addition, we can also to calculate the features in real time and give the user instantaneous feedback. This should help the user to come closer to his/her desired goals. Porting the technology to different platforms such as laptops, PDAs and mobile phones can potentially further improve the usability of these devices.

A personal electronic conversational feedback assistant could help in many ways:

- Many people feel unsure when confronting a professional sales person. For example, when negotiating with a car dealer about incentives, additional features and the price for a new car. The buyer sees the salesman as the well-trained expert, who uses manipulative strategies to out-maneuver the customer. The use of the assistant might be a welcomed aid to balance the buyer's perceived disadvantage. Buyers would feel much stronger and would also get feedback when the negotiation turns to their disadvantage.

- In a situation where an employee wants to discuss with his/her boss a salary increase. This is often a very delicate topic and a situation many employees would prefer to avoid even if they believe they actually deserve a raise. To be equipped with an assistant that can capture the nonverbal communication, interpret them and provide the user with the corresponding feedback, makes this difficult task much easier.

- In politics and diplomacy many important decisions are made in direct one on one talks, from low level local representatives up to conversations between statesmen. Particularly, in issues where both sides have a strong opinion and they disagree as regards content, nonverbal signals and meaningful. If one side could pick up, based on

the conversational flow and signals, regarding which issues to counterpart is flexible, an agreement could be achieve faster and easier. Since the two sides are too much concentrated on content they do not focus on nonverbal signals. The mobile feedback assistant could call the attention to these dynamics and also provide suggestion how to change the behavior.

1.2 Outline

The organization of the thesis is as follows:

- Chapter 2 reviews the research and literature on nonverbal communication, its affect on speech and decision making in groups. Then the features that measure social signaling are introduced and explained.
- Chapter 3 discusses the application of social signaling to negotiations. An experiment to determine if social signaling is a personal characteristic or the result of an interaction is described. Finally, some insights are given into the relationship between social signaling, other psychological measurements and performance.
- Chapter 4 describes a pilot study to apply social signaling in a group context using the group polarization effect.
- Chapter 5 summarizes the results and concludes with suggestions for future work.

Chapter 2

Background

2.1 Previous Work

2.1.1 Nonverbal Communication

The groundwork for the analysis presented in this thesis can be found in the vast research on nonverbal communication. This category includes, amongst others, gesture, posture, facial expression and tone of voice. The pioneer for this work was Darwin [17] in 1872 with his book "The Expression of the Emotions in Man and Animal." Using the terms man and animal in the book's title is naturally related to Darwin's broader work in biology but also shows the evolutionary roots of nonverbal behavior. According to Darwin and other biologists nonverbal signs seem to be natural and innate. La Barre [35] thinks that humans also learn many signals from the social environment. It is not easy to identify what percentage of communication is exchanged nonverbally, the numbers vary from 65% [5] to more then 90% [38].

Still, many people think, even if they acknowledge the significance of nonverbal communication, that important information is mainly transmitted as factual content either written or oral. However, in many situations, non-linguistic social signals (e.g., body language, facial expressions, and tone of voice) are as important as linguistic content in predicting

behavioral outcomes [1, 41]. Indeed, some have argued that such vocal signaling originally evolved as grooming and dominance displays, and continues to exist today as a complement to human language [19, 47].

What makes nonverbal communication so interesting is that many signals are sent unconsciously and often both the sender and the receiver are unaware of them. In many cases, the same behavior can be used either as an intentional or as a natural unconscious signal. For example, a smile can be used to show somebody sympathy whereas natural laughing or smiling can be a sign of amusement. Sometimes we are also misguided by the interpretation of nonverbal signals. There can be a strong consensus on how to read or interpret a nonverbal behavior, but in some cases these assumptions are proven to be wrong. In a study by Kraut and Poe [34] participants were recorded while trying to smuggle some items past the U.S customs. Experts and laymen where then asked to tell by the nonverbal behavior to distinguish between the smugglers and regular passengers. They were not able to identify the two groups although there was a strong consensus among the observers who the smugglers were and which cues were indicating their role.

With the example of head nodding the variety of even one nonverbal communication channel can be well illustrated. Across cultures, head nodding has been observed as an indicator of agreement or understanding while a head shake has indicated a negative signal for disbelief or disapproval. Kapoor [31] mentions that head nodding also plays a role in conversational feedback where both the speaker and the listener nod synchronously to keep the conversation flowing. At the most basic level, this behavior can be compared to the reptilian principle of isopraxism, where one animal imitates the behavior of the other.

Another possible role of head nodding may be related to the chameleon effect as described by Chartrand and Bargh [12]. They observed that people mimic body movements of their conversational partners. Interestingly the mimicking behavior is more reflected in the behavior of the more empathetic person. In a recent study, Briñol and Petty [10] showed that head nodding could even have a self stimulating effect by changing the attitude of the nodding person.

2.1.2 Affect in Speech

Closely related to the features examined in this thesis is the domain of affect in speech. Three separate processes are of importance when studying vocal communication of emotion: encoding (speakers expression of emotion), transmission and decoding (inference of speakers attitude and emotions by the receiver) [51]. Several components of speech have the potential to convey affect [11]. Physiological influences (either from parasympathetic or the autonomic nervous system) can change the level of arousal. Emotions such as anger or fear can increase blood pressure, increase the respiration rate and dry the mouth. These changes can then influence the tone of voice: greater speed and loudness or extended pitch range. Low-arousal states such as relaxation or grief result in slow and low pitched speech with weak high frequencies [61].

Acoustical features were also found to have an impact on the perception of emotion. Fairbanks and Pronovost [21] studied five emotions and their effect on pitch. They found that pitch range, average pitch and overall slope of the pitch contour, to mention some examples, could differentiate the following five emotions: anger, fear, indifference, grief and contempt. Anger showed great changes in pitch and generally downward inflection. Grief could be identified with the slowest speech rate and minimal variability among rhythm and pitch.

The prosodic features put more emphasis on the receiver. Prosody refers to the tonal, temporal and dynamic features. Pitch, rhythm and intensity are used as measures for the perceived emotional state. According to Collier [14] pleasant emotions cause regular rhythm while unpleasant emotions such as sadness exhibit more irregularity.

These findings lead to the goal of finding a global model, which can determine the emotional state of a speaker, or what kind of emotions the speaker wants to transmit. Inherent to this problem is the definition of the different affective states. Affect can be categorized either in basic emotions such as fear, anger or happiness [20] or in continuous dimensions. For the continuous approach, the most common axes are arousal and valence [52]. Feature selection is an art in itself, since the number of features that can be calculated based on a speech signal is nearly unlimited. In his PhD thesis, Raoul Fernandez [23] tested over 100 different

features (derived from seven base types).

Overall there are many indicators that affect can be detected in voice. But it remains a very complex task. Table 2.1 shows how two studies came up with different results for the same measurements. Even though the labels used for two of the four emotions are not identical, we assumed that they were measuring approximately the same emotion.

Fairbanks and Hoaglian:	Anger	Fear	Grief	Indifference
Williams and Stevens:	Anger	Fear	Sorrow	Neutral
Median F0	high	highest	low	lowest
	highest	high	lowest	low
F0 Range	wide	widest	narrow	narrowest
	widest	wide	narrowest	narrow
Speech Rate	rapid	rapid (faster than anger)	slow	fastest
	rapid	rapid (slower than anger)	slow	fastest

Table 2.1: Comparison of Fairbanks & Hoaglian and Williams & Stevens speech correlates of emotions

Mood on performance

To a certain degree, even the measurement of emotion in speech can have meaning related to decision making. Several aspects have an influence on performance and decision making: general personality, current mood, access to information and relationship with counterpart(s). This enumeration covers only some basic aspects, obviously there are many more. According to several scientists, one major category of information that is transmitted over voice is emotion. Many people would say that mood is not necessarily a predictable measure for performance. The skills that a person has are important, and these are independent of how a person currently feels. But mood can have an influence on outcome. Isen [27] [28] showed in several studies that performance is related to mood. In two tasks generally associated with creativity subjects improved their performance after being induced with positive mood. Subjects in a clinical decision making experiment were quicker in identifying their choices and went beyond their task in the positive-affect condition.

2.1.3 Conversational Analysis

Basu [3] laid the groundwork for analyzing the structure of conversations. Before his work the focus, even when looking at vocal cues, had been on a lower level of detail. Hirschberg and Nkatani [26] tried to build a topic spotter that could identify beginning and ending of intonational phrases (acoustic segmentation). In their effort to create a multi media browsing tool for group meetings, Waibel [58] focused on automatic summarization of conversations. But the main focus was to support speech recognition rather then gaining insight into the speaking patterns themselves. A major focus in Basu's work was to detect different conversation types and to predict turn taking behavior. Based on his foundations, the goal in this thesis is to understand conversational interaction in a specific context.

2.1.4 Thin Slices

Is it possible to predict outcome based on a small sampling at the beginning of a conversation? Many people judge strangers based on their first impressions. This is one of many heuristics that humans use to process information faster. In a meta study analysis Ambady and Rosenthal [1] found that the overall effect size for the accuracy of predicting objective outcome based on the short observation of expressive behavior was 39%. They introduced the term "thin slices" for this phenomenon. Gladwell [24] describes thin-slicing as, "the ability of our unconscious to find pattern in situations and people based on very narrow 'slices' of experience." In a frequent cited study Ambady found that consensual judgment of the behavior of college teachers in a 30 second silent video clip significantly predicted global end-of-semester student evaluation. Other studies showed similar effects for therapist competency ratings [8], influences from faces of newscaster on voting behavior [39], and even courtroom judges' expectations for trial outcome [7]. In a new study Borkenau [9] found that personality inferences from thin slices were significantly associated with reports by knowledgeable informants.

2.2 Audio Features

Most nonverbal communication is extracted from the voiced segments in speech which correspond to the vowels. The widely used term for paralinguistic speech "tone of voice" emphasizes the melodic aspect and thus the importance of the vowels as well. This sound quality is perceived as pitch. Normally pitch and fundamental frequency (F0) can be used as synonyms. (Since the term pitch is used for the subjectively perceived "height" of a sound there can be cases where there is a so called "virtual pitch" but no corresponding fundamental frequency). By looking at a spectrogram the voiced segments can easily be identified. In Figure 2-1 one voiced segment is marked. The stepwise structure is a clear indicator for voiced segments. Each step defines one formant (F1,F2,F3,...). The fundamental frequency is not identifiable in this small band spectrogram. To display F0 a wideband spectrogram has to be generated.

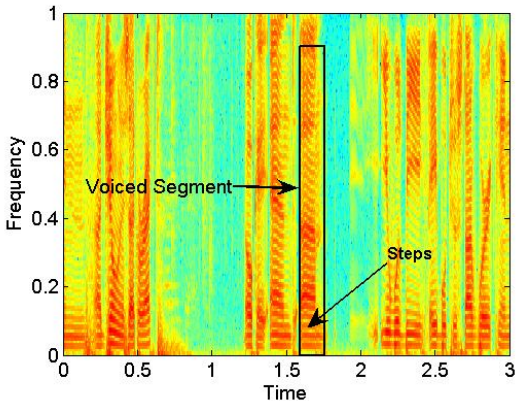

Figure 2-1: Example of voiced segment in spectogram

To generate the social signaling features, two main pieces of information have to be extracted from the voice signal. The regions of speech have to be identified for the interactive calculation and the fundamental frequency as a baseline for the individual measurements. Pitch detection algorithms can work either on the time or frequency domain or on both. Different signal properties can be used to detect pitch. Usually, a pitch detector analyzes the speech signal and the classification of voiced versus non-voiced is done based on the presence or absence of pitch.

Basu [3] introduced an algorithm that reliably detects speaking segments of energy and even in noisy environments. We will introduce briefly the features that are used. A combination of noisy autocorrelation and relative spectral entropy are used for the detection of the voiced segments. A simple Hidden Markov Model (HMM) then identifies the speaking and non-speaking elements based on the voiced/unvoiced segments.

Autocorrelation

Autocorrelation is calculated on a per frame basis with the following formula:

$$A[k] = \frac{\sum_{n=k}^{N} s[n]\, s[n-k]}{\left(\sum_{n=0}^{N-k} s[n]^2\right)^{\frac{1}{2}} \left(\sum_{n=k}^{N} s[n]^2\right)^{\frac{1}{2}}}$$

For our analysis the frame size is 32 milliseconds (256 samples) with a step size of 16 milliseconds. (All audio files were sampled at 8 kHz). Figure 2-2 shows a plot for two unvoiced and voiced frames.

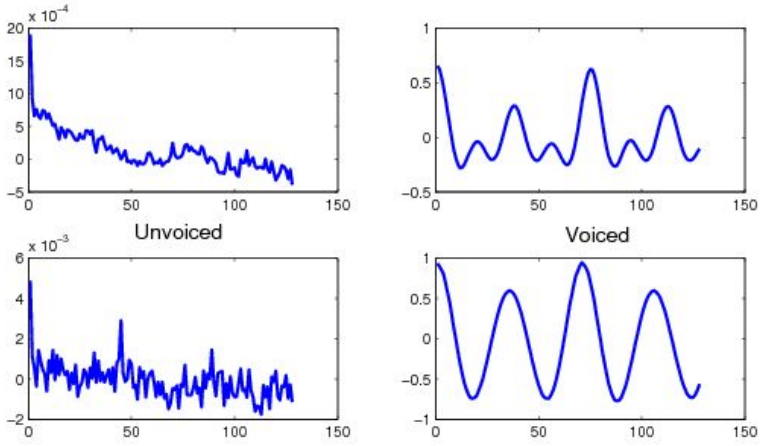

Figure 2-2: Autocorrelation plots for unvoiced (left) and voiced (right) segments

Two main characteristics distinguish the autocorrelation signal. Voiced frames (on the right in Figure2-2) have a few very strong peaks because of the periodic component while the unvoiced or noise frames (on the left) have many small peaks. The maximum peak and the number of peaks (zero crossing) are thus a strong indicator for the frame type. Figure 2-3 shows the different distributions for the voiced and unvoiced segments.

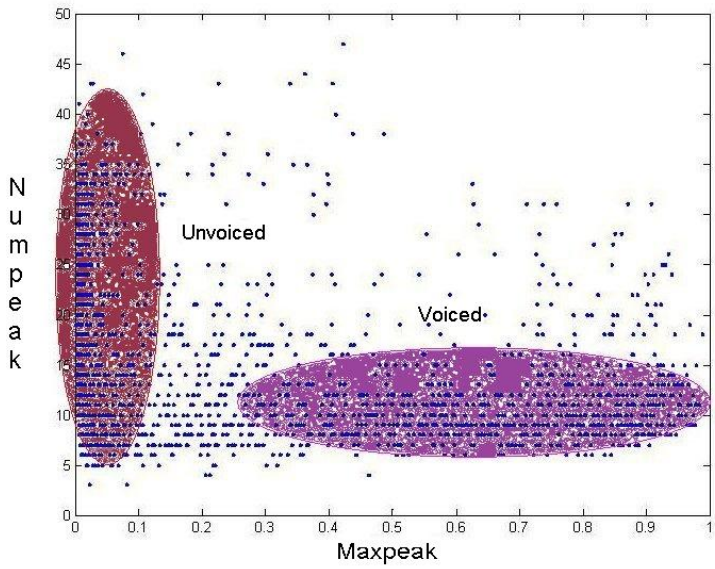

Figure 2-3: Maxpeak-numpeak distribution for voiced/unvoiced segments

Unfortunately, a very small-valued and noisy periodic signal will also produce strong peaks. This flaw can be solved by adding spectral entropy to the autocorrelation indicators.

Relative Spectral Entropy

To calculate the relative spectral entropy the Fourier transform of the pitch $P[\omega]$ has to be normalized first:

$$p[\omega] = \frac{P[\omega]}{\sum P[\omega]}$$

The relative spectral entropy is then the KL divergence between the current $p[\omega]$ and the local mean spectrum $m[\omega]$:

$$H_{rel\_spec} = -\sum_{\omega} p[\omega] \, log \frac{p[\omega]}{m[\omega]}$$

The pitch causes the voiced segments to be highly structured while the unvoiced frames will be much more random. Thus voiced segments will show lower entropy than the unvoiced ones. Combining all three indicators (maxpeak, numpeak and spec. entropy) in an HMM results in a reliable classifier for the voiced/unvoiced segments

Fundamental Frequency

The fundamental frequency (F0) was calculated based on the same observation that the voiced segments show repeating bands (see Figure 2-1). These bands are the formants. One characteristic of the formants is that they are exact multiples of F0. In order to extract these bands the spectrogram needs to be convolved with a periodic signal (in our case the cosine). The convolution is performed by taking the real part of the FFT. The lowest peak in the appropriate frequency (20-500Hz) returns the F0.

2.3 Social Signaling Features

The general purpose of a signal is to indicate a certain quality, as strength, wealth or confidence. An example for a signal in the animal world is the antler of an elk; it is a display for his strength. Traditionally, a signal requires a certain cost. In the example used, the elk has to walk around with the heavy antler. Therefore, it must be worthwhile for the sender to use the signal otherwise he would not continue to use it. Signals can be used consciously, driving an expensive car, or unconsciously if they are adopted over time. When we use the term social signaling we refer to indicators in speech and conversations that unconsciously convey information about the speakers intentions. Since they are only one part of a conversation, they are not full indicators of the intensions.

In this section we will introduce the four social signaling features, which have been identified in a variety of different settings (business, friendship, gaming, dating) [16, 44, 37]. By calculating the value over a five minute time frame, we hope to reduce the noisiness and to be able to focus on the underlying baseline. To a certain extent this approach can be compared to the gender detector algorithm developed under Koppel [33]. When classifying written texts according to the gender of the author, he actually analyze only the most common stop words and n-gram structures. By ignoring the content loaded words and focusing on the unconscious use of filling-words they were able to classify the author's gender with 80% accuracy. The gender leaves a hidden fingerprint in the text.

Social signaling covers two main aspects: individual signals and interactive signals. On the individual level we can observe and measure how a person speaks and what tone of voice he/she is using. On the simplest layer of the interactive level the turn taking behavior of two or more people can be analyzed. Common features which are observed in this category are: amount of speaking time, holding floor, interruptions and pauses. Basu [3] categorized different conversations based on these measurements and identified different conversation types such as story telling, lectures or biased discussion. On a higher interactive level we can try to capture some of the dynamics and influences between the different group members. In the next few paragraphs, each social signaling feature will be introduced and explained in more detail.

Based on broad reading of the voice analysis and social science Pentland [44] constructed the four basic social signaling measures: stress, engagement, mirroring and activity level. In the next few paragraphs, each social signaling feature will be introduced and explained in more detail.

2.3.1 Stress

Prosody refers to speech features that are longer than one phonetic segment and are perceived as stress, accentuation, or rhythm [60]. The concept of prosodic emphasis has appeared in research on child development. For example, Fernald and Mazzie [22] argued that mothers' use of exaggerated pitch peaks to mark focused words may aid infants in their speech processing. Tone of voice and prosodic style are among the most powerful of social signals, even though (and perhaps because) people are usually unaware of them [41]. Stress in one's tone of voice could be purposeful (e.g., prosodic emphasis) or unintentional (e.g., physiological stress caused by discomfort). Vocal stress could be either an asset or a liability; higher prosodic emphasis, when brought about consciously, could signify more forceful or dynamic speech, whereas a tremor or jitter in the voice could be a physiological reaction to psychological anxiety and hence perceived as a sign of weakness.

Stress is measured by the variation in prosodic emphasis [25]. For each voiced segment we

extract the mean energy, frequency of the fundamental format, and the spectral entropy. Averaging over longer time periods provides estimates of the mean-scaled standard deviation of the formant frequency and the spectral entropy. The z-scored sum of these standard deviations is taken as a measure speaker stress.

2.3.2 Engagement

Research in social psychology shows that humans are strongly influenced by their surroundings. In the context of small groups and group meetings, one of the major influences on an individual is the behavior of other group members. Normally, a person is not aware of either the interpersonal dynamics or the influence by the other group members on his behavior.

Conversational turn-taking is a particularly familiar part of human behavior. For instance, we speak of someone "taking charge" of a conversation, "driving" a conversation. Such dominance of the conversational dynamics is popularly associated with higher social status or a leadership role [19]. Similarly, some people seem skilled at establishing a "friendly" interaction. The ability to set conversational tone in this manner is popularly associated with good social skills, and is typical of skilled salespeople and social "connectors" [24].

Thomas and Malone [55] used discrete-state models to assess the dynamics for dyadic interactions. They used their model to analyze parent-child interaction. The mother's behavior (gaze or smile) depended on the child's previous response but the converse was not observed. When two people are interacting, their individual turn-taking dynamics influence each other and can be modeled as a Markov process [30]. Pentland [44] referred to this measurement as engagement. Choudhury's [13] PhD thesis compared engagement with betweenness centrality and found that they were highly correlated. Thus, the amount of time an individual displayed engagement was a nearly perfect predictor of how much of a 'connector' he/she was.

The learning ability and the interpretability of a model greatly depend on the model's parameterization. The requirement for a minimal parameterization has motivated the development of Coupled Hidden Markov Models (CHMMs) to describe interactions between

two people, where the interaction parameters are limited to the inner products of the individual Markov chains. This allows a simple parameterization in terms of the influence a person has on other persons. The two-person CHMM model can be generalized to handle interactions between many people by use of the so-called Influence Model (IM). The IM describes the connections between many Markov chains as a network of convex combinations of the chains. Basu et al. [4] used the same model to estimate influence during group interactions based on their speaking states.

Engagement was measured by the standardized influence each person had on the other's turn-talking. By quantifying the influence each participant had on the other, we obtained a measure of their engagement, or the degree to which they were "driving the conversation."

2.3.3 Mirroring

Mirroring behavior, in which the body language of one participant is "mirrored" by another, is considered to signal empathy, and has been shown to positively influence the smoothness of an interaction as well as mutual liking [12]. The distribution of utterance length is often bimodal. Sentences and sentence fragments typically occur at several-second and longer time scales. At time scales less than one second there are short interjections (e.g., 'uh-huh'), but also back-and-forth exchanges typically consisting of single words (e.g., 'OK?', 'OK!', 'done?', 'yup.'). The z-scored frequency of these short utterance exchanges is taken as a measure of mirroring.

2.3.4 Activity

Perhaps the simplest social signal is activity level. Percentage of speaking time, for example, is known to be correlated with interest level [19] and extroversion [41]. In the domain of negotiation, Barry and Friedman (1998) found a trend (albeit not statistically significant) whereby extroversion correlated positively with individual negotiation outcomes in an integrative bargaining task similar to the one we used in the present study. Conversational activity level was measured by the Z-scored percentage of speaking time.

Chapter 3

Negotiations

In this chapter we will describe and analyze two studies where the goal was to understand the importance of social signaling in negotiations.

3.1 Introduction to Negotiation

Negotiation is viewed by many people as an art and by no fewer as a science. Usually, when we hear the word negotiation, we think about two or more business partners with the goal of making a favorable deal. But many situations in our daily lives can be viewed as negotiations: deciding with a friend where to have dinner, arguing with one's child who wants the latest toy, or finding a vacation destination that matches the taste of both spouses. The most dominant and obvious way to evaluate a negotiation is the objective outcome. Was the goal achieved? How well did I do compared to the other person? But there are other important factors as well. Often a negotiation is not only a one-time event. People have to continue to work or to live with each other. In an ongoing relationship, both private and business, a person often does care what the other party thinks about him/her. In addition to the relationship factor, a person's own feelings should not be neglected. This is true on an emotional as well as on a moral level.

Looking again at the objective outcome, there are two important dimensions: creating value and claiming value. Creating value is beneficial for both parties. By enlarging the pie for both sides, this aspect is often called a win-win solution. By working together, it is possible to discover the hidden opportunities that increase the share for both parties. This kind of negotiation, where the shares can be increased is also called integrative bargaining. "Claiming value" refers to consideration of how the total available value is distributed. Negotiating across this dimension is therefore often referred to as distributive bargening. Each party tries to get as much as possible from the fixed pie. In this case we have a win-lose situation; the better one side performs, the worse the other performs. So, when looking at the outcome of a negotiation, both dimensions have to be considered. A person could successfully create value but then leave all the shares to the other person, or the opposite could occur: from the little value that was created, a person can claim most of it.

3.2 Measurements

In this section all measurements, either used in one or both experiments, are described.

3.2.1 Objective Outcome

The first and most trivial measurement for this experiment is the performance of the subjects in the negotiation. For this reason, we picked a scored negotiation. The participants would know how many points they could achieve for the different issues involved in the negotiation. This allowed us to calculate a final score for both participants. It makes sense to look both at the individual outcomes (for claiming value) and the combined outcomes (for creating value).

3.2.2 Social Signaling

All negotiations were recorded either on a Personal Digital Assistant (PDA) or on a regular PC laptop. Later they were transferred to a server where the audio features were extracted.

Based on these features, the social signaling measurements were calculated as described in the introduction. (Its not clear to me from the introduction what social signaling measurements were conducted, you might want to reiterate or elaborate a bit here.)

3.2.3 Personality

Identifying and characterizing personality is its own science. For the purpose of this thesis we will use one of the standard assessments to identify personal traits. From psychology we know that our personality has a strong impact on our daily behavior. There are many personality assessments (MMPI, NEO PR-I, IPIP, MBTI)(need references?) available that try to categorize people using different criteria. The five most common criteria are: neuroticism, extroversion, openness, agreeableness and conscientiousness. For this study, we used a 20-bipolar-item "Big Five" measure, which is shown to be highly predictive for the 60 item NEO-FFI [36]. Past research found some general aspects of voice to be correlated with personality [51]. Pittam [46] showed that extrovert persons (extroverts?) speak with higher pitch than subdued persons. Other fundamental features are volume, pitch range and speech rate.(correlated with?)

In regard to negotiations the personality measurements could have the following impact on a person's behavior:

- **Neuroticism** stands for the expression of negative affect. Sometimes the scoring is reversed and it is then called emotional stability. High scores indicate higher probability of being anxious, tense or moody. A potential positive effect is the capability of feeling the counterpart's concerns and tendencies. A disadvantage could be that a person might be too sensitive and might overestimate (the value of?) negative information.
- **Extroversion** characterizes the sociability of a person. It indicates how outgoing, talkative sociable or assertive an individual is. Positive aspects could be openness to others and an energetic, optimistic approach to life, which can help to create a good flow in a negotiation.

- **Openness** to experience. This dimension includes having wide interests and intellectual curiosity, and being imaginative and insightful. A high score on openness can be helpful if a negotiation comes to an impasse. Open people are also willing to consider novel ideas and unconventional approaches. It might be more difficult for high scoring people to claim value.

- **Agreeableness** indicates traits such as sympathy, kindness and assertiveness. Being altruistic and helpful are additional characteristics of high scores in this dimension. Agreeable individuals might assume that their partner will act in an honest manner. Low scoring subjects might be more skeptical toward others, which can protect them from being exploited.

- **Conscientious** people are well organized, good planners and persistent. In negotiations this trait could be an advantage for both creating and claiming value by making sure that all possibilities are exploited. Low scoring people might not prepare well for a negotiation.

3.2.4 Dual Concern Model

Personality might have an influence on a person's overall behavioral patterns but it does not capture the current mood or attitude of a person. We wanted to have a measurement that focuses more specifically on the self experienced behavior during the negotiation. We adopted a version of the Dual Concern Model (DCM) that was specifically tailored for negotiations. The DCM is based on Blake and Mouton's work [6] and was first articulated by Pruitt and Rubin [50]. Several models were developed based on the DCM. The best known is the Thomas Kulman Inventory (TKI). Figure 3-1 shows the five different styles according to TKI in small letters and the adopted strategies for negotiations in big letters. The two dimensions are assertiveness and cooperativeness. The first indicates how much a person is concerned for him/her self (his own outcome) the latter how much a person cares about the other (the other's outcome). For example, if a person yields often this is an indicator that he/she is interested in finding a solution by accepting the position of the

Figure 3-1: Diagram for dual concern model dimensions

partner while sacrificing some of his/her own interests. A sample question for this dimension is "I sacrificed my interests for the good of the relationship."(Not a question?)

3.2.5 Subjective Value Inventory

This measure was developed by Curhan, Elfenbein and Xu [15]. Many people think that the only aspect that matters in negotiations is the agreement reached. Other people believe that being liked or respected is as important as the outcome. For a single negotiation, for example, buying a house from a person you will never see again, the most important dimension might be the price of the house. In cases where future interactions are possible or likely it might be important to build a trustworthy relationship as well. The Subjective Value Inventory (SVI) measures four different dimensions that people tend to care about: instrumental outcomes, feelings about themselves, feelings about the process, and feelings about their relationship. The SVI can also help negotiators to conceptualize their performance along the four dimensions.

3.3 Thin Slices in Negotiation

3.3.1 Method

One hundred and twelve graduate students enrolled in a required MBA course on organizational behavior participated in the research study on a volunteer basis. Participants were randomly formed into 56 same-sex dyads for an integrative bargaining negotiation simulation. Dyads were given approximately 45 minutes to negotiate. [1]

The participants' task was based on a standard negotiation exercise called "The New Recruit" [45], an 8-issue employment negotiation between a candidate (the Middle Manager) and a recruiter (the Vice President) concerning the candidate's compensation package. Each of the eight issues offered five possible options for resolution, and each of those options was associated with a specific number of "points". Two of the eight issues (starting date and salary) were distributive or "fixed-sum" issues such that the parties interests were diametrically opposed. Two of the issues (job assignment and company car) were compatible issues such that both parties received the same number of points for a given option, and thus the parties interests were best served by the same option [56]. The remaining four issues (signing bonus, vacation days, moving expense reimbursement, and insurance provider) were integrative or potential logrolling issues such that the differences in point totals among options for a given issue enabled potential trade-offs which would increase the joint value of the agreement for both parties [49]. All participants were instructed that their goal was to maximize their own personal gain.

3.3.2 Results

Eight dyads were dropped from the analysis because they made mistakes in calculating and/or reporting their scores. In addition, two dyads were dropped from the analysis due to problems with the recording quality. The remaining 92 participants comprising 46 dyads

[1] This section relies on "Thin slices of negotiations: Predicting outcomes from conversational dynamics within the first five minutes" [16]

were retained for the analysis that follow. Table 3.1 presents descriptive statistics and the inter-correlations between all speech features.

	Middle Manger Features					Vice President Features			
Variable	1	2	3	4		5	6	7	8
Middle Manager									
1. Engagement	—	-.32*	-0.08	-0.26		.69***	-.31*	0.22	-0.05
2. Mirroring		—	0.1	-0.2		-.38**	.96***	0.08	0.21
3. Stress			—	-0.28		-0.18	0.1	.56***	-0.23
4. Activity				—		-0.28	-0.23	-0.16	-.50***
Vice President									
5. Engagement						—	-.35*	0.12	-0.19
6. Mirroring							—	0.05	0.18
7. Stress								—	-0.05
8. Activity									—
M	0.06	7.43	0.8	0.44		0.06	7.58	0.81	0.44
SD	0.03	4.32	0.13	0.11		0.03	4.73	0.14	0.09
Minimum	0	0	0.53	0.25		0	0	0.6	0.25
Maximum	0.16	20	1.04	0.84		0.13	22	1.11	0.61

* p<.05, ** p<.01, *** p<.001

Table 3.1: Means, Standard Deviations, and Pearson Correlations Between Speech Features of Middle Manager and Vice President

Inter-correlations within role were relatively low, ranging from r = -.35 to r = .28. Only the correlations between the engagement feature and the mirroring feature were statistically significant (for MM: r = -.32, $p < 0.05$; for VP: r = -.35, $p < 0.05$). In contrast, however, all inter-correlations between Middle Manager's and Vice President's use of the same feature were quite high (all rs = .50, ps <.001), particularly for the Mirroring feature (r = .96, $p < 0.001$). The amount of multicollinearity among our predictor variables suggested that a multiple regression in which all variables were entered simultaneously would not be appropriate. Thus, we conducted three stepwise linear regressions to ascertain the combinations of speech features that, taken together, would predict the maximum amount of variance in negotiation outcomes. In all three stepwise regressions, alpha-to-enter was set at .05 and alpha-to-remove was set at .10. The results of these stepwise regressions are presented in Table 3.2.

The three stepwise regressions demonstrated that measures of all four speech features,

	MM Points				VP Points				Joint Points		
Predictor	B	SE B	β		B	SE B	β		B	SE B	β
MM											
Engagement											
Mirroring	959	309	.40**								
Stress	-5989	2463	-.38*		5393	2118	.36*				
Activity					9542	2942	.56**				
VP											
Engagement					19593	9886	0.31				
Mirroring									4710	2283	.30*
Stress	6011	2325	.40*								
Activity					10155	3828	.47*				
R^2	30%**				27%**				9%*		

Total variance accounted for by each model is indicated in the last row.
MM = Middle Manager, VP = Vice President
* p<.05, ** p<.01, *** p<.001

Table 3.2: Stepwise Regressions of Instrumental Outcomes on Speech Features Occurring Within the First Five Minutes of Negotiation

occurring during the first five minutes of the negotiation, predicted the outcome of the negotiation. The first regression predicted a total of 30% of the variance in Middle Manager Points, F = 5.86, p < .01. Middle Manager Points was positively associated with Middle Manager's mirroring (β = .40, p < .01), negatively associated with Middle Manager's stress (β = -.38, p < .05), and positively associated with Vice President's stress (β = .40, p < .05). The second regression predicted a total of 27% of the variance in Vice President Points, F = 3.79, p < .05. Vice President Points was positively associated with Vice President's activity (β = .47, p < .05), positively associated with Middle Manager's activity (β = .56, p < .01), and positively associated with Middle Manager's stress (β = .36, p < .05). Moreover, a marginally significant effect suggested that Vice President Points also was positively associated with Vice President's engagement (β = .31, p = .054). Finally, the third regression predicted a total of 9% of the variance in Joint Points, F = 4.26, p < .05. Joint Points was positively correlated with the Vice President's mirroring (β = .30, p < .05).

For this experiment the SVI was not yet available. Still, the participants were asked to

answer some subjective questions in a post-negotiation questionnaire. For some of them we could find some strong correlations to the social signaling measurements. The engagement measure had a significant positive correlation (r=0.63) with the subjective "impression I thought I made on my partner" rating and a significant correlation with the "did your partner let you win" rating (r=0.65). The mirroring measure had a significant positive correlation with the extent to which participants said they were seeking to avoid disagreements (r=0.62).

3.3.3 Discussion

As hypothesized, four conversational dynamics occurring within the first five minutes of a negotiation were highly predictive of individual outcomes. In fact, whereas the average effect size in past thin slices research is r = .39 [1], our effect size was r = .54 for Middle Manager Points and r = .52 for Vice President Points. This effect is comparable in magnitude to the predictive power of negotiator aspiration levels, a factor generally considered to be a powerful determinant of negotiated outcomes [2].

The most consistent predictor of negotiation outcomes across both roles was prosodic emphasis. At the outset, we were uncertain as to whether our measure of stress would tap dynamic speech fluctuations intended to connote emphasis or unintentional jitter in the voice as a reaction to psychological anxiety. While we do not have the data to be certain, our results suggest that the latter is true. In our study, vocal stress during the first five minutes of a negotiation appeared to be a liabilityparticularly for Middle Managers.

We modeled our measure of mirroring after the mimicry behavior described by Chartrand and Bargh [12], but our measure pertained to speech patterns rather than body language. Nevertheless, as predicted, mirroring in our study appeared to have a positive effect on negotiation. It is noteworthy that mirroring in our study was predictive of individual outcomes only among low-status parties. Chartrand and Bargh found that mimicry tended to occur more among individuals with dispositionally greater perceptual activity directed at others. Since low-power parties tend to pay more attention to high-power parties [32],

it is not surprising that low-power mimicry of high-power parties would be more common and thus more normative than the reverse. Furthermore, if mirroring is a consequence of perspective-taking, then the fact that mirroring by Vice Presidents predicted Joint Points would suggest that perspective-taking is beneficial for integrative bargaining, a controversial issue in the negotiation field [18].

As we predicted, activity level was positively associated with negotiation outcomes, but this effect was apparent only among the Vice Presidents. Higher activity among Middle Managers correlated positively with points earned by the Vice President. Future research will be necessary to explore this effect and the mechanism behind it, but we have observed cases where Vice Presidents "took charge" of the negotiation and began by questioning the Middle Manager with the result that Middle Managers also displayed high activity levels.

Finally the marginally significant positive association between influence on conversational turn-taking and negotiated outcomes for Vice Presidents, as predicted, is consistent with Dunbar's assertion that dominance of the conversational dynamics is popularly associated with higher status [19]. Additionally, Vice Presidents who "took charge" of the conversation probably also controlled the agenda for the negotiation which, in turn, might have led to a strategic advantage [43].

The results of this experiment are very promising. They back the effort to implement a negotiator assistant on a small wearable device to support negotiators. Such a device could unobtrusively record the conversation and give feedback to the user after several minutes. This would allow the negotiator to change his style to increase his chances for a better outcome. In certain cases, it might be already very helpful and important to increase the performance only a few percent.

The technology could be helpful in politics, business and private life. In politics, for example, an interesting application could be developed for international summits. In negotiations where parties speak different languages or only use their second or third languages, the negotiation assistant could be a useful device. It could be sensitive to different cultures and styles. The user might be able to configure the device according to his negotiation partner.

The negotiation assistant then could help the user interpret unfamiliar social signaling. This could help the user to understand the other side better, to be aware of underlying conversational dynamics, and to change or adjust his behavior/attitude if needed.

The negotiation assistant could also be of great value for salespeople. Equipped with the assistant, they could improve their revenues. Many salespeople might be happy to have a digital device, which supports them in making judgments in the process of finishing a deal. If they would have a device that could indicate when they push to much or when the, they could adjust their strategy to bring the buyer back on track. It could also warn him after several minutes that his chances are very low to make a good deal and that it is not worthwhile to spend to much time on this customer.

This scenario works fine as long as only one person uses the negotiator assistant. But what happens if both parties are allowed to use the same feedback device? We can only speculate about this case. There are several options. It could be that the advantage of both sides would balance itself and neither side would have any gains. This might still be desirable since, at least, it prevents either side from being exploit by a counterpart that uses the negotiation assistant. Or, it could help both sides to improve their outcomes. In this case the feedback assistant would not help claiming value but creating value, which is still in the interests of both parties. As a last option, it could be possible that the feedback would change the dynamics in an unpredictable way. Then, the assistant could even have a negative impact by damaging either one or even both users' outcome.

3.4 Personal Attitudes in Negotiation

As a next step to the implementation of negotiator assistant, we need to understand if social signaling is an individual or a dyadic measurement. If it is a individual measurement an assistant could be meaningful. Otherwise we probably just measured a certain interaction pattern between different social signaling styles.

The following example should illustrate the problem. Lets assume we know that the amount

of saying "yes" of the low status participant is correlated with the outcome of the high status person. If the behavior of the high status person is causing the "yes"'s, then we could use the correlation for a feedback mechanism for the high status person. If saying "yes" only depends on the mood of low status person, then the correlation would be useless. The question is whether social signaling is merely an indicator of underlying dynamics, which are a result of the interaction, or whether a person has a certain negotiation style that could explain the social signaling. In addition to this question, we wanted to study other possible correlations with negotiation outcome, such as personality and tactical approaches or attitudes.

3.4.1 Method

Participants were thirty six MBA students who enrolled in a one-day seminar on negotiation. They were assigned to either the recruiter or applicant role in a scored multi-item employment negotiation task. Before the seminar, the participants were asked to complete an online personality survey. At the beginning of the seminar, each participant received written confidential instructions describing the role and the relevant issues with the corresponding score ratings. The students had 45 minutes to read and prepare themselves for the negotiation task. There were two negotiation rounds. Every student played the same role twice. The partner was randomly assigned for each round. Each person was recorded on a separate channel. The negotiation task included five scored issues: two issues were distributed, one was compatible and two were integrative. In addition to the five scored items, the starting date for the new job was introduced as a possible contentious issue but no points where assigned to it. The goal for each side was to optimize their score. After each session all participants had to fill out an online survey where they submitted their scores and completed the SVI and DCM questionnaires.

3.4.2 Results

Due to technical problems, we only had twelve first round and thirteen second round audio recordings. The questionnaires (personality, DCM and SVI) are mostly complete, one/two data points are missing for the first/second session. Most probably WIFI problems caused the loss of these three missing data points.

We used the bivariate correlation procedure to compute Pearson's correlation coefficient. For the correlation table we used all five measurements (personality, social signaling, DVM, SVI and objective performance) for both of the two sessions. We were looking for repeating statistically significant patterns.

The first interesting, but not surprising, observation was that personality is not correlated with any of the other measurements.

The four different SVI sub dimension were highly correlated for both the first and second sessions (Table 3.3). The high correlation values in the last column for global SVI are not surprising since svi global is the mean of the four other SVI dimensions. At least it justifies the use of a global SVI as a measure of personal satisfaction for a negotiation.

	svi outcome 1	svi self 1	svi process 1	svi relation 1	svi global 1
svi outcome 1	1	0.41*	0.59**	0.38*	0.77**
svi self 1		1	0.46**	0.43*	0.71**
svi process 1			1	0.67**	0.86**
svi relation 1				1	0.79**
svi global 1					1
	svi outcome 2	svi self 2	svi process 2	svi relation 2	svi global 2
svi outcome 2	1	0.55**	0.66**	0.67**	0.87**
svi self 2		1	0.21	0.32	0.58**
svi process 2			1	0.82**	0.87**
svi relation 2				1	0.91**
svi global 2					1

Table 3.3: SVI correlations

The next interesting pattern is the fact that the values for the current behavior measure were all correlated with each other between the first and the second session (Table 3.4).

Thus, the strategy and attitude seems to be inherent to a person's style/mood and is less impacted by the negotiation partner.

	contending 2	integrating 2	avoiding 2	yielding 2
contending 1	0.38*	-0.14	-0.22	-0.12
integrating 1	-0.15	0.7**	-0.28	0.29
avoiding 1	0.09	-0.09	0.63**	0.19
yielding 1	-0.23	0.44*	0.38*	0.5**

Table 3.4: Attitude measure correlations

The same consistency over the two negotiations can be found in the social signaling features (Table 3.5). The negative correlation for engagement is not disturbing since it is not significant.

	engagement 2	mirror 2	stress 2	activity 2
engagement 1	-0.21	-0.27	-0.06	0.13
mirror 1	-0.08	0.65**	0.19	0.36
stress 1	-0.03	-0.07	0.71**	0.42
activity 1	0.01	-0.13	0.34	0.54*

Table 3.5: Social signaling correlations

The last interesting correlation pattern relates to objective outcome. Both the recruiter and applicant scores are significantly correlated with each other over both sessions.

Results	recruiter 2	applicant 2
recruiter 1	0.37*	-0.39*
applicant 1		0.42*

Table 3.6: Instrumental outcome correlations

3.4.3 Discussion

Unfortunately, the amount of useful data was very small in this experiment. An initial small number of participants combined with technical problems resulted in a small number of final complete data points entering the correlation table. As a result, only strong effects can be statistically significant. This might explain why we could not find more correlations. The sample size was too small to meaningfully test the predictor for outcome based on

social signaling, which was found in the first experiment (section 3.3).

Despite these problems, we found some interesting patterns in our analysis. It seems that people have a certain approach to a negotiation. Both the reported attitude measures and the social signaling were significantly correlated between the first and the second session. The SVI values, although significantly correlated with each other, don't show this property. This implies that the subjective impression of how a person felt after a negotiation depends on the experience during the interaction and varies from partner to partner. However, the strategies and behavior used during the negotiation are more based on a general attitude and less influenced by the current dynamics.

Regarding the outcome, we can observe that both recruiters and applicants who did well in the first session continued their success in the second session. The correlations are significant but not extremely high. The data suggest that most of the participants were close to mean and a few outliers that were constant in both session caused the correlation. Since the dataset was too small, it is difficult to say if there were just by chance two or three people who did consistently well or poorly in this experiment or if this could be a general trend.

It is interesting to consider the open question of whether there is a causal relationship in social signaling in addition to the correlational one. Can a negotiator be trained using social signaling concepts to bring about a conscious change in his signaling to improve his/her outcome? We conducted an exploratory trial, where we instructed participants to use a certain behavioral style. Some subjects were told to practice active listening to increase their mirroring values and others to engage in an active and dominating role to get higher engagement scores. Real time feedback should help to remind the participants about their strategies. While participants were able to produce the suggested behavior during a five minute training session, we could not observe any changes during the actual negotiation.

The short training time (between two and four minutes) might have been a factor. Odds are high that the subjects were too focused on the content of the negotiation to engage in the instructed behavior. Another possible explanation is that the desired behavior could be produced for one or two minutes but for longer time periods the natural tendencies prevail.

If this is the case, by the end of the five minute negotiation period the measurements were confused, reducing the accuracy of both the predictor and the measure. A final explanation could be that our feedback was not well designed and not helpful during the negotiation. A smarter feedback mechanism might be the solution in this case.

An automated training device for negotiation could be very valuable for companies. We know that there are limits to teaching, since people tend to forget new information quite fast as long as they don't have chance to practice. Moreover, when training a certain behavior, we would also like to know how well we are doing, since one of the methods of training is to provide feedback on improved behavior. This is the reason why people spend a lot of money for private trainers in many sports. Repeating the same mistake many times is not constructive. The trainer observes the behavior and can then give immediate instructions for improvements. The problem is that personal one-on-one training is very expensive. The negotiation assistant could provide the necessary feedback at nearly no cost and to larger numbers of people at once.

Instead of a mobile application, we could also imagine a permanent installation for companies. They might have their "negotiation room". This kind of smart room would be more powerful than the mobile application, since in addition to the voice analysis, other nonverbal communication channels could be captured as well. This might bring the social signaling measurements to the next level, although privacy issues could be a problem in this case. The other party would have no interest in being observed, so it could lead to negative impacts on the long term relations between such a company and its partners.

Chapter 4

Group Polarization

The goal oft his experiment is to understand social signaling in a group context. All of the earlier analysis described above was limited to dyadic interactions (negotiations, speed dating, and poker). The strong psychological phenomenon of group polarization provides an interesting and novel environment for this study. Based on both explanatory mechanisms that will be introduced below, we hoped to capture social signaling by different members of the group, particularly, the subjects on the high and low ends of the risk scale.

4.1 Introduction to Group Polarization

Based on a study of risk taking, Stoner [53] discovered in 1961 that group decisions are riskier than the individual decisions of the group members prior to the group discussion. Stoner used the questions that were devised by Wallach and Kogan [59] to study individual differences in risk-taking. Subjects were faced, among other items, with twelve questions where they expressed their opinion by assigning a probability to their preference. As an example, question number two is reproduced here:

> Mr. B, a 45-year-old accountant, has recently been informed by his physician

that he has developed a severe heart ailment. The disease would be sufficiently serious to force Mr. B to change many of his strongest life habits - reducing his work load, drastically changing his diet, giving up favorite leisure-time pursuits. The physician suggests that a delicate medical operation could be attempted which, if successful, would completely relieve the heart condition. But its success could not be assured, and in fact, the operation might prove fatal. Imagine that you are advising Mr. B. Listed below are several probabilities or odds that the operation will prove successful.

Please check the lowest probability that you would consider acceptable for the operation to be performed.

[ ] Place a check here if you think Mr. B should not have the operation no matter what the probabilities.

[ ] The chances are 9 in 10 that the operation will be a success.

[ ] The chances are 7 in 10 that the operation will be a success.

[ ] The chances are 5 in 10 that the operation will be a success.

[ ] The chances are 3 in 10 that the operation will be a success.

[ ] The chances are 1 in 10 that the operation will be a success.

In addition, consider these summarized versions of two other sample questions:

- A man of moderate means may invest some money he inherited in secure, "blue chip" low-return securities or in more risky securities that offer the possibility of large gains.
- A captain of a college football team, in the final seconds of a game with the college's traditional rival, may choose a play that is almost certain to produce a tie score, or a more risky play that would lead to sure victory if successful, sure defeat if not.

In Stoner's study male students first studied the questions individually. Then, groups of six students were assembled and the questions were discussed again with a unanimous group

decision at the end. Stoner found that 39% of the subjects shifted towards higher risk while only 16% lowered their risk preferences during the group phose. This effect was described as "risky shift". Over the years several hundred studies replicated Stoner's finding under different conditions. Interestingly, for two out of the twelve questions there was a tendency for the group decision to be more cautious [42]. It was discovered that certain questions produce consistently more cautious group decisions. Consequently, the term "caution shift" was used for these choice dilemmas. Several explanations have been offered for these group shift phenomena. The reason for the opposite shift (to more cautious behavior) could be social norms related to the particular topic. Another suggestion is that in cases where an individual participant, or a person from the close social circle of a participant, is the subject of the question cautiousness is dominant.

The magnitude of the shift is actually correlated to the initial mean of the individual positions. The more extreme (risky or cautious) the individual decisions were the bigger the shift [54]. This dependency suggests that the "shift" phenomenon is part of the more general body of research dealing with "group polarization". A tendency toward a certain opinion of individual group members is enhanced after a group discussion.

In a meta study about group polarization Isenberg [29] summarized the two main explanatory mechanisms: social comparison and persuasive argumentation. Both of these processes were tested and found to be effective both together and independently.

Social Comparison

The basic assumption of this theory is that a person wants to be seen in a socially favorable light. In the case of group polarization, it means that the individual decision is based on a subjective assessment of what a person actually believes and the perceived social norm. Obviously, the individual does not know the other group members' position during the independent decision phase. During the group discussion the group norm is exposed and each person will take a position that puts him in a more favorable light: closer or above the group mean [48, 40].

Persuasive Argumentation

According to this theory there exists a given pool of possible arguments for each item. Some items have more arguments for risky behavior, some have more arguments for cautious behavior and others have an equal number on each side. When an individual has to make a decision, a certain number of arguments will occur to him/her. The choice is then made based on these arguments. During the discussion, the number of arguments will increase as other group members contribute their arguments. The group choice, after pooling the arguments, is then influenced by the newly available number of arguments [57].

4.2 Measurements

The paragraphs below explain how the social signaling measurements were modified from their dyadic interaction implementation to work with larger group sizes.

Engagement

The influence model, which measures engagement, can be applied to groups of four as well as two, although the meaning of the values is slightly different. The model returns an influence value for each person for the six direct links between that person and the other group members and four values for the influence on oneself. For dyadic interactions, engagement was measured only as the influence on the other person. In the current setting, it is not clear how to interpret the different influence values on the other participants as an engagement measure for one person. Instead of assigning a value for each connection, we calculated engagement as one minus all outgoing influence values.

Mirroring

The mirroring measurement can be adapted from the dyadic interaction. Again, we summarized all the mirroring between one person and all the other subjects as a single value.

Stress and Activity

Both stress and activity are personal indicators that can be measured in the same ways as for dyadic interactions.

"Leader": The person that took the highest risk (in risky choice) might have an interest in moving the group decision in the higher risk direction. According to the social comparison explanation, this might be due to the perception that the individual would gain favor with the group by holding his position while moving the group closer to his point of view. Persuasive argumentation theory suggests that special signaling could be based on the fact that this person has more arguments at hand.

"Loser": On the other end of the risk scale the person that took the lowest risk may be expected to show certain characteristic behaviors or patterns that can be measured with social signaling. This person has the socially least favorable position and might feel uncomfortable and try to improve his/her position.

4.3 Data Collection

As part of a class project sixteen students participated in this study. The participants filled out an online personality survey (NEO-FFI). These students were assigned randomly to four groups. The procedure for a session was the following: The four students were seated at a table and each person received the pile with the standard twelve risk-taking questions. They received time to read each question and to record their opinion on an individual answer sheet. Then, three minutes were allowed to discuss the question in the group. The group discussion was recorded on four synchronized Linux PDAs, each person on one device. As the final step, they were asked, after the discussion, to state their opinion publicly and the experimenter wrote the answer down. This procedure was repeated for all twelve questions.

4.4 Analysis

Because this was an exploratory study, the number of participants was deliberately kept low. Using this small sample size we were not able to reproduce the group polarization shift observed in other studies. A paired T-test between the individual means and the group means showed that H0 (no difference in means) could not be rejected ($p = 0.75$). This means that there was no observable overall risky shift.

Interestingly, we were still able to reproduce a phenomenon known as the shift predictor to a certain degree. The first ones to identify the predictor were Teger and Pruitt [54]. The shift predictor laid the basis for the group polarization effect: The more polarized a group is before the group discussion the stronger the shift will be. The assumption that a balanced mean in the individual decisions before the group discussion leaves more space for a big shift cannot be supported. The opposite is true; the initial disposition to take a high risk or to be risk aversive is reinforced by a group discussion. After removing two outliers with a large shift caused by misunderstanding of the question, we could find this correlation even in our small dataset. Figure 4-1 shows this correlation. The R^2 of 0.68 is highly significant. When comparing the values of shift size and mean after the group discussion the correlation ($R^2 = 0.39$) was significant ($p < 0.05$) even including the outliers.

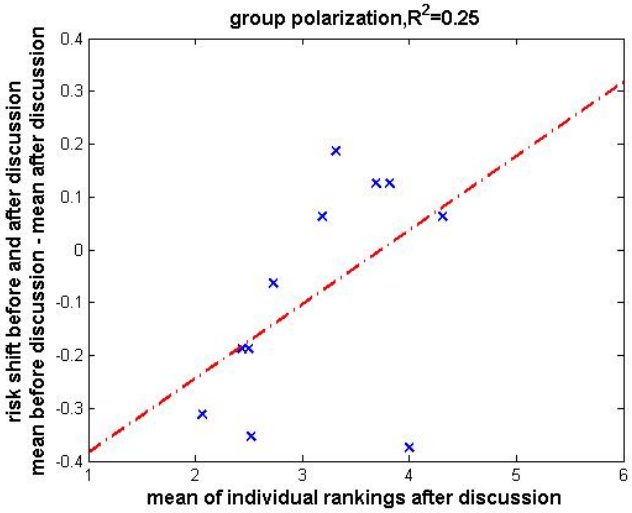

Figure 4-1: Shift Predictor

Even without observing risky shift, we could still use the data for our analysis. The main purpose of our data collection was not to replicate the group polarization phenomenon but to study social signaling. It is a first attempt at extending the social signaling measures to a group setting.

Looking at the individual behavior during all twelve session we discovered that certain people had a tendency to change their opinions regularly while others stuck to their original decision (see Figure 4-2). Person four in group three, for example, never changed his mind while person three in group four did so eight times. The fact that some people are more influenced by the group discussion than others, could be caused by personality differences. A linear regression shows that 45 % of the variance can be explained by openness and agreeableness ($p < 0.02$).

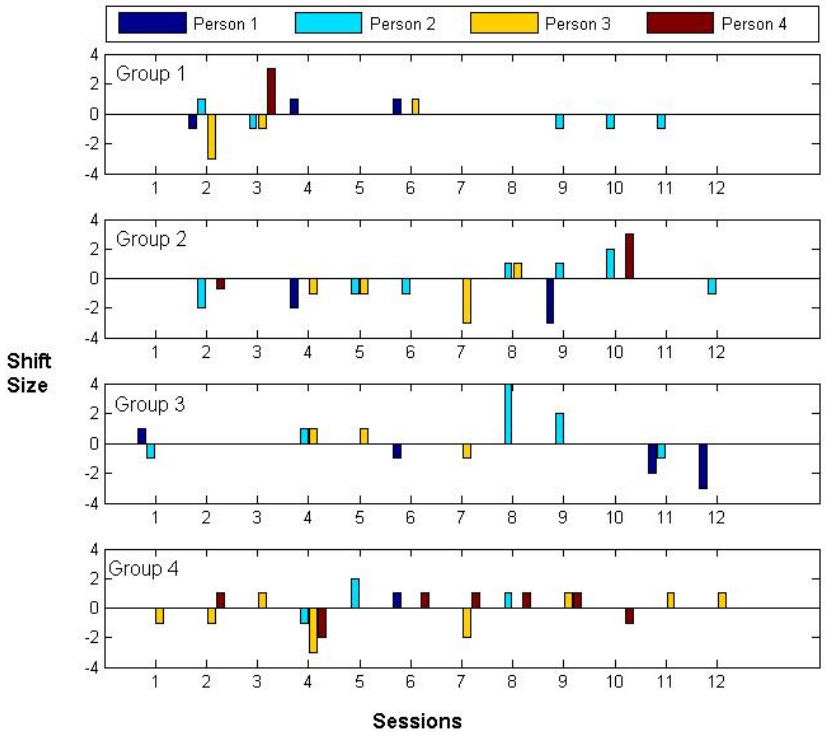

Figure 4-2: Change of opinions for all users and all sessions

We used several methods to try to correlate or predict individual or group risk patterns and behavior: discovering who changed his position, who led the discussion in a certain

direction or who was most influenced by others in a session. Unfortunately we could not find any indicator for the usefulness of the social signaling measures in the context of our pilot analysis.

4.5 Discussion

The analysis done in this experiment represents a pilot study. Therefore, it not surprising that our results are not more conclusive. There are several possible reasons that clear explanations for individual behavior in groups were not found based on the social signaling features. First, as mentioned earlier, we are not sure how to measure the interactive signals in a group context. Should the focus be on the interaction of each individual and the sum of all other participants or on each individual's one-to-one interactions? It might also be the case that the social signaling was simply not strong enough We can see from the data that the shifts were relatively low and we observed that the recorded discussions were relatively relaxed. It might be necessary to find a better experimental setup to elicit stronger social behaviors more amenable to voice measurement. Finally, it might simply be the case that group interactions become too complex and that a single nonverbal communication channel is not enough to reveal the underlying dynamics.

If we could understand social signaling in groups, we might apply it to group meetings. In such a context, the goal would not be to give feedback to individuals but rather to the group as a whole. If certain dynamics were detected, an automatic signal could indicate negative or hindering group dynamics. As a result, group performance could be optimized by reducing the time that people waste in long unproductive group meetings.

Chapter 5

Conclusion

5.1 Summary

In this thesis, we tried to deepen the understanding of the social signaling measurements. We applied the idea of "thin slices" combined with social signaling to negotiations. We were able to predict 30% of the variance in individual outcome based on the first five minutes of a negotiation. This corresponds to an effect size of $r > .52$, which can be compared to the predictive power of negotiation aspiration levels.

In the experiment for personal attitudes in negotiations we observed individual signaling and behavior over two consecutive negotiations. This experiment was conducted without any intervention and thus reflects the natural tendencies of the participants. We showed that social signaling appears to depend more on individual negotiation style than on the negotiation partner. While attitude, as a short term behavior measurement, was also based on personal style, personality did not show any interesting correlations. As was to be expected, the only measurement that depended on the partner was subjective value inventory.

We met with limited success in our initial attempt to apply social signaling concepts to groups larger than two. It might be necessary to redefine social signaling in this context. Or, it might be that the dynamics in bigger groups are just too complex to be measured by

nonlinguistic speech signals alone.

Overall, we can conclude that social signaling is a promising approach for understanding and predicting dyadic interactions. The question of application to bigger groups needs to be investigated further.

5.2 Future Work

One advantage of our methodology, alluded to earlier, is the fact that all micro-coding of speech features is done automatically. Thus, similar algorithms could be used to provide negotiators with real-time feedback so as to diagnose and improve their negotiation skills. Of course, one would need to ascertain first whether manipulating speech features would result in improved negotiation outcomes. Additionally, future research would need to determine whether negotiators could alter their own speech features consciously. Because social signaling is largely unconscious, it has proven relatively difficult to train people to change their signaling. This is true, as mentioned above, particularly if people are not familiar with signaling strategies.

The one technique that does appear promising is similar to method acting: the participant is asked to pretend to be a different person, one who is more dominating and focused [(for the Vice President role) or one who is more friendly and extroverted (for the Middle Manager role)]I'm pretty sure you haven't mentioned these two roles before. If that's true you should reword with a more descriptive tag for the role. Something like "more dominating and focused for a strong leadership role". This approach is founded on the idea that attitude/role drives social signaling, and that it is relatively difficult to alter through conscious manipulation. The "method acting" suggestion could help to prevent a relapse into natural behavior when confronted with higher cognitive load. A feedback mechanism might still be useful, because even a trained expert might lapse from the desired behavior and thus benefit from an active monitoring device.

The main purpose of the social signaling is to measure conversation interactions. In our

research we focused on negotiations. An interesting field to apply our measurements could be call centers. The entire infrastructure to record the phone calls is already in place in many call centers. The integration of social signaling measurements could have several benefits. First, it could give the call center customer agent additional information about the direction the conversation is heading. Is the customer nervous and impatient or relaxed and open minded? Our assumption is that the system would be able to detect some subtle cues before the operator, because his/her attention is on the content of the customer's request. Social signaling has the additional advantage of not only analyzing to caller but also considers the customer agent's reaction for providing appropriate feedback. When needed, the system could warn the agent and he/she could shift the focus of the conversation to reduce the customer's frustration. Second, big call centers also have supervisors who observe the customer agents' interactions for quality control by tapping random conversations. Our suggested system might pick up critical conversations and inform the supervisor directly, allowing him/her to observe the conversation and to assist the operator if needed.

Social signaling could also be used for data mining. By collecting the signals in various situations, we might improve the quantitative aspect of the measurements. This could result in very accurate predictions of conversations, not only for cases with a concrete scored outcome, as in the two negotiation experiments, but also for general conversations.

As an alternative to finding a general model for understanding certain characteristics in prosodic speech features, an individual-based approach might prove interesting. This would involve studying how attitude characteristics manifest themselves in dyadic interaction. Observations would be made not only of individual speech features but also of special characteristics of interaction such as conversational turn taking, interruptions, listening style and dominance structures. Since we know who the other speaker is, we could start analyzing how a persons speaking style depends on the conversational partner. The purpose would be to predict when a given conversation deviates from its normal pattern.

Assuming that certain baseline conversations could be detected successfully, several interesting applications could be implemented. A mobile phone would be able to give feedback

during a conversation and indicate special conditions to the speaker. It could, for example, let a speaker know that he was beginning to fall into his usual pattern of useless discussions with his business partner. Or, it could indicate to the speaker that the chances are very high that if he continued the current conversation in this way the other side will soon be upset.

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