ANALYSIS OF LAUGHTER IN TASK BASED INTERACTIONS

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The purpose of the dissertation is divided into two parts of study. The first part of the study presents a detailed analysis of the role of conversational dominance in laughter in task based interactions. The second part of the study focuses on analyzing the distribution of different types of laughter in laughter segments. Multisimo corpus is utilized for conducting the analysis on both parts of the study. The corpus consists of 18 video sessions consisting of two participants tasked with answering quiz questions and a facilitator tasked with supervising the discussions of the participants. Laughter is categorized into mirthful and discourse laughter based on laughter annotations provided in the video. Each video session is divided into three sections based on the topic and each section is further sub-divided into four section quarters of equal intervals. Analysis of laughter is conducted on each of these section quarters. A significant number of interesting conclusions are drawn from the analysis and some of the them supported by data and statistical significance are as follows: 1) Highly dominant participants frequently engage in mirthful laughter than low dominant participants. 2) Less dominant participants frequently engage in discourse laughter than mirthful laughter compared to highly dominant participants. 3) Discourse laughter is frequently observed compared to mirthful laughter before topic termination.

Summary

The purpose of the dissertation is divided into two parts of the study. The first part of the study presents a detailed analysis of the role of conversational dominance in laughter in task based interactions. The second part of the study focuses on analyzing the distribution of different types of laughter in topic segments.

Conversational Dominance is a state in an interaction where an individual have the ability to influence other people's opinion and emotions. There are two types of laughter utilized in the current study based on the annotations provided in the dataset - Mirthful and Discourse Laughter. Mirthful Laughter can be described as laughter which causes excitement or amusement to an individual. Some individuals may laugh for no reason or laugh just to maintain conversation. This type of laughter is called discourse laughter. Laughter is also classified into solo, shared, unratified and ratified laughter. Individuals may laugh alone in a conversation(solo laughter) or may overlap with other people (shared laughter). When an individual engage in solo laughter and the laughter is reciprocated by another individual, it is called unratified laughter. When an individual engage in solo laughter and laughter is being reciprocated by other people, it is called ratified laughter.

The corpus utilized for the current analysis is Multisimo corpus. The corpus consists of 18 video sessions consisting of two participants assisted by a facilitator. The participants are assigned the task of answering three quiz questions

posed by facilitator. The main purpose of the facilitator is to supervise discussions among participants.

Each video session consists of three sections. Each section denote the time interval where participants discuss and answer a quiz question. The section also denotes discussion about a particular topic. Each section consists of two subsections - naming and ranking phase. Naming phase denotes the time interval where participants discuss among participants and identify the three correct answers to the question. Ranking phase denotes the time interval where the participants rank the identified answers and provide the answer to the facilitator. Each section is divided into four quarters of equal time intervals - Quarter 1, Quarter 2, Quarter 3 and Quarter 4. Dominance scores for the participant are provided along with the participant and are in the range 1-4. Participants with dominance score of 1 possess very low dominance. Participants with dominance score of 4 possess very high dominance.

The first part of the study examines the relationship between conversational dominance and laughter. From the study, interesting conclusions were inferred. Participants with dominance of 3 and 4 are more likely to engage in mirthful laughter than participants with dominance of 1 and 2. Participants with dominance of 1 and 2 are more likely to engage in discourse laughter compared to mirthful laughter. Highly dominant participants participate frequently in shared laughter and low dominant participants participate in unratified laughter.

The second part of the study focus on analyzing the distribution of mirthful and discourse laughter in different section quarters. Discourse laughter is the most frequently observed laughter in the final section quarter compared to first three section quarter i.e discourse laughter is highly observed before topic termination. Shared laughter is frequently observed relative to unratified laughter in the first two section quarters but Unratified laughter is frequently observed

in the final two section quarters. Duration of mirthful laughter is significantly higher than discourse laughter in all section quarters.

Laughter research can be utilized in several applications like design of conversational AI agents, quantification of collaboration, task success and conversational dominance.

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Chapter 1

Introduction

1.1 Background study of Laughter Research

Many recent attempts have been made to study human interaction in conversations. Human interactions can be studied by analyzing linguistic and non-linguistic elements of conversation. Linguistic elements of human interaction involved analyzing the lexico-grammatical features [Crawford et al., 2019], linguistic style matching [Niederhoffer and Pennebaker, 2002]. Non Linguistic studies on human interaction involved analyzing gestures [Dimitra et al., 2016], laughter and turn taking [Ghilzai and Baloch, 2015].

Laughter is considered as one of the non-verbal forms of communication and its analysis can utilized in different applications. Many studies on laughter correlate its occurrence with different scenarios other than humour. Laughter can be caused either due to mirth, embarrassment or simply to maintain conversation. Due to the availability of multimodal corpora, there is a steady rise in laughter research and areas of research include laughter detection, segmentation, classification and finding structural pattern of laughter.

Different studies have proposed different approaches of classifying laughter. The works by [Tanaka and Campbell, 2014], [Campbell et al., 2005] have classified laughter into different types predominantly using acoustic features. Tanaka et al [Tanaka and Campbell, 2014] classified laughter into polite or mirthful categories based on acoustic features. Campbell et al [Campbell et al., 2005] have classified laughter based on functional classes and phonetic segments.

Differentiating laughter from speech is another area which gained a lot of traction. Knox et al [Knox and Mirghafori, 2007] utilized Artificial Neural Network for performing automatic laughter detection. Similarly, the work by Truong et al [Truong and Leeuwen, 2005] utilized Gausian Mixture Model to differentiate laughter and speech. Many authors have proposed different approaches to segment laughter into different levels. Knox et al [Knox et al., 2008] proposed laughter segmentation using Hybrid models combining Multi Layer Perceptron and Hidden Markov Model. Recent works also suggest with statistical evidence that distribution of laughter is not random but rather exhibit a structure.

Recently, studies have also focused on the relationship between laughter and topic boundaries. Holt et al [Holt, 2010] have explored how shared laughter is associated with topic termination. Bonin et al [Bonin et al., 2014] examined the relationship between laughter and topic change in AMI and TableTalk corpora.

Contributions of the current research is explained in Section 1.2.

1.2 Contributions of the work

Contributions of the thesis are as follows:

1. Examining the relationship between conversational dominance and laughter.

2. Examining the distribution of different types of laughter - mirthful and discourse laughter. Mirthful and discourse laughter is explained in Section 2.2.1 of Chapter 2.

3. Examining the distribution of solo, shared, ratified and unratified laughter. Solo, shared, ratified and unratified laughter is explained in Section 2.2.2 of Chapter 2. Illustration of Ratified and Unratified Laughter is provided in 4.7 of Chapter 4.

1.3 Applications of the Current Work

1.3.1 Quantifying Collaboration and Task Success

Participants express different emotions during conversation and it play an important role in analyzing collaborative behaviour of participants. Analyzing distribution of non-verbal communication like laughter in group dialogues can be utilized in quantifying collaboration. Quantifying collaboration will also aid in predicting task success in group activities.

1.3.2 Quantifying User Engagement in talks

Speakers in today's world will be interested in knowing whether the user paid attention to the conversation. User's [Haider et al., 2017] social signals like laughter serve as a vital tool in identifying and quantifying user engagement in conversation. Quantification of user engagement in talks will help speakers improve their ability to engage users in conversation.

1.3.3 Design of Conversational AI Agents

Laughter analysis can be applied in enhancing the quality of interaction between humans and robots [Ishi et al., 2019]. Apart from improving the linguistic ability of robots, social signals like laughter will also augment human-like emotions in it. This will help in better design of humanoid robots and other AI agents.

1.4 Structure of Thesis

Chapter 1 explains the background of laughter research, contribution and application of dissertation. Chapter 2 explains in detail about conversational dominance and types of laughter . A detailed literature survey regarding the contribution of thesis is explained in Chapter 3. Dataset utilized for the analysis, software utilized in extraction of data and annotations are explained in Chapter 4. Chapter 5 discusses the steps involved in data preparation and statistical tests

utilized in the current analysis. Chapter 6 discuss the analysis of examining relationship between conversational dominance and laughter. Chapter 7 focuses on analysis of the distribution of mirthful/discourse laughter. It also focuses on analysis of the distribution of solo, shared, ratified and unratified laughter. Chapter 7 explains the purpose and summary of dissertation. Chapter 8 discusses the extension of current work to be undertaken in future.

Chapter 2

Laughter Dynamics and Conversational Dominance

2.1 Conversational Dominance

Conversational Dominance is a state in an interaction where an individual have the ability to influence other people's opinion and emotions. In group interactions, certain individuals tend to dominate other people in conversation. According to Itakura [Itakura, 2001], dominance can be viewed along three constructs. Viewing along the lines of sequential construct, dominant people can control other participant with their ideas. In view of participant construct of dominance, people can hinder other people's speaking rights. In view of quantitative dominance, dominance can be viewed as the amount of speaker's contribution to the interaction by measuring the number of words uttered by the speaker. Many studies correlate dominance with different features like speaker duration, turn taking, overlap duration, number of overlaps, gestures. Conversational dominance studies is extensively utilized in design of conversational AI agents which can automatically estimate dominance of human participants using different features like turn taking, speaker duration, number of words, gestures, laughter.

2.2 Types of Laughter

Different authors have introduced different types laughter. Ruch et al [Ruch et al., 2013] proposed four different types of laughter - joyful, intense, schadenfreude, grinning based on facial features. Schadenfreude laughter denotes pleasure derived from knowing misfortunes of others. Hough et al [Hough et al., 2016] introduced three types of laughter - laughter based on pleasure, social laughter, laughter based on embarrassment in DUEL corpus. Tanaka et al [Tanaka and Campbell, 2011] proposed five categories of laughter - mirthful, polite, derision, embarrassment and other. Mirthful and discourse laughter is considered for the current analysis.

2.2.1 Types of Laughter Based on Context

Mirthful Laughter

Mirthful laughter [Sabonytė, 2018] occurs when a situation produced excitement or amusement to an individual. For instance, humorous or funny incidents may cause mirthful laughter.

Discourse Laughter

Sometimes, an individual may produce laughter for no reason. An individual may utilize discourse laughter [Sabonytė, 2018] to maintain a conversation in order to assess different situations.

2.2.2 Types of Laughter Based on Participants Involved

Laughter is classified into four categories based on participants involved - solo laughter, shared laughter, unratified laughter and ratified laughter.

Solo Laughter

Solo Laughter is also known as non-overlapping laughter. Solo Laughter occurs when an individual laughs alone in a conversation.

Shared Laughter

Shared Laughter is also known as overlapping laughter. Shared Laughter occurs when two or more individuals participate in laughter in a conversation.

Unratified Laughter

Unratified Laughter occurs when solo laughter occurs without interruption by another individual. This can also be termed as unreciprocated laughter.

Ratified Laughter

Ratified Laughter occurs when solo laughter occurs with interruption immediately followed by a shared laughter or solo laughter from another individual. This can also be termed as reciprocated laughter. Examples of ratified and unratified laughter is explained in Chapter 4.

Chapter 3

Literature Survey

3.1 Conversational Dominance

Pakzadian et al [Pakzadian and Tootkaboni, 2018] analyzed the role of gender in conversational dominance. The author proposed that dominance is achieved by different methods like interruption, topic change, silence, criticism by dominant speakers. The research concluded that men are more likely dominant than women in conversation.

Koutsombogera et al [Koutsombogera et al., 2018] analyzed the relationship between the Big 5 personality traits, gaze features, conversational features like number of turns, number of words and conversational dominance. Big 5 personality traits include Agreeableness, Extraversion, Openness, Neuroticism, Conscientiousness. The authors concluded that high dominance is related to extraversion and low dominance is related to agreeableness. They have also found that dominance scores are closely related to the number of words uttered by the speaker.

Rienks et al [Rienks and Heylen, 2005] used features like number of turns, speaking time, number of times interrupted, number of successful interruptions to estimate conversational dominance. The author utilized Support Vector Machine algorithm to predict conversational dominance with accuracy of 75%.

Yatsushiro et al [Yatsushiro et al., 2013] used gaze and turn taking features to estimate conversational dominance. The author utilized gaze features like

number of mutual gazes, amount of gaze at other participants, interruption to predict dominance with root mean square of 0.85. The coefficients of the machine learning model suggests a high correlation between dominance and amount of gaze at other participants.

Previous studies have explored the relationship between conversational dominance and various linguistic / non-linguistic features such as gazes, turn taking, gender, personality traits. No recent literature focused on analyzing the relationship between conversational dominance and laughter. The current work will focus on filling the gap in the literature as it will focus on examining the relationship between dominance and laughter.

3.2 Analysis of Different Types of Laughter

3.2.1 Mirthful and Polite or Discourse Laughter Analysis

Tanaka et al [Tanaka and Campbell, 2011] analyzed acoustic features of mirthful and polite laughter. This analysis also proposed that mirthful and polite laughter varied in its duration. The author also concluded that duration of mirthful laughter is longer than polite laughter.

Sabonyte et al [Sabonytė, 2018] proposed that mirthful and polite laughter varied in its structure and duration. Mirthful laughter possess larger amount of syllables than polite laughter. Results of this analysis is in accordance with Tanaka et al's conclusion where duration of mirthful laughter is longer than polite laughter.

Previous works have focused on analyzing the acoustic features and duration of mirthful/polite laughter. In our current study,the analysis will focus on analyzing the laughter distribution of mirthful and discourse laughter at various laughter segments including topic initiation and topic termination.

3.2.2 Overlapping and Non-Overlapping Laughter Analysis

Pope et al [Pope et al., 2018] explored the distribution of different types of laughter like audience laughter, babble laughter, solo laughter in a comedy show.

Babble laughter can be considered as the laughter between small group of people. Larger amount of audience laughter is observed at the beginning of the comedy show and babble laughter(shared laughter between small groups of people) is observed more frequent during the end of the comedy show.

Bigi et al [Bigi and Bertrand, 2016] analyzed the duration and frequency of laughter occurrence in French conversations using CID Corpus [CID, 2018]. Gender played an important role in affecting the duration of laughter. Female participants laugh more likely than the male participants and duration of overlapping laughter is observed significantly higher than non-overlapping laughter.

Truong et al [Truong and Trouvain, 2012] analyzed the duration of overlapping laughter in four corpora namely ICSI Meeting Recorder corpus, AMI corpus, HCRC Map Task corpus, and the Diapix Lucid corpus. There is a positive correlation between the number of the participants in the conversation and number of overlapping laughter. Laskowski et al [Laskowski and Burger, 2007] also concluded that percent of overlapping laughter relative to total laughter time is higher than the percent of overlapping speech relative to total speaking time.

Bonin et al [Bonin et al., 2014] explored the distribution of shared and solo laughter at topic transition and topic continuation moments. The research concluded that solo laughter occurs more frequently than shared laughter during topic transition.

In our current study, analysis will focus on analysis of shared/solo/ratified and unratified laughter at various laughter segments including topic initiation and topic termination.

Chapter 4

Data

4.1 Data Description

Multisimo corpus[Koutsombogera and Vogel, 2018] is utilized for the analysis of laughter. The main purpose of the corpus [Koutsombogera and Vogel, 2018] is to study the collaborative aspects of human behaviour in group interactions. The corpus consists of 18 video sessions and the duration of each session is approximately 10 minutes. Each session contains a video of group interaction consisting of two participants and a facilitator. The main role of two participants is collaborating among themselves to achieve a shared goal. The main role of facilitator is to coordinate participants in achieving shared goal.

4.2 Experimental setup

The participants in each session is assigned a task of answering quiz questions posed by the facilitator. The participants must provide the three possible answers to the question and rank them in the decreasing order of popularity. For example, question could be "What are the possible places where people can catch flu or cold?" and the answer could be "Public Transport, Hospitals, Schools" ranked in the decreasing order of popularity. Participants can collaborate among themselves by exchanging different ideas before arriving at the final answer and providing them to the facilitator. The role of the facilitator is

supervising the discussion among participants.

4.3 Terminologies associated with the dataset

4.3.1 Session

A session consists of two participants answering quiz questions coordinated by a facilitator. Participants answers a total of three quiz questions posed by the facilitator.

4.3.2 Section And Subsection

Each session consists of three sections - Question 1, Question 2 and Question 3. Each section denotes a time period spent by participants in discussing and answering each question. Each section consists of two sub-sections - naming phase and ranking phase.

Naming Phase

Participants spend time discussing the possible answers to the question and identify three correct answers.

Ranking Phase

Participants rank the identified three answers from the most popular to least popular.

4.4 Laughter Segmentation For Further Analysis

4.4.1 Segmentation By Sections

Each Section denotes a topic of discussion. In our context, the topic denotes discussion among the participants about the question posed to them. Each time interval of a section is further segmented into four quarters of equal time intervals to perform analysis on each of these quarters. Quarter 1 denotes time

interval of topic initiation and Quarter 4 denotes time interval of topic termination.

4.4.2 Segmentation By SubSection

The dataset is also segmented by SubSections. The SubSections are Question 1 - Naming Phase, Question 1 - Ranking Phase, Question 2- Naming Phase, Question 2 - Ranking Phase, Question 3- Naming Phase, Question 3 - Ranking Phase.

4.5 ELAN

ELAN is a tool developed by Max Planck Institute utilized by professionals to annotate complex video and audio annotations. Annotations in ELAN are grouped into Tier and time interval is assigned to each annotation of Tier.

4.6 Laughter Tier and Annotations

Each type of laughter is represented by a different Tier in ELAN. For instance, shared_ParticipantID1_ParticipantID2 denotes a shared laughter between two participants ParticipantID1 and ParticipantID2. solo_ParticipantID denotes a solo laughter engaged by participant ParticipantID. Laughter_ParticipantID denotes laughter either overlapping or non-overlapping engaged by participant ParticipantID. Each laughter tier is annotated with two types of laughter - Discourse and Mirthful Laughter.

Figure 4.1 shows an example of solo or non-overlapping laughter annotation. solo_7 denotes the Participant with ID 7 engages in solo discourse laughter.

Figure 4.2 shows an example of shared or overlapping discourse laughter annotation. shared_6_7 denotes the shared laughter between 6 and 7. Laughter_6 and Laughter_7 denotes the laughter section of 6 and 7 respectively. Since the laughter is shared between participants 6 and 7, we could observe a overlap of laughter sections between Laughter_6 and Laughter_7.

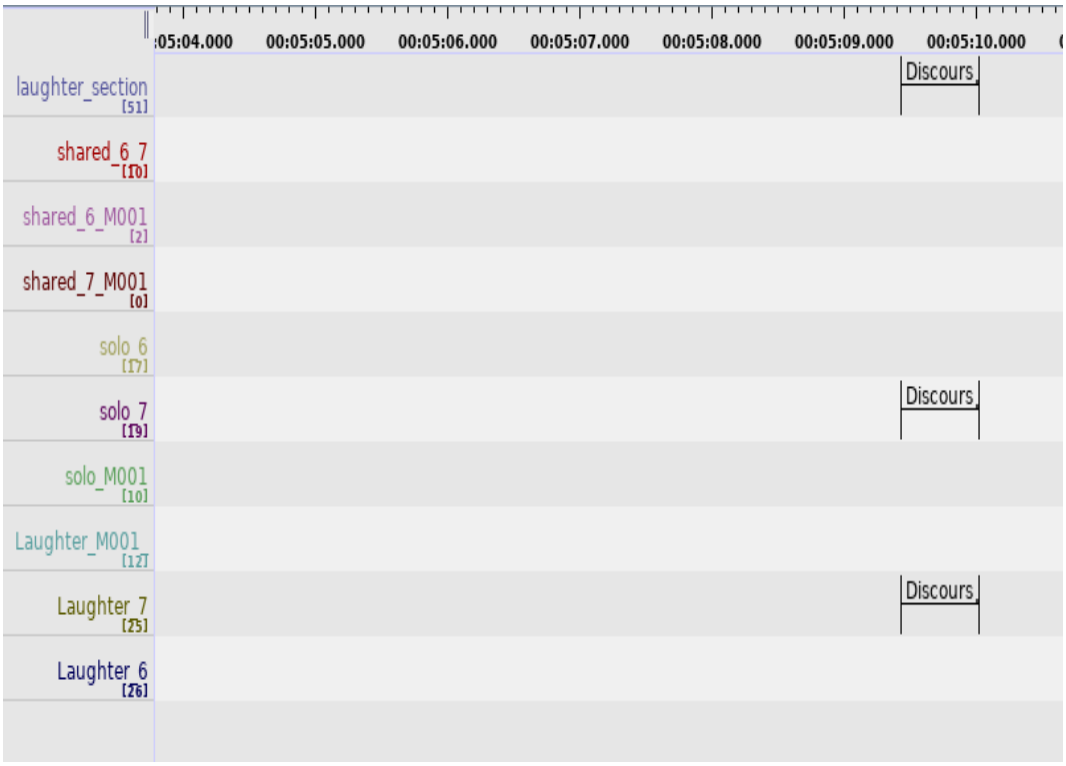


Figure 4.1: Example of Solo Laughter

4.7 Unratified and Ratified Laughter Illustration

Unratified Laughter occurs when a participant engages in a solo laughter without interruption or when a laughter is not reciprocated. Figure 4.3 illustrates an example of unratified laughter. Participant 7 engages in unratified mirthful laughter without being reciprocated by another participant.

Ratified Laughter occurs when a participant engages in a solo laughter and then, laughter is being reciprocated by another participant. Figure 4.4 illustrates an example of ratified laughter. Participant 49 engages in a solo laughter(solo_49) immediately followed by a solo laughter(solo_S23) by another participant. Therefore, Participant 49 engages in a ratified solo laughter.

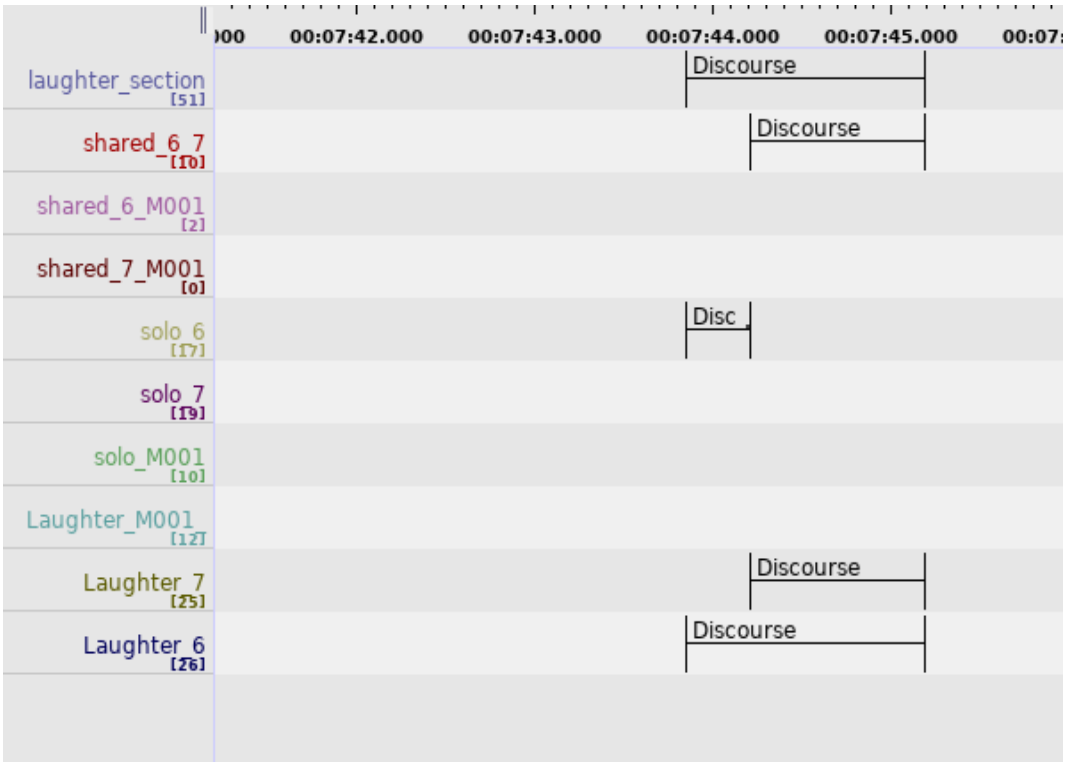


Figure 4.2: Example of Shared Laughter

4.8 Conversational Dominance dataset

Each participant identified in the multisimo corpus excluding the facilitators are provided with the dominance scores in the range 1-5. A total of five annotators were asked to watch all session videos and assign dominance scores in the range of 1-5 to participants in the video excluding the facilitator. Participants with a dominance score of 5 posses very high dominance and participants with a dominance score of 1 doesn't possess dominance at all. Median of the dominance scores are being used for further analysis. Median dominance scores ranges from 1-4.

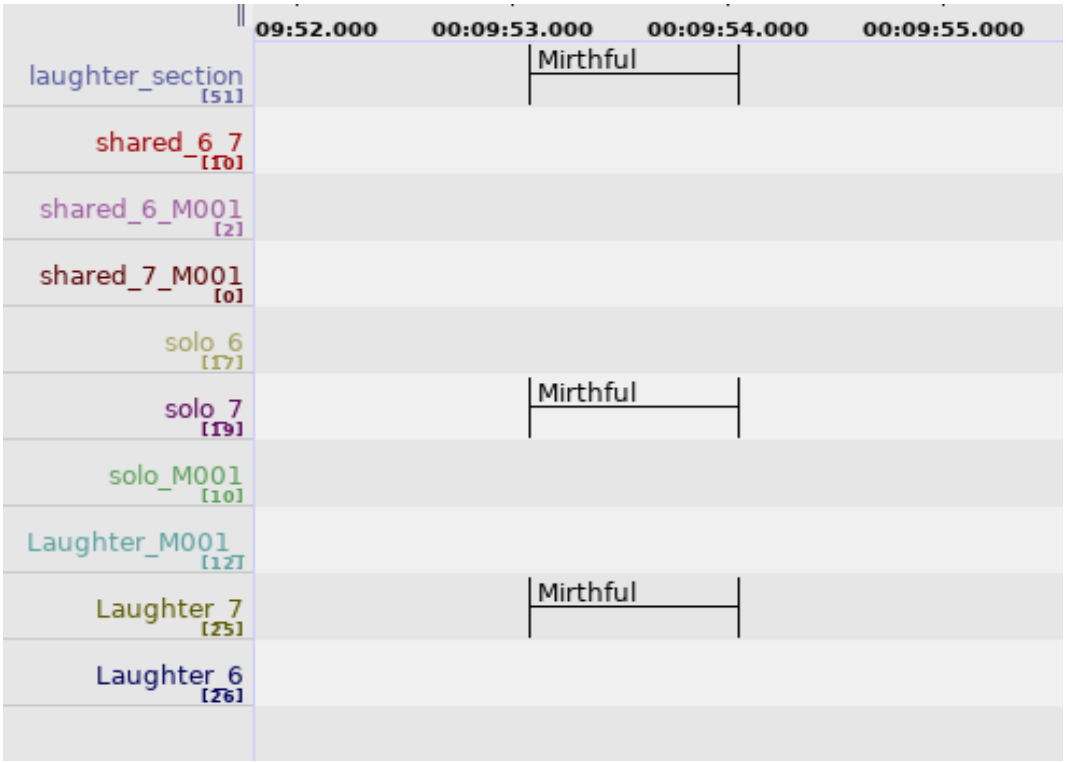


Figure 4.3: Example of Unrafified Laughter

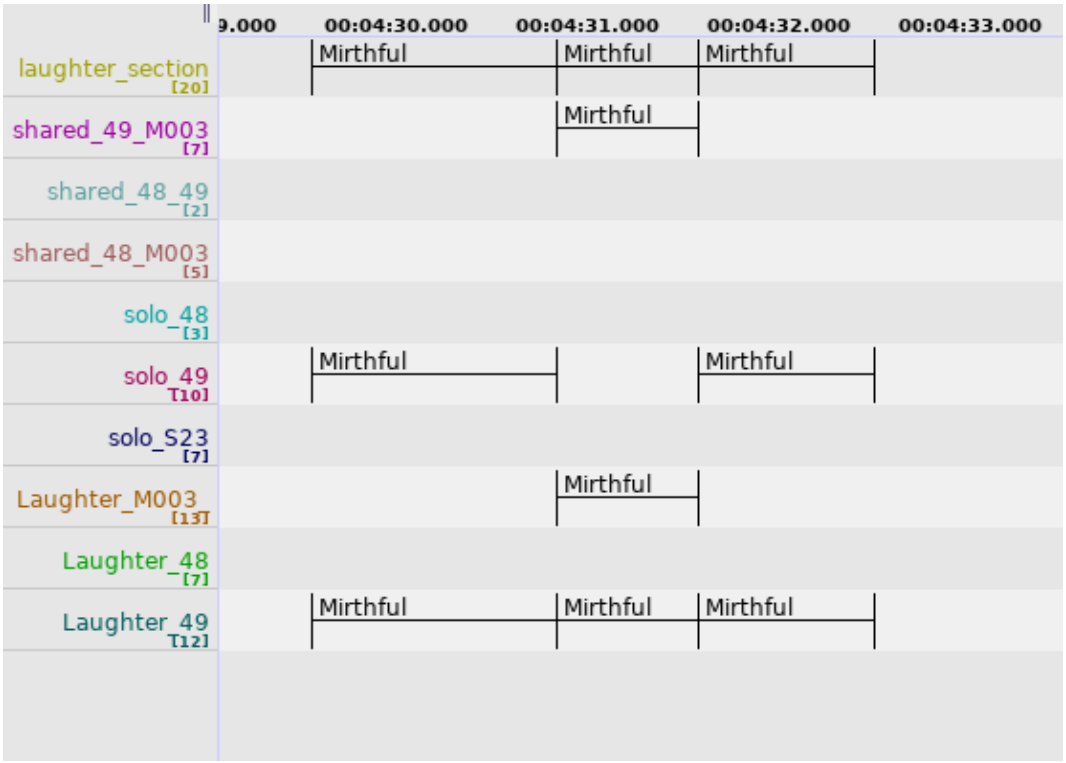


Figure 4.4: Example of Ratified Laughter

Chapter 5

Methodology

5.1 Data Preprocessing

5.1.1 Preparation of Master CSV file

ELAN files consists of tiers, annotations and time interval. There is a total of 18 video sessions and each video session is provided with an ELAN file. Each ELAN file is exported as comma separated(csv) file format. CSV files associated with each video session are merged to form a single csv file format. Schema of ELAN file is as follows:

1. **Session -** Session Id of Video
2. **Tier -** Annotations are grouped into tiers as explained in Chapter 4. For instance, solo_6 denotes the solo laughter tier
3. **Annotation -** A note or marker associated with the video during a specified time interval belonging to a tier. For instance, "Mirthful" is a laughter annotation.
4. **Begin -** Start time of a particular annotation associated with the tier. Start time is represented in HH:MM:SS.SSZ.
5. **Begin_sec -** Start time of annotation in seconds.

Session	Tier	Annotation	Begin	Begin_sec	End	End_sec	Duration	Duration_sec

Table 5.1: Schema of ELAN

Session	Tier	Annotation	Begin	Begin_sec	End	End_sec	Duration	Duration_sec

Table 5.2: Schema of Laughter Annotation similar to Table 5.1

6. **End -** End time of a particular annotation associated with the tier. End time is represented in HH:MM:SS.SSZ.
7. **End_sec -** End time of annotation in seconds.
8. **Duration -** Duration of a particular annotation associated with the tier. Duration is represented in HH:MM:SS.SSZ.
9. **Duration_sec -** Duration of annotation in seconds.

5.1.2 Filtering Laughter Tiers in Master CSV

Once the preparation of master csv is complete, rows are filtered to contain only laughter tiers and annotations using regular expressions. The schema of resultant csv is similar to Section 5.1.1.

5.1.3 Preparation of Dominance Dataset

Dominance scores assigned to the participants are in the score range 1-5. Schema of the Dominance of different participants are as follows:

1. **ParticipantID -** ID associated with participant
2. **Annotator1 -** Dominance score provided by Annotator 1
3. **Annotator2 -** Dominance score provided by Annotator 2
4. **Annotator3 -** Dominance score provided by Annotator 3

Participant_ID	Annotator1	Annotator2	Annotator3	Annotator4	Annotator5	Medium_Dominance

Table 5.3: Schema of Dominance Data

5. **Annotator4 -** Dominance score provided by Annotator 4
6. **Annotator5 -** Dominance score provided by Annotator 5
7. **Median_Dominance -** Median of Dominance scores provided by five annotators - Annotator 1, Annotator 2, Annotator 3, Annotator 4, Annotator 5

5.1.4 Merging Dominance Scores and Laughter Annotations

Participant IDs are extracted from the Laughter Tier information as specified in Table 5.2 using regular expression. For instance, solo_6 denotes Participant 6 engaging in solo laughter. Inner join is performed between Participant ID of Laughter Tier information and dominance data as mentioned in Table 5.3. The resultant csv file contains laughter information along with the dominance scores of participant.

5.1.5 Extraction of Section and SubSection Related Information

Section and SubSection related information are provided along with the dataset. The definition of section and sub-section is explained in 4.3.2. The schema of the Section is as follows:

1. **SessionID -** ID associated with video session
2. **Section -** Section Name of session. Section could be Question 1, Question 2, Question 3
3. **Section_Quarter -** As mentioned in 4.4.1, each section of video is divided into four quarters of equal time interval - Quarter 1, Quarter 2, Quarter 3, Quarter 4

4. **Begin_sec -** Start time of section quarter in seconds
5. **End_sec -** End time of section quarter in seconds
6. **Duration -** Duration of section quarter in seconds

The schema of the SubSection is as follows:

1. **SessionID -** ID associated with video session
2. **SubSection -** SubSection Name of session. Section could be Question 1 Naming Phase, Question 2 Naming Phase, Question 3 Naming, Question 1 Ranking Phase, Question 2 Ranking Phase, Question 3 Ranking Phase
3. **Begin_sec -** Start time of section quarter in seconds
4. **End_sec -** End time of section quarter in seconds
5. **Duration -** Duration of section quarter in seconds

Each laughter annotation is mapped to Section and Sub-Section information by joining based on time-stamps of laughter annotation and section/subsection.

5.2 Statistical Hypothesis Testing

Analysis of laughter in our current study consists of testing whether certain hypothesis hold true. For instance, analysis would involve testing whether duration of shared laughter is higher than duration of solo laughter. This hypothesis could be translated as whether mean or median of duration of shared laughter is significantly higher than solo laughter. The initial step of hypothesis testing consist of identifying the distribution of solo/shared laughter and selecting the suitable statistical test to test the hypothesis.

Hypothesis Testing is used to test an assumption or a belief about a population. There are two components of hypothesis testing - null hypothesis and alternative hypothesis. Null hypothesis represent the widely believed fact about population before a new experiment is carried out in a population or samples

of population. Alternative hypothesis also known as research hypothesis represent the current belief about the population after an experiment is conducted on a population or samples of population. Alternative hypothesis contradicts the statement of null hypothesis. The outcome of hypothesis testing is either the acceptance or rejection of null hypothesis. P-value [alp, 2019] is the probability of obtaining extreme results given that the null hypothesis is true. Alpha [alp, 2019] is the probability of rejecting the null hypothesis given that the null hypothesis is true.

There are two types of hypothesis test - parametric and non-parametric test. Parametric Test assumes the samples drawn from a population follow a certain statistical distribution. Eg. One way Analysis of Variance (ANNOVA) assumes the samples are normally distributed. Non-parametric test do not assume the samples follow a certain statistical distribution. Eg. Kruskal Wallis test do not assume the samples follow a certain distribution.

This section briefly explains the hypothesis tests utilized in the current research work.

5.2.1 Shapiro Wilk Test

Shapiro Wilk Test is used to test whether observations are normally distributed.

1. **Null Hypothesis -** Observations are normally distributed.

2. **Alternative Hypothesis -** Observations are non-normally distributed.

Shapiro wilk test outputs a test statistic and p-value. Smaller values of test statistic indicates that observations are drifting away from being normally distributed. If p-value < alpha, then null hypothesis is rejected and the observations are assumed to be non-normally distributed.

5.2.2 Chi-Square Test of Independence

Chi-square test of independence is used to examine if there is a significant association between two categorical variables.

1. **Null Hypothesis -** Two categorical variables are independent. There is no significant relationship between two categorical variables.

2. **Alternative Hypothesis -** Two categorical variables are dependent. There is a significant relationship between two categorical variables.

Chi-square test outputs a Chi-square statistic and p-value. If p-value < alpha, there is a significant relationship between two categorical variables.

5.2.3 Kruskal Wallis Test

Kruskal Wallis test is a non-parametric test used to test equality of the median of two or more independent groups of variables.

1. **Null Hypothesis -** Median of all groups are equal. There is no significant difference in the median of two or more groups.

2. **Alternative Hypothesis -** Median of all groups are not equal. There is a significant difference in the median of all groups.

Kruskal Wallis test outputs a test statistic and p-value. If p-value < alpha, there is a significant difference in the median of two or more groups.

5.2.4 Wilcoxon Rank Sum Test

Wilcoxon Rank Sum Test is a non-parametric test is used to compare the mean of two independent groups of variables.

1. **Null Hypothesis -** Mean of two groups are equal. There is no significant different in the mean of two groups.

2. **Alternative Hypothesis -** Mean of two groups are not equal. There is a significant difference between mean of two groups.

Wilcoxon Rank Sum Test outputs a test statistic and p-value. If p-value < alpha, there is a significant difference in the mean of two groups.

Chapter 6

Examining the relationship between Conversational Dominance and Laughter

6.1 Analysis of Dominance and Laughter

6.1.1 Distribution of Dominance scores

Figure 6.1 shows the distribution of dominance scores of participant. Shapiro wilk test suggest that the dominance scores of participants are non-normally distributed with p-value less than 0.05. Skew statistic is -0.49 which reveals the distribution of dominance scores are negatively skewed. The mean of the dominance score is 2.83 and the median is 3.

6.1.2 Analysis of the relationship between Mirthful/Discourse Laughter and Dominance

This section explore two major hypothesis regarding mirthful/discourse laughter. The first hypothesis is that low dominant individuals frequently engage in discourse laughter compared to mirthful laughter. The second hypothesis is that highly dominant individuals frequently engage in mirthful laughter compared to low dominant individuals. The basis of hypothesis is that highly domi-

nant people engage in conversation more frequently than low dominant people and, therefore invoke laughter causing laughing excitement more frequently. Hence, the hypothesis is that high dominant people engage in mirthful laughter frequently than low dominant participants. Participants may invoke discourse laughter to maintain a conversation or may signal agreement to a discussion. Therefore, it is expected that low dominant people engage in discourse laughter compared to mirthful laughter.

Table 6.1 shows the Discourse/Mirthful Laughter counts and Dominance Score. Chi-square test of independence is performed between Discourse/Mirthful Laughter counts and Dominance. Chi-square test is applied as it doesnot assume any statistical distribution of data. P-value less than 0.05 (95% confidence interval) reveals there is a significant relationship between Laughter Type and Dominance. From Table 6.1, it is observed that participants with dominance value of 3.0 engage in more laughter than people with other dominance scores. Also, increasing laughter instances in participants with dominance scores of 3 and 4 could be attributed to the increasing number of participants with dominance score of 3 and 4. This leads to a conclusion that chi-square test of dependency is not a reliable statistic in describing the relationship between laughter type and dominance score.

Table 6.2 shows the average number of discourse and mirthful laughter counts for different levels of dominance. For instance, average number of discourse laughter of participants with dominance level of 1 is calculated as ratio of total discourse laughter count engaged by participants of dominance level of 1 and total number of participants with dominance level of 1. The average discourse laughter count for dominance level of 1 is 6 and is significantly higher than the average mirthful laughter count for the same dominance level. Similarly, the average discourse laughter count for dominance level of 2 is 10.14 and is significantly higher than average mirthful laughter count for the same dominance level. Figure 6.2a and 6.2b shows the distribution of mirthful and discourse laughter for dominance levels of 1 and 2 respectively. The distribution of mirthful and discourse laughter for all dominance levels are non-normally distributed on performing Shapiro Wilk test. Therefore, non-parametric tests like Kruskal Wallis test and Wilcoxon Rank Sum test is applied to compare median

and mean of laughter counts respectively. Kruskal Wallis test asserts that there is a statistically significant difference in the medians of discourse and mirthful laughter for participants with dominance level of 1 with p-value < 0.05 and 95% confidence interval. Wilcoxon Rank Sum test also implies that there is a statistically significant difference in the mean of discourse and mirthful laughter counts for dominance level 1. Similarly,difference in the mean and median of discourse and mirthful laughter counts of participants with dominance level of 2 are statistically significant. The difference in the mean and median of discourse and mirthful laughter counts for participant with higher dominance levels (dominance score of 3 and 4) are not statistically significant. This implies that less dominant individuals with dominance level of 1 and 2 engage in discourse laughter more frequently than mirthful laughter which satisfies the first hypothesis.

Highly dominant participants are the participants with dominance levels of 3 and 4. Less dominant participants are the participants who possess dominance levels of 1 and 2. From Table 6.2, the average mirthful laughter count for dominance level of 3 and 4 is 5.25 and 6.11 which is significantly higher than average mirthful laughter count for dominance level of 1 and 2. Highly dominant participants are the participants with dominance levels of 3 and 4. Less dominant participants are the participants who possess dominance levels of 1 and 2. Figure 6.3a shows the distribution of mirthful laughter counts for high and low dominant participants. Figure 6.3b shows the distribution of discourse laughter counts for high and low dominant participants. Kruskal Wallis test suggest that median of mirthful laughter counts for highly dominant participants is significantly higher that of low dominant participants. Similarly, Wilcoxon Rank Sum test suggest that mean of mirthful laughter counts for highly dominant participants is significantly higher that of low dominant participants. But, the difference in mean and median of discourse laughter counts of high and low dominant participants are not statistically significant. Therefore, the second hypothesis holds true which states that highly dominant participants engage in mirthful laughter more frequently than low dominant participants.

Dominance	Discourse	Mirthful
1	24	14
2	71	25
3	106	84
4	63	55

Table 6.1: Amount of discourse and mirthful laughter engaged by participants of different dominance levels

Dominance	Discourse	Mirthful
1	6	3.5
2	10.14	3.57
3	6.63	5.25
4	7	6.11

Table 6.2: Average Discourse and Mirthful laughter engaged by participants of different dominance levels

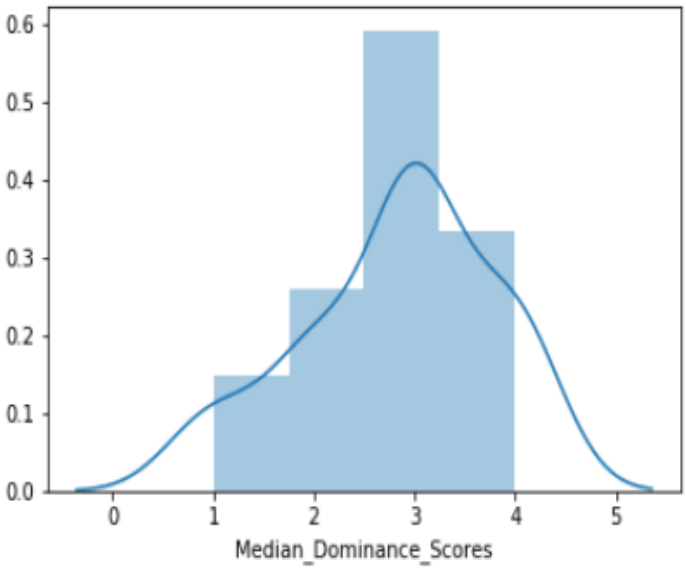
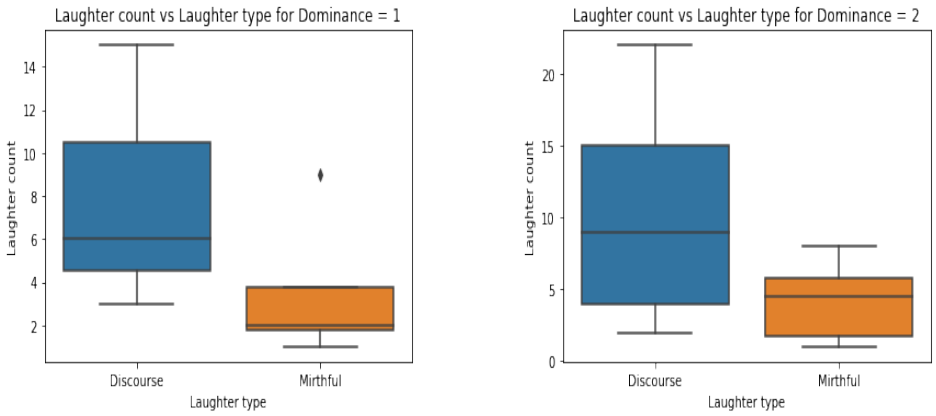


Figure 6.1: Distribution of Dominance Scores

6.1.3 Analysis of the relationship between Solo/Shared/Unratified/Ratified Laughter and Dominance

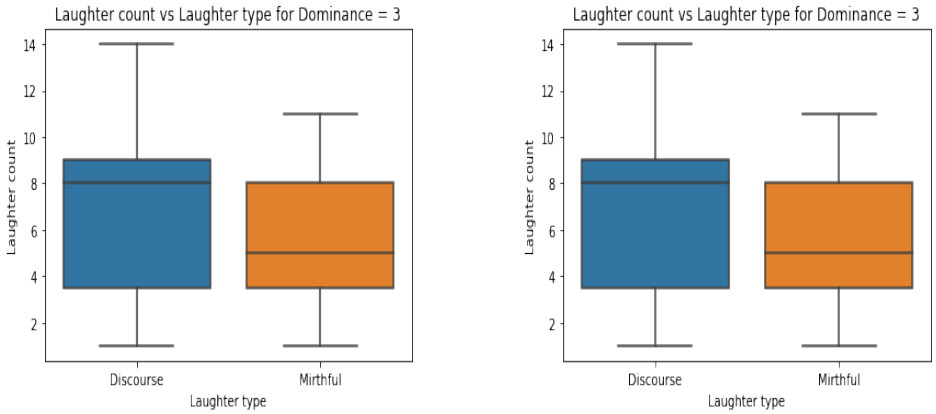
This section explores three hypothesis. The first hypothesis is highly dominant individuals frequently engage in shared and unratified laughter than low dominant individuals. The second hypothesis is low dominant individuals frequently engage in unratified laughter compared to high dominant individuals. The basis of hypothesis is that high dominant people are highly sociable and therefore, invoke laughter involving everybody in conversation(shared) opposed to low dominant people.

Table 6.3 shows the average laughter counts of solo, ratified, unratified and shared laughter with dominance scores. For instance, average number of solo laughter of participants with dominance level of 1 is calculated as ratio of total solo laughter count engaged by participants of dominance level of 1 and total number of participants with dominance level of 1. The average shared laughter for dominance levels of 3 and 4 is higher than the average shared laughter laughter for dominance levels of 1 and 2. Figure 6.4a shows the distribution of shared laughter for high and low dominant participants. Though the mean of



(a) Dominance = 1

(b) Dominance = 2



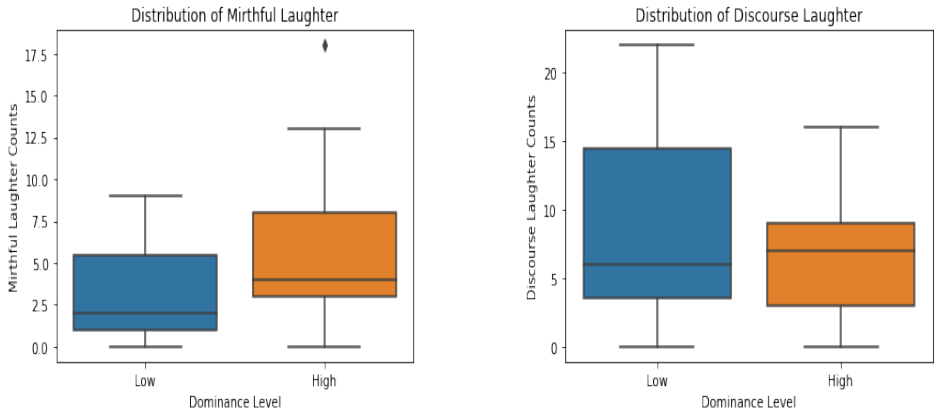
(c) Dominance = 3

(d) Dominance = 4

Figure 6.2: Distribution of Mirthful and Discourse Laughter for different levels of dominance

shared laughter counts of high dominant participants is higher than that of low dominant participants, the median of shared laughter counts of low dominant participants is higher than that of high dominant participants. However, the mean of shared laughter counts of highly dominant participants is not significantly higher than that of low dominant participants on performing Wilcoxon Rank Sum Test. There is no statistical evidence to prove that highly dominant participants frequently engage in shared laughter than low dominant participants which leads to rejection of first hypothesis.

The mean and median of unratified laughter counts of low dominant participants are higher than that of high dominant participants but Wilcoxon Rank



(a) Distribution of Mirthful Laughter for High and Low Dominance Levels

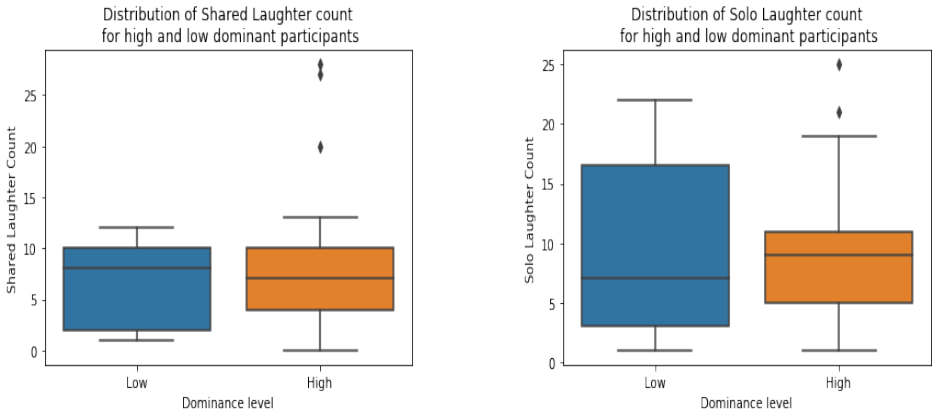
(b) Distribution of Discourse Laughter for High and Low Dominance Levels

Figure 6.3: Distribution of Discourse and Mirthful Laughter for High and Low Dominance Levels

Dominance	**Average Solo Laughter Count**	**Average Shared Laughter Count**	**Average Unratified Laughter Count**	**Average Ratified Laughter Count**
1	7.25	4.25	5.25	2.0
2	10.71	7.43	6.0	4.72
3	9.81	8.13	3.88	5.94
4	8.56	9.22	3.33	5.22

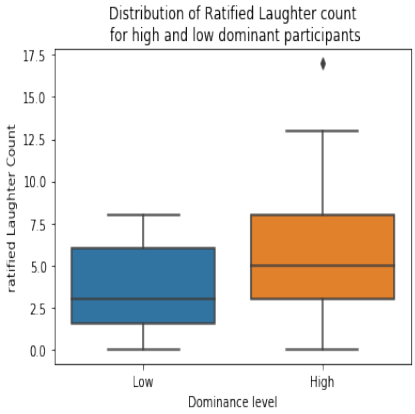
Table 6.3: Average Solo, Shared, Ratified and Unratified Laughter counts of participants with different levels of dominance

Sum test suggest that differences in mean of unratified laughter of high and low participants are not statistically significant as p-value>0.05. The mean and median of ratified laughter counts of high dominant participants are higher than that of low dominant participants but but Wilcoxon Rank Sum test suggest that differences in mean of unratified laughter of high and low participants are not statistically significant as p-value>0.05. There is no empirical evidence to show that low dominant participants frequently engage in unratified laughter and high dominant participants engage in ratified laughter which leads to rejection of second hypothesis.

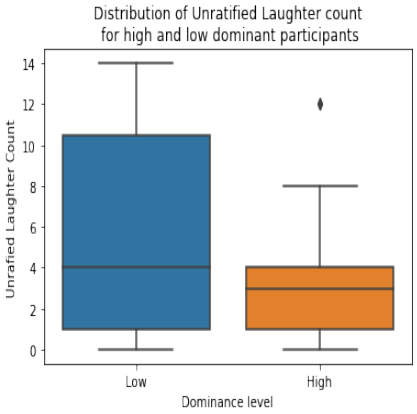


(a) Shared Laughter

(b) Solo Laughter



(c) Ratified Laughter



(d) Unratified Laughter

Figure 6.4: Distribution of Different types Laughter for different levels of dominance

6.2 Inferences drawn from Conversational Dominance Analysis

The conclusions made from analysis of relationship between Conversational Dominance and Laughter are as follows:

- It is evident statistically that low dominant participants engage in discourse laughter frequently compared to mirthful laughter.
- High dominant participants engage in mirthful laughter frequently compared to low dominant participants.

- Statistically, it is not evident that highly dominant participants frequently engage in shared laughter and low dominant participants engage in unratified laughter.

Chapter 7

Examining the Distribution of Different types of Laughter

Each video session consists of three sections. Each section denotes the topic of discussion. Each section is divided into four section quarters of equal time intervals. Each section can also divided into two subsections - naming and ranking section. The definition of sections and sub-sections of dataset is explained in Section 4.3.1 and 4.3.2.

7.1 Analysis on Distribution of Mirthful and Discourse Laughter counts in different section quarters of topic discussion

This section explores two major hypothesis. The first hypothesis is that discourse laughter is highly observed before topic termination or final quarter of topic discussion compared to first three quarters of topic discussion. The second hypothesis is mirthful laughter is highly observed in first two quarters of the or first half of the topic discussion. The basis of the hypothesis is that in the final quarter of the topic discussion, it is expected to very few mirthful laughter instances and high discourse laughter instances if the intensity of the topic discussion is maintained in task based interactions. In the first two quarters

of the topic discussion, individuals might engage in conversations causing excitement and thereby, invoke mirthful laughter in the initial half of the topic discussion.

Table 7.1 shows the total number of mirthful and discourse laughter engaged by the participants during different section quarters 1, 2, 3, 4 for each of the three questions Question 1, Question 2 and Question 3. The total number of discourse laughter observed during Quarter 4 during each of the three questions is 55, 63 and 79 respectively which is significantly higher than discourse laughter observed in quarter 1, quarter 2 and quarter 3 for all three questions. Figure 7.1a shows the distribution of discourse laughter aggregated over all three questions for section quarters - Quarter 1, Quarter 2, Quarter 3 and Quarter 4. It is observed that median of discourse laughter observed in fourth section quarter is significantly higher than median of discourse laughter observed in first three section quarters. Wilcoxon Rank Sum test is performed to compare the mean of discourse laughter counts of section quarter 1,2,3 with section quarter 4. This test suggest that difference in mean between section quarter 4 with all three section quarters 1,2,3 are statistically significant. Figure 7.1 shows the distribution of mirthful laughter aggregated over all three questions for section quarters - 1,2,3 and 4. Kruskal Wallis test asserts that there is no statistically significant difference between medians of mirthful laughter count in all the section quarter.

Pearson chi-square test is also conducted to examine the relationship between laughter counts of discourse and mirthful laughter with Section Quarter as both Laughter type and Section Quarters are categorical variables. Table 7.2 shows the adjusted residuals of chi-square test conducted between laughter counts and section quarter. The adjusted residuals observed in discourse laughter count of fourth section quarter is 4.1(approx) which suggests that observed frequencies of discourse laughter count is significantly greater than expected frequencies of discourse laughter and over-representative of the overall laughter counts. This leads to acceptance of first hypothesis that discourse laughter is significantly higher in the final section quarter. Similarly, the residuals observed in mirthful laughter count of fourth section quarter is -5.1(approx) which suggests that observed frequencies of mirthful laughter count is signifi-

Question Number	Section Quarter	Discourse Laughter Count	Mirthful Laughter Count
Question 1	1	18	5
	2	15	21
	3	17	22
	4	55	18
Question 2	1	26	22
	2	17	10
	3	26	19
	4	63	13
Question 3	1	35	46
	2	27	42
	3	21	24
	4	79	13

Table 7.1: Mirthful and Discourse Laughter counts of different questions and section quarters of topic discussion

cantly lesser than expected frequencies of mirthful laughter and under-representative of the overall population. Similarly, observed discourse laughter counts of second section quarter is less than expected discourse laughter count and observed number of mirthful laughter in second section quarter is greater than expected number of mirthful laughter. This suggests, that discourse laughter is observed significantly higher than mirthful laughter during topic termination and mirthful laughter is observed significantly higher than discourse laughter in the second quarter of the topic discussion. The second hypothesis partially holds true as there is a statistical evidence that mirthful laughter is significantly higher than discourse laughter in the second quarter of topic discussion but doesn't hold true for first quarter for topic discussion.

The number of mirthful and discourse laughter observed in naming subsection is 188 and 199 respectively. The number of mirthful and discourse laughter observed in ranking subsection is 200 and 67. The difference in the number of mirthful and discourse laughter is statistically significant on performing Chi-square test between sub-section and amount of laughter.

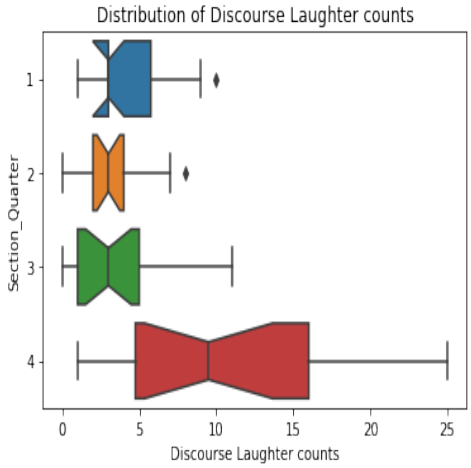
Section Quarter	Discourse Laughter Count	Mirthful Laughter Count
1	79	73
2	59	73
3	64	65
4	197	44

(a) Mirthful and Discourse Laughter counts for different section quarters of topic discussion

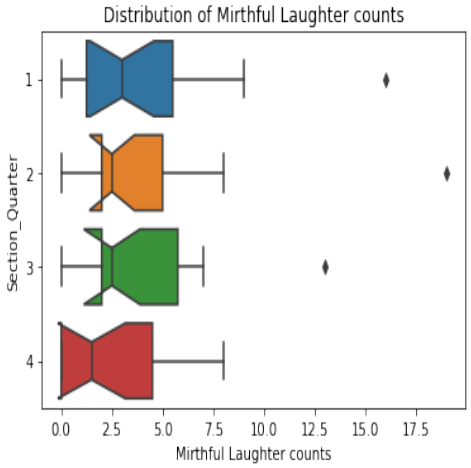
Section Quarter	Discourse Laughter Count	Mirthful Laughter Count
1	-1.426185	1.783989
2	-2.399397	3.001362
3	-1.657216	2.072982
4	4.120832	-5.154675

(b) Chi-square residuals for contingency table for table 7.2a

Table 7.2: Mirthful and Discourse Laughter counts for different section quarters of topic discussion



(a) Distribution of Discourse Laughter for different Section Quarters



(b) Distribution of Mirthful Laughter for different Section Quarters

Figure 7.1: Distribution of Discourse and Mirthful Laughter for Different Section Quarters

7.2 Analysis on Mirthful and Discourse Laughter Duration in different section quarters of topic discussion

This section explored whether duration of mirthful laughter is higher than discourse laughter in all section quarters. According to [Sabonytė, 2018], duration

of mirthful laughter is higher than polite laughter. This section check if it holds for all quarters of topic discussion.

Table 7.3a shows the total duration of mirthful and discourse laughter in all four section quarters. From the table, it is observed that mirthful laughter duration is higher than duration of discourse laughter in the section quarters - 1,2 and 3 but duration of discourse laughter is higher than that of mirthful laughter in the final section quarter. Total duration of laughter is also directly correlated with the number of laughter instances in the corresponding sections. Table 7.3b shows the average duration of mirthful and discourse laughter in all four section quarters. Average duration of mirthful laughter is higher than discourse laughter in all the four section quarters - 1,2,3 and 4. Table 7.3c shows the average duration of mirthful and discourse laughter in subsections - naming and ranking phase. It is observed that average duration of mirthful laughter is higher than that of discourse laughter in all subsections. Figure 7.2 shows the distribution of duration of discourse and mirthful laughter. The median and mean of mirthful laughter is higher than median and mean of discourse laughter respectively. Kruskal Wallis test asserts that there exists a statistically significant difference in the median of the discourse and mirthful laughter duration implying median of mirthful laughter is significantly higher than median of discourse laughter in all section quarters of topic discussion. Similarly, Wilcoxon Rank Sum test asserts that there is a statistically significant difference in the mean of the duration of mirthful and discourse laughter implying median of mirthful laughter is significantly higher than mean of discourse laughter in all section quarters of topic discussion. Therefore, it is inferred that duration of mirthful laughter is longer than discourse laughter in all section quarters of the topic discussion.

Section Quarter	Discourse Laughter Duration	Mirthful Laughter Duration
1	95.154	107.421
2	57.454	99.878
3	74.486	81.112
4	223.170	53.252

(a) Total Duration of Mirthful and Discourse Laughter for different section quarters of topic discussion

Section Quarter	Discourse Laughter Duration	Mirthful Laughter Duration
1	1204.48	1471.52
2	973.79	1368.19
3	1163.84	1247.87
4	1132.84	1210.27

(b) Average Duration of Mirthful and Discourse Laughter for different section quarters of topic discussion

SubSection	Discourse Laughter Duration	Mirthful Laughter Duration
naming	1108.26	1391.18
ranking	1148.6	1195.84

(c) Average Duration of Mirthful and Discourse Laughter for different subsections

Table 7.3: Duration of Mirthful and Discourse Laughter of different sections

Figure 7.2: Overall Distribution of Discourse and Mirthful Laughter Duration

7.3 Analysis on Distribution of Solo, Shared, Ratified and Unratified Laughter counts in different section quarters of topic discussion

This section compares the occurrences of solo, shared, ratified and unratified laughter in all the section quarters of the topic discussion. Shared laughter is expected to be frequent in the first half of the topic discussion and unratified laughter is expected to be frequently observed in the final half of the topic discussion.

Table 7.4 shows the number of shared, solo, unratified and ratified laughter instances in different section quarters - 1,2,3 and 4. The overall laughter is significantly higher in the final quarter than that of the first three quarters in all the four types - ratified, unratified, shared and solo laughter. Table 7.5 and 7.6 depicts the number of mirthful and discourse laughter instances respectively in all four types of laughter - shared, solo, ratified and unratified laughter. While mirthful laughter instances is lower in the final section quarter than in the first three section quarters in all the laughter types, discourse laughter is higher in the final section quarter than in the first three section quarters in all the laughter types.

Shared laughter is frequently observed relative to unratified laughter in the

Section Quarter	Shared Laughter	Solo Laughter	Unratified Laughter	Ratified Laughter
1	53	103	48	55
2	46	106	44	62
3	38	97	43	54
4	68	184	101	83

Table 7.4: Shared, Solo, Ratified and Unratified Laughter for different section quarters of topic discussion

first two quarters but Unratified laughter is frequently observed in the final two section quarters. The differences between shared and unratified laughter observed is statistically significant only in the final section quarter. Though not supported by statistical significance, shared laughter is frequently observed after topic initiation and unratified laughter is frequently observed during topic termination.

The number of shared laughter instances in the mirthful laughter category is observed more than number of unratified laughter in the similar category for section quarters 1,2 and 3. Wilcoxon Rank Sum test confirms there is a statistically significant difference in the mean of shared and unratified laughter in the mirthful laughter category. Conversely, in the discourse laughter category, unratified laughter is observed more than shared laughter in all the section quarters backed by both data and statistical significance (from Wilcoxon Rank Sum test).

The number of ratified laughter instances in the mirthful category is significantly higher than unratified laughter. Conversely, the number of unratified laughter instances in the discourse category is significantly higher than ratified laughter.

Section Quarter	Shared Laughter	Solo Laughter	Unratified Laughter	Ratified Laughter
1	37	43	13	30
2	34	53	11	42
3	25	44	13	31
4	14	29	14	15

Table 7.5: Shared, Solo, Ratified and Unratified Mirthful Laughter for different section quarters of topic discussion

Section Quarter	Shared Laughter	Solo Laughter	Unratified Laughter	Ratified Laughter
1	16	60	35	25
2	12	53	33	20
3	13	53	30	23
4	54	155	87	68

Table 7.6: Shared, Solo, Ratified and Unratified Discourse Laughter for different section quarters of topic discussion

7.4 Analysis on Duration of Solo, Shared, Ratified and Unratified Laughter in different section quarters of topic discussion

This section explores the hypothesis that duration of shared laughter is higher than solo laughter in all section quarters. According to [Truong and Trouvain, 2012], duration of shared laughter is higher than solo laughter. This section explores if it holds true for all quarters of topic discussion. This section also compares the duration of unratified and ratified laughter in all section quarters.

Table 7.7 and 7.8 shows the average duration of shared, solo, ratified and unratified laughter in all the section quarters and subsection respectively. Average Duration of shared laughter is higher than solo laughter in section quarters - 1,2 and 3 and also observed in naming section. The mean of shared laughter is significantly higher than solo laughter only in the section quarter - 1 and 3 on performing Wilcoxon Rank Sum Test with p-value<0.05. Surprisingly, aver-

Section Quarter	Shared Laughter	Solo Laughter	Unratified Laughter	Ratified Laughter
1	1180.10	904.85	916.21	894.95
2	890.63	799.46	924.39	710.81
3	1183.18	835.28	901.28	782.72
4	857.07	921.31	983.35	845.82

Table 7.7: Average Duration of Shared, Solo, Ratified and Unratified Laughter for different section quarters of topic discussion

SubSection	Shared Laughter	Solo Laughter	Unratified Laughter	Ratified Laughter
naming	1090.32	837.33	902.27	784.72
ranking	866.87	926.52	992.91	851.83

Table 7.8: Average Duration of Shared, Solo, Ratified and Unratified Laughter for different section quarters of topic discussion

age duration of solo laughter is higher than shared laughter in the final section quarter and in ranking section but the claim is not supported by Wilcoxon Rank Sum Test with p-value>0.05. This leads to conclusion that average duration of shared laughter is higher than solo laughter in the section quarters - 1,2 and 3 but doesn't hold true for final section quarter.

Wilcoxon Rank Sum Test asserts that average duration of unratified laughter is significantly higher than ratified laughter in section quarters - 1 and 3. This leads to conclusion that average duration of unratified laughter is significantly higher than ratified laughter in section quarters - 1 and 3 but doesn't hold for section quarter 2 and 4. Overall, average duration of unratified laughter is significantly higher than ratified laughter supported by Wilcoxon Rank Sum Test.

7.5 Inferences drawn from Analysis of Laughter Distribution

The conclusions drawn from the analysis of laughter distribution are as follows:

- Discourse Laughter is highly observed in the final section quarter of the topic discussion or before topic termination.
- Mirthful Laughter is highly observed in the second section quarter of the topic discussion.
- Duration of mirthful laughter is significantly higher than discourse laughter in all section quarters of topic discussion.
- Shared Laughter is frequently observed in the first two quarters of the topic discussion compared to final two quarters but not supported by statistical significance.
- Unratified Laughter is frequently observed in the final two quarters of the topic discussion compared to first two section quarters but are not supported by statistical significance.
- Duration of shared laughter is significantly higher than solo laughter in the first three quarters of the topic discussion. Duration of shared laughter is higher than shared laughter in the final quarter of the topic discussion though not backed by statistical significance.
- Duration of unratified laughter is significantly higher than ratified laughter.

Chapter 8

Conclusion

The dissertation presented a comprehensive study of the relationship between conversational dominance and laughter. The study also focused on analyzing the distribution of different types of laughter. Multisimo corpus is utilized for the current analysis. Laughter Annotations were available in ELAN file format. Dominance scores for each participant were provided along with the dataset.

Chapter 6 detailed a comprehensive analysis of the role of laughter in conversational dominance. Analysis of mirthful and discourse laughter distribution were conducted for each dominance level. Similarly, analysis on the distribution of solo, shared, unratified and ratified laughter were carried out on each of the four dominance levels. Different statistical hypothesis tests were conducted based on assumptions formulated for the study.

Chapter 7 focused on analysis on the distribution of different types of laughter. Each session in the dataset is segmented into different section. Each section in a session denotes the topic of discussion. Each section is further segmented into four quarters of equal time intervals and analysis of laughter distribution were conducted on each section quarter.

This dissertation can be utilized for several applications like design of conversational AI agents to enhance the quality of interaction between humans and robots. Further applications include quantification of collaborative activity of humans, dominance and user engagement in talks.

Chapter 9

Future Work

This research can be extended to include the analysis of the relationship between personality traits and laughter. Big Five personality traits are the most commonly utilized personality model in different studies in the field of Computational Linguistics and physcolinguistics. Big Five personality traits include Extraversion, Agreeableness, Openness, Neuroticism and Conscientious. This work can be extended to test two major hypothesis about the role of personality in laughter. The hypothesis is as follows: 1) Participants who possess extraversion personality trait are more likely to engage in mirthful laughter than participants who doesn't possess extraversion trait. 2) Participants who possess Agreeableness personality trait are more likely to engage in discourse laughter than those participants who doesn't possess agreeableness personality trait. [Koutsombogera et al., 2018]'s work on conversational dominance form the basis of the above two hypothesis.

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Appendix