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Rhetorical Moves and Hedging in Medical Research Articles and their Online Popularizations

Theses of the PhD Dissertation

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Pécs

2014

1. Introduction

Since the 1990-s, as a result of the technological revolution, the World Wide Web has become a global platform of information flow. A basic knowledge of the Internet becomes increasingly fundamental for professionals, and it is also an important source of health-related information. Students, scholars and researchers extensively use Web sources in their works. The Internet is an important source of information about medical advances in the field of health, not only for researchers but also for lay people. The online news media commonly translates the content of scientific articles while also influencing the decision-making process of the audience. Nowadays it is increasingly accepted that the results of science are important for everyone. There is a need to translate academic writing for the lay public, as people are getting more and more interested in recent findings of health-related research. This interaction helps the work of researchers to build a bridge between experts and lay people by adding lay perspectives and experience to research, as well as by enhancing lay-professional relationships.

Linguistic studies mostly concentrate on scientific discourse. There have been few studies that focus on popular science articles in the field of medicine, or compare the language use of medical research papers and their popularizations. This work aims to broaden our knowledge about the popularization of science. The focus of the study is to investigate and compare the rhetorical structure of research and popular articles by means of move analysis; while also examining how the linguistic phenomena of hedging -expressing uncertainty and tentativeness- are used in the two text types.

First, the study attempts to investigate the generic structure of scientific and popular science articles. This structural analysis is extended by investigating selected lexico-grammatical features of hedging in each rhetorical section. The role of hedging, which is a central feature of medical discourse, has not been extensively studied yet in online scientific discourse.

The results of these analyses can be appropriate to assist non-native and even native professionals in the interpretation and production of both scientific and popular science articles.

The method of investigation is corpus-based. The analysis is based on an electronic corpus of 60 articles divided into two sub-corpora: 30 Medical Research Articles (MRAs) about prenatal vitamins and nutrition, and 30 corresponding Popular Science Articles (PSAs). The computerized, quantitative analysis is supplemented with manual analysis and qualitative methods.

2. Hypotheses

To facilitate clear understanding of the relationship between MRAs and PSAs in general and the role of hedging in them in particular, the following hypotheses are drawn up:

- Hypothesis 1 - A typical discourse structure of PSAs cannot be described by means of move-analysis.
- Hypothesis 2 -The rhetorical structure of the PSA differs from that of the underlying MRA.
- Hypothesis 3 - Hedging is not applied in online popular science articles.

3. Materials and methods

Data collection and the research corpus

The present study includes two sub-corpora: MRAs from prestigious medical journals and their online popularized versions. They all provide information about recent scientific findings on maternal vitamins and prenatal nutrition. A wide variety of issues is covered by the articles including the connection between vitamins and premature birth or other birth complications, c-sections, preeclampsia, foetal development, cleft palate, lung function of the child, asthma, language problems, autism, heart defects, childhood obesity, diabetes risk, neuro-cognitive development and multiple sclerosis.

Most of the MRAs present findings of the latest research about prenatal care as they were written between 2004 and 2013. In the process of random selection popular articles from 20 different websites were used.

The method of investigation

First, the study attempts to characterize the discourse structure of the two genres. The texts in the two sub-corpora were analyzed and divided into moves, which mark the content of the particular discourse unit. As a second step, based on the move-analysis of all texts in the corpus, a characteristic move structure for both genres was identified. The next step of the investigation was a linguistic analysis of moves, focusing on the use of hedging, which is a typical element of medical discourse. The study focuses on the incidence of selected lexical hedging devices in the two genres. Typical lexical items commonly regarded as hedges were selected, and, other expressions that relate to tentativeness and uncertainty were also identified. For the purposes of comparison hedging devices were categorized into the following distinct grammatical classes: modal verbs, semi-auxiliaries, lexical verbs, adverbs, adjectives and nouns. Prototypical forms of hedging were investigated and classified in each move. The distribution of hedges in the different discourse units was established. Finally, a comparison of hedging phenomena in the popular and research articles was carried out.

Data-analysis

First, the texts were coded into rhetorical moves and the software *WordSmith Tools Version 6.0* (Scott, M., 2012, *WordSmith Tools version 6*, Liverpool: Lexical Analysis Software) was used to identify and classify the various hedge words in the individual moves of the two subcorpora. The lexical items were analyzed in context with the help of the concordances. It was followed by statistical tests to compare the total number of hedging devices in the two genres and also to compare the grammatical classes of hedging devices. Significance testing for correlations, sign test, two independent samples test for proportions and test for homogeneity of proportions were used with the help of *Excel*, *IBM SPSS Statistics 19* and *Stata 11.1*.

4. Results

Structural move analysis of MRAs

The analysis of MRAs identified 11 moves that make up the texts in the corpus. Based on the analysis of 30 texts, the most typical was a move structure of 10 moves. The articles consisted of an average of 9.6 moves, and 15 articles out of 30 are composed of 10 moves. The move explaining specific research outcomes (M9) occurred only 8 times in the corpus, therefore M9 was considered as a non-typical element of MRAs.

Move	Discourse function
M1	Presenting Background Information
M2	Identifying Gaps in Existing Research
M3	Stating Research Purpose
M4	Describing Material/Participants and Data-collection
M5	Describing Experimental Procedure
M6	Describing Data-analysis
M7	Reporting Observations
M8	Discussing Main Findings
M9	Explaining Specific Research Outcomes
M10	Discussing Study limitations, Strengths and Weaknesses
M11	Stating Research Conclusions

Table 1. Moves and their discourse function in the corpus of MRAs

The articles in the corpus most commonly start with the background information, which is followed by the questionable or lack of data in established knowledge. The authors always clearly formulate the objective of the study, which is usually one sentence at the end of the Introduction section. The Methods section follows a rigid format, starting with describing materials/participants, afterwards describing methods of investigation in details and end with providing the statistical tests performed. The Results section encompasses one move only. The Discussion section compares the obtained results to the literature in that field and to the objectives of the study. This section may contain a move that emphasizes specific, unexpected outcomes or results of great importance. There is an optional move to mention the strengths and weaknesses of the research. The Conclusion section may contain the element of study limitations as well.

The articles end with the last move of concluding the results and suggesting future implications.

Structural move analysis of PSAs

The analysis of texts in the second sub-corpus reveals that a typical popular science article includes the following types of information:

Move	Discourse function
M0*	Headline-Summarizing the Most Important Information
M1	Presenting Background Information
M2	Announcement of Recent Research Findings
M3	Reviewing Previous Related Research
M4	Presenting New Research
M5	Presenting Research Results in Detail
M6	Describing Data Collection and Procedures
M7	Indicating Main Outcomes and Explaining Them
M8	Stating Research Conclusions
M9	Indicating the Original Source Article

Table 2. Moves and their discourse function in the corpus of PSAs

* It is marked as M0, as headlines are not usually considered part of the text in Move Analysis.

Based on the observations, in a typical PSA the headline is followed by announcing the main finding of the research being popularized. This is usually a brief statement of one or two sentences. It is the initial move in most PSAs and precedes the move of background information. M3 -the review of related research - was found to occur only in 12 texts so it can be considered as an optional element of popular articles. The next move is presenting the purpose of the new research, in several cases alluding to the researchers and in some cases to the original medical paper. Move 4 is usually followed by move 6, which is concerned with the discussion of data identification, collection and procedure of experimentation. This move partly corresponds to the information found in the first two moves of the methods of a research article. Move 7 was found to occur in 63% of the corpus and its place is not stable in the order of moves.

It indicates and also explains the main outcomes. Move 8 is a major move in PSAs; it provides the conclusion of the research. Authors usually interpret the results and add comments and views of researchers carrying out the study or other researchers. The last element is the indication of original source article, which also directs the reader to the actual text by means of hyperlinks. However it is not a typical move, it was found to occur in 19 texts. In conclusion, the results show that a typical MRA contains 10 moves in the corpus, and a typical PSA is built up of 8 moves. The scientific research articles are more homogeneous in terms of rhetorical structure than their popularizations, which is best shown in the frequencies and order stabilities of moves in the two texts. Most of the rhetorical moves present in MRAs are also found to occur in the corresponding popularizations. On the other hand,, significant structural differences exist between the two genres. The first move of the MRA is concerned with providing background information. The PSA starts with the announcement of recent research findings and provide background information in the next move. The moves depicting data collection methods and procedures are present in both genres but the details are not important in popularization. The moves about discussing main findings and conclusion are found in both corpora and their location within the move structure is stable.

Hedging in the corpus of Medical Research Articles

Hedging is a fundamental characteristic of scientific writing as writers of academic texts inevitably indicate their attitude towards their own claims and those of others. Hedging expressing scientific uncertainty is expected to occur quite frequently in the corpus of MRAs. The different moves of MRAs are summarized in terms of selected lexico-grammatical features used as hedges. The results indicate that M8 (Discussing Main Findings) is the most heavily hedged move in the corpus. M10 (Discussing Study Limitations) and M7 (Reporting Observations) also contained hedging devices frequently. However, the number of hedges in the latter two moves is about half of the devices found in M8. The results also show that the moves M2 (Identifying gaps in existing research) and M11 (Stating Research Conclusions) and M1

(Presenting Background Information) exhibit a number of hedges. By contrast, moves M3 (Stating Research Purpose), M4 (Describing Material/Participants and Data-collection), and M5 (Describing Experimental Procedure) exhibit the lowest number of hedges. In the Methods section M6 (Describing Data Analysis) is the most heavily hedged move. The total number of lexical hedging found in the corpus was 1832 items.

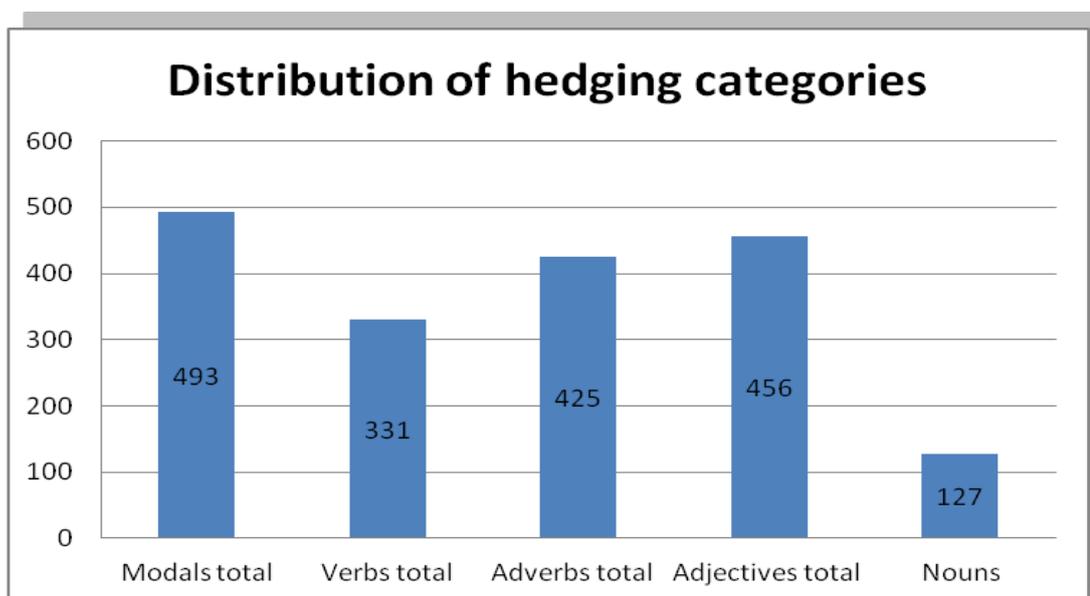


Figure 1. Distribution of different categories of hedges in the corpus of MRAs

The relative incidence of lexical hedges is 17.08 per 1000 words in the study corpus.

Hedging categories	Incidences	Frequency per 1000 words
Modals+ Semi-auxiliaries	493	4.59/1000
Verbs	331	3.08/1000
Adverbs	425	3.96/1000
Adjectives	456	4.25/1000
Nouns	127	1.18/1000
total	1832	17.08/1000

Table 3. The relative incidences of the hedging categories in the corpus of MRAs

Six different modal auxiliaries were found to occur in hedging interpretation, namely, *may, might, can, could, should* and *would*. The total number of semi-auxiliaries in hedging use was 49 in the study corpus and mostly took the form of epistemic words such as, *appear, seem, tend*. The most typical epistemic full verbs in the study corpus were *suggest, consider, indicate, hypothesize, conclude, believe, implicate, propose, think* and *imply*. In the corpus 39 different adverbs were identified, *significantly* and *approximately* were found to occur the most commonly. Altogether 456 incidences of hedges were identified in the study corpus, which may be grouped as probability adjectives, adjectives of indefinite frequency or degree and approximative adjectives. The incidence of nouns used as hedges was the lowest in the study corpus. The most common forms can be categorized as nouns of tentative likelihood. Altogether 127 occurrences were identified, *possibility* amounts to 29, *potential* to 24 incidences.

Hedging in the corpus of Popular Science Articles

The different moves of PSAs were analyzed in terms of selected lexicogrammatical features that are most typically interpreted as hedges, similarly to the research articles. The results demonstrate that M8 (Stating Research Conclusions) is the move that contains the most lexical hedgings. M1 (Presenting Background Information) and M7 (Indicating and Explaining Main Outcomes), contained about the same number of hedges. However, the incidence of hedges in these two moves is about half of the incidences in M8. In M2 (Announcement of Recent Research Findings), M3 (Reviewing Previous Related Research) and M5 (Presenting Research Results in Details) hedging was found to occur in about 30 cases. Lexical hedges were less frequent in M0 (Headline), M4 (Presenting New Research) and M6 (Describing Data Collection and Procedures).

The total number of lexical hedging found in the corpus of PSAs was 326 items.

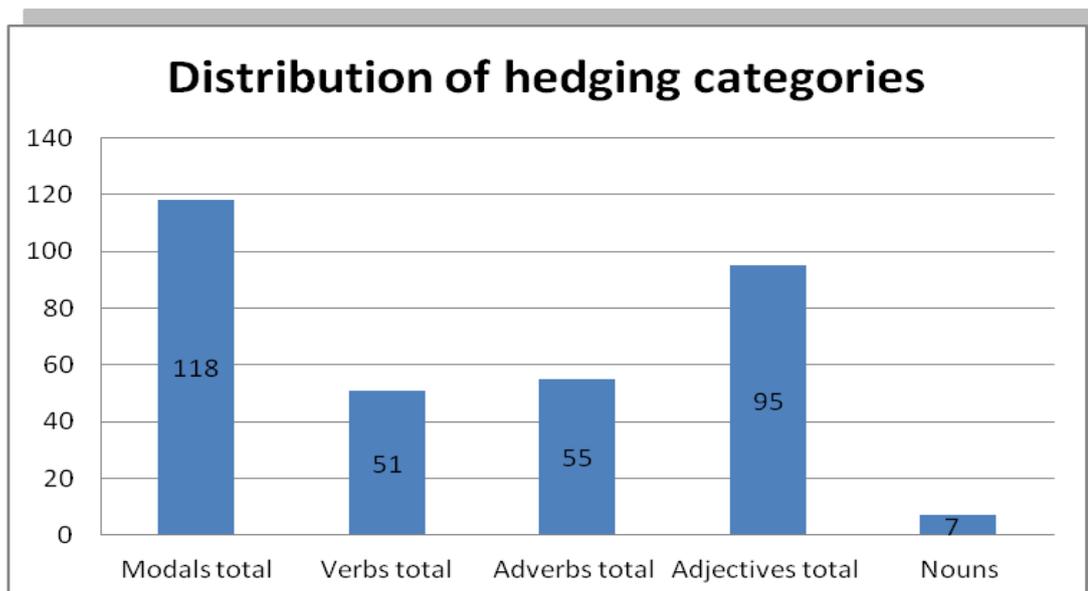


Figure 2. Distribution of different categories of hedges in the corpus of PSAs

The relative incidence of lexical hedges is 20.94 per 1000 words –as compared to the 17.08 per 1000 words in MRAS in this study corpus.

Hedging categories	Incidences	Frequency per 1000 words
Modals +Semi auxiliaries	118	7.57/1000
Verbs	51	3.27/1000
Adverbs	55	3.53/1000
Adjectives	95	6.10/1000
Nouns	7	0.45/1000
Total	326	20.94 /1000

Table 4. The relative incidences of the hedging categories in the corpus of PSAs

Six different modal auxiliaries were identified in hedging interpretation. *May, might, can and could* were found to occur the most frequently. The total number of epistemic words, such as *appear, seem and tend* was 15. Altogether 11 different full verbs categorized as non-factive reporting verbs or tentative cognition verbs were used as hedges in the corpus of popular articles. The relative frequency of such hedging is similar to the corpus of MRAs. The most typical epistemic full verbs in the study corpus were *suggest, believe, conclude and think*.

Altogether, lexical items belonging to the categories of adverbs and adjectives occurred 150 times as hedges in the popular articles. The corpus of popular articles included 25 different adverbs in hedging position. The adverbs interpreted as hedges were probability adverbs such as *likely* and *probably*; adverbs of indefinite frequency such as *often*, *rarely*, *sometimes*, *typically*, *usually*, *commonly*, *generally*; adverbs of indefinite degree such as *significantly*, *greatly*, *largely*, *routinely*, *slightly*, *markedly*, *extremely*, *particularly*, *surprisingly* and *substantially*; and approximative adverbs such as *nearly*, *about*, *everywhere*, *almost*, *approximately* and *around*. The popular science articles contained 18 different adjectives interpreted as hedging devices. Adjectives of probability, indefinite degree or indefinite frequency and approximative adjectives were identified in the corpus. The most commonly used hedges in this group were *certain*, *likely*, *some*, *many*, *most* and *potential*. The other adjectives used as hedges were *apparent*, *possible*, *little*, *consistent with*, *few*, *several*, *numerous*, *typical*, *uncommon*, *remarkable*, *small* and *some kind of*. Nouns were used the least frequently in hedging position. Only 7 incidences of hedges were identified in this subgroup. The lexical items used were *potential*, *notion*, *likelihood* and *to our knowledge*.

5. Discussion

The results indicate that PSAs have an identifiable pattern and a typical popular article contains 8 moves. To sum up, the results contradict hypothesis 1, that the discourse structure of popular science articles cannot be described by rhetorical moves, since the analysis of the study corpus suggests a typical pattern of science popularization. The writers of PSAs are likely to take over some of the rhetorical moves that are present in MRAs. However, significant structural differences exist between the two text types. The MRA starts with the *background information*, while the PSA typically opens with the *announcement of the main outcome*. This deductive pattern is possibly used to capture the attention of the reader.

The *review of previous research* and *identification of gaps in established knowledge* is a more stable move in MRAs than in PSAs. The moves depicting *data collection methods and procedures of experimentations* are present in both genres, but it is more detailed in research papers. The information about *statistical methods* is only provided in MRAs. *Study limitations* are not typically present in popularizations, while it is present in most of the MRAs included in the present study. The move of *conclusion* is a major element in both corpora and the location of this move within the typical move structure is fixed.

The results support hypothesis 2, that the rhetorical structure of the PSA differs from that of the underlying MRA. The findings related to the two sub-corpora indicate that changes take place in the discourse structure when medical research is rewritten for lay audiences. The way the information is presented is considerably changed in the popularization process. Novelty is a key element of both genres but in different approaches. In scientific writing researchers need to share their novel findings with their peers, the authors follow a conventional structure and present facts precisely. Popular articles, on the other hand, report about newsworthy scientific findings or breakthroughs. To sum up, as presumed in hypothesis 2, the structure of the MSAs and PSAs is one of the most striking differences between the two genres.

Hypothesis 3 of the present study was that hedging is not applied in online popular science articles. The findings in the present study do not justify this hypothesis, as hedging was found to occur commonly in the PSAs of the study corpus. Moreover, the results concerning the total number of selected hedges show that hedging is more frequent in popular science articles (20.94 /1000 words), than in medical research articles (17.08/1000 words). The results show that modals and semi-auxiliaries are most frequently used as hedges in both corpora. The modal auxiliary *may* expressing epistemic modality is the most commonly used lexical item in both research and popular articles.

Regarding the grammatical category of verbs, *suggest* occurs the most frequently in both text types, and the proportion of verbs used as hedges to the total number of words is similar in the two sub-corpora. However, the selection of other verbs suggests that more cognition verbs are used in popularizations, such as *believe, think, consider, hope* and *suspect*. There is no statistically significant difference in the use of adverbs as hedges, whereas adjectives are more commonly used as hedges in popularizations. Adverbs that can be linked to epistemic modality such as *probably, possibly, potentially* are more commonly used in research articles. The adjectives in both corpora are probability adjectives or act as quantifiers. Nominal hedges are more frequent in MRAs.

As the authors address lay audiences, the motivation of hedging is different in popularization from that in scientific communication. A possible explanation is that the author of the popular article adopts the tentative tone of the original science article. Hedging may be used when the author of the popular article intends to convince the lay audience that the article is the translation of real science. To sum up, it is a stylistic feature used in order to convey the meaning that PSAs are written like science. It can also be viewed as a defence tool by the authors of these articles. They hedge their statements to create fuzziness and provide inaccurate information this way reducing responsibility. The present study also revealed that the authors of popular articles frequently use linguistic techniques that can be interpreted as hedging, as their aim is to limit the author's responsibility for the information in the articles.

6. Conclusions

To sum up, the discourse structure of popularizations is quite different from the medical research papers. The genre of popular science article has its typical structure made up of 8 moves. The 30 medical research articles could be described in terms of 10 rhetorical moves. The two genres are organized differently. The generic structure of the popular articles is closer to journalism than science. Popular articles, however, seem to take over the tentative tone of scientific communication.

Lexical hedges, which typically occur in MRAs, are extensively used in popularizations of the study corpus. Unexpectedly, the results suggest that lexical hedging is even more commonly used in the sample of popularizations than research articles.

The findings support the contemporary view of science popularization, which assumes that popularization is not about simplifying and distorting scientific information but rather interpreting the discoveries of science for different audiences. Scientists need to share their knowledge with lay people who are interested in their research findings. Consequently, popularization has a positive effect and a significant role in communicating the discoveries and latest results of science. Popular media can also help scientists gain resources and funding for a particular research project. Researchers should have information about the public understanding of science. The study of popular science articles can be an important means to achieve this goal.

Innovations of the Study

An innovation of the present study is that the corpus presents new findings in the field of prenatal vitamins and nutrition, and the medical research articles are matched up with popularized articles of the same research. Therefore, to the best of the author's knowledge, it is the first attempt to create a corpus of medical research articles and corresponding online popularizations. The author of this dissertation used international medical journals, such as *The British Medical Journal*, *the Journal of the American Medical Association* and *the New England Journal of Medicine* as sources to collect articles about recent findings related to prenatal vitamins.

The present study is a corpus-based investigation to compare the discourse structure and the use of hedging phenomena in MRAs and corresponding online popular science articles. The present analysis examines the generic discourse features of the two genres, and then describes the lexical hedges used in the different rhetorical moves.

The comparison of lexical hedges in the two genres was complemented by statistical tests as well. Science popularization is not a common topic of discourse analysis and the process of interpreting medical research for the layman in the new communication medium of the Internet has not been extensively studied yet.

Implications

Research comparing academic and popular science discourse is motivated by the needs of those experts or readers, who interpret or produce these genres. Besides the IMRAD structure for research articles, the rhetorical moves identified in the present study can be used as guidelines when producing both popular and scientific articles. The move analysis and lexicogrammatical study of this corpus can be used to analyze other corpora of research or popular articles. Further investigations are needed to explore the discourse structure and the use of hedging in other genres and text types. Typical forms of lexical hedges can be valuable in transmitting the conventions of both genres into the teaching of English for Medical Purposes.

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ACKNOWLEDGEMENTS

First of all, I am deeply indebted to Dr. Gábor Rébék-Nagy for his encouragement and continuous support of my Ph.D. studies. I am also grateful to my supervisor, Dr. Vilmos Warta for his guidance, insightful readings and comments on my publications and the present study.

I am grateful to the Doctoral School of the Faculty of Health Sciences, first of all to Prof. Dr. József Bódis, Head of PTE ETK Doctoral School of Health Sciences and Prof. Dr. Endre Sulyok, Secretary to the Doctoral School of Health Sciences.

I am also indebted to a number of my colleagues and friends at the Department of Languages for Specific Purposes, at Pecs University Medical School, who helped and inspired me in various matters. I wish to thank Péter Mátrai for his expertise and help in the statistical analyses.

Most useful critical remarks and suggestions provided by Dr. Éva Demeter and Dr. Péter Kanizsai, preliminary opponents of this dissertation, were greatly appreciated.

I wish to thank my family for their support, patience and encouragement over the past few years.