Strategies of hedging in science writing

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Abstract
The paper gives a brief review of research covering hedging in science writing, its functions and main means of expression. Focus is on research articles and theses in the field of engineering. As science writing always carries the individual’s point of view, the article introduces some linguistic devices for expressing hedging of different types. The aim is to show how writers can present their claims cautiously, accurately and modestly to meet science community’s expectations and gain acceptance to their statements.

Keywords
Hedging, rhetorical strategy, strategic hedges, lexical hedges, density of hedges

Introduction
The research article is the main means employed by the hard sciences for the introduction of new findings and claims. Claims are ratified only following their approval by a research network as a whole [1]. The authors’ intentions are to persuade the science community to accept new knowledge claims [2]. Research theses are considered “major intellectual enterprises” which provide their producers with valued professional credentials and membership in academic discourse communities. For new claims made in the thesis to be accepted the reviewers need to be persuaded of the validity of these claims [3], [4]. Reviewers and supervisors set the requirements and define expectations.

According to Belcher [5], the means of achieving the goals of persuasion and consensus building is rhetorical, and as Olson and Torrance [6] maintain, texts can acquire authority not only by virtue of the status of the writer, but also by their ability to stand up to criticism. Delivery of a persuasive message and acquisition of credibility and authority, as Gildorf [7] points out, can be achieved by knowing the audience’s frame of reference and its expectations. Hyland’s studies of use of hedging in science writing are wellknown in the academic community. According to Hyland [8], “knowledge is power, but this is the knowledge to make one’s way in one’s discipline and claim authority.”

This paper aims to review results of studies focused on authors’ rhetorical strategies for use of hedging in research articles and theses. The corpus of analysis used by Koutsantoni [9] consisted of seventeen research articles and nine theses from different fields of engineering. Focus was on the density and function of hedges and, in particular, discourse-based strategic hedges [10], [11], [12].

1 Rhetorical strategy of hedging
According to Hyland’s [13] definition, hedging refers to linguistic strategies that qualify categorical commitment to express possibility rather than certainty in scientific writing, hedging is central to effective argument. On the other hand, English is considered more direct in argumentation, but writers in English are expected to know when to be tentative in the claims they make in writing.

Hedging, the modification or toning down of claims, is one of the most prevalent rhetorical strategies of scientists, motivated by both epistemological and social factors. Star [14] maintains that “scientists constantly face the uncertainty of science”. A scientist interviewed by Campbell [15] confirms this point by saying that

… if you are looking for total certainty you’ll never get it. It’s not possible in this world, and it’s not possible in science (…) you’ve got to recognise that there is a point beyond which you cannot go (…).

Certainty is impossible for science because science doesn’t make those kind of statements. Science deals in probabilities, and it deals in theories.

Hyland [10], [12] points out that in view of this uncertainty, hedges have been seen as devices that help writers to present statements with appropriate accuracy and caution, and as resources that help scientists express the correct degree of their certainty to their claims. On the other hand, there are the power asymmetries between contributors and disciplinary reviewers, which dictate that contributors allow room for alternative interpretations and tone down that claim in order to solicit acceptance to them.

This paper focuses on two types of hedges: lexical and strategic, as proposed by Hyland [8]. This category includes whole sentences that refer to limitations of the study, the methodology or model used and admission of lack of knowledge. To these are added sentences that refer to agreement of a study’s findings with other studies. According to Koutsantoni [16], these are also tentative ways for justification of one’s claims by aligning their work with the work of other researchers, implying that since they are not the only ones who came to a certain conclusions, their conclusions must be correct.
2 Strategic hedges

2.1 Density of hedges

Strategic hedges acknowledge limitations of various types, which authors are the first to point out before they are referred to by others. It was found by Koutsantoni [9] that thesis authors hedge more than the research article (RA) authors; the density of hedges per line in theses found was 0.07, as opposed to 0.05 in the research articles (see Table 1).

Theses writers also employ more strategic hedges than research article writers. 20% of all hedges in the theses were found strategic, as opposed to 14% in the RAs (see Table 2).

Table 1. Density of hedges in research articles and theses

<table>
<thead>
<tr>
<th>Hedges</th>
<th>RAs</th>
<th>Theses</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of items</td>
<td>227</td>
<td>472</td>
</tr>
<tr>
<td>No. of lines</td>
<td>6006</td>
<td>6791</td>
</tr>
<tr>
<td>Density per line</td>
<td>0.05</td>
<td>0.07</td>
</tr>
</tbody>
</table>

The use of hedging techniques in RAs and theses has been studied by analyzing grammatical and lexical units, such as modal auxiliaries, epistemic verbs and adjectives, epistemic nouns or adverbial expressions of probability, possibility and necessity, which together are often referred to as modal meanings, or simply, modality.

2.1.1 Word choice in hedges

On the one hand, style guides for authors accept use of hedging but they also warn that writers need to guard against using hedging to excess. Qualifiers, words that modify or limit the meaning of other words, may be added justifiably to a science text to limit the scope of a statement [17].

Words and phrases commonly encountered to express approximation, probability, or doubt:

Adjectives: apparent, certain, consistent with, few, many, most, possible, presumed, probable, putative, several, some, supposed

Adverbs: apparently, arguably, fairly, in general, largely, likely, more or less, mostly, often, perhaps, possibly, presumably, probably, quite, rather, somewhat, unlikely, usually

Nouns: appearance, indication, inference, likelihood, possibility, probability, suggestion, tendency, to my knowledge

Verbs: aim, appear, assume, can, could, estimate, indicate, infer, intend, may, might, presume, propose, seem, seen as, should, speculate, suggest, suppose, tend

Research on the devices of hedging has also covered expression of epistemic modality by native and nonnative theses writers. Overall, native graduate students use those expressions much more frequently than non-native students (+50%). In particular, it concerns use of epistemic adjectives and adverbs that native students use about 75% more frequently than non-native students. It is suggested that the use of epistemistic modality by non-native writers is influenced by the status and practices of epistemic modality in their culture and first language in general, and in their educational and academic contexts in particular [18].

When used in moderation, qualifiers temper a researcher’s certainty about a method or observation. However, double, triple, and quadruple synonyms are unnecessary, e.g. may be possible; seems to suggest; rather likely to indicate; may be seen as rather unlikely. It is accepted that the number of qualifiers should be limited to those necessary for accuracy [19].

2.2 Categories of strategic hedges

Koutsulani [9] has divided strategic hedges into five categories: limitations of method, limitations of the scope of the paper, limited knowledge, agreement with other research, and limitations of the study.

Tables 3, 4 and 5 show the frequency of occurrence of the types of strategic hedges in order of frequency.
Table 3. Types of strategic hedges in the RAs (in order of frequency)

<table>
<thead>
<tr>
<th>Types of strategic hedges in RAs</th>
<th>Number of items</th>
<th>Percentages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limitations of method</td>
<td>16</td>
<td>40</td>
</tr>
<tr>
<td>Limitations of scope of paper</td>
<td>10</td>
<td>25</td>
</tr>
<tr>
<td>Limited knowledge</td>
<td>5</td>
<td>12.5</td>
</tr>
<tr>
<td>Agreement with other research</td>
<td>5</td>
<td>12.5</td>
</tr>
<tr>
<td>Limitations of study (testability)</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 4. Types of strategic hedges in Electronics and Electrical Engineering theses

<table>
<thead>
<tr>
<th>Types of strategic hedges</th>
<th>Number of items</th>
<th>Percentages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limitations of scope of thesis</td>
<td>..0</td>
<td>0</td>
</tr>
<tr>
<td>Limitations of study (testability)</td>
<td>..6</td>
<td>43</td>
</tr>
<tr>
<td>Limitations of method</td>
<td>..5</td>
<td>36</td>
</tr>
<tr>
<td>Limited knowledge</td>
<td>..0</td>
<td>0</td>
</tr>
<tr>
<td>Agreement with other research</td>
<td>..3</td>
<td>21</td>
</tr>
<tr>
<td>Total</td>
<td>14</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 5. Types of strategic hedges in the theses (in order of frequency)

<table>
<thead>
<tr>
<th>Types of strategic hedges</th>
<th>Number of items</th>
<th>Percentages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agreement with other research</td>
<td>46</td>
<td>49</td>
</tr>
<tr>
<td>Limitations of method</td>
<td>25</td>
<td>27</td>
</tr>
<tr>
<td>Limitations of study (testability)</td>
<td>18</td>
<td>19</td>
</tr>
<tr>
<td>Limited knowledge</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Limitations of scope of thesis</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>94</td>
<td>100</td>
</tr>
</tbody>
</table>

3 Expression of limitations

3.1 Limitations of method

This type of strategic hedge is employed by authors to protect themselves from negative criticism and to admit to limitations before they are pointed out by reviewers. The frequency of this type of hedge was found the highest in the articles (40%), and second in frequency in research theses, with the frequency being slightly higher in electronics and electrical engineering theses (36%) as opposed to 25% in chemical engineering [9].

Examples:

Because of the complexity of the problem it was not possible to evaluate the confidence of the estimate mean and variance, however, the results suffice to illustrate trends [20].

It proves to be quite difficult to obtain the theoretical probabilities $P_\text{fa}$, $P_\text{m}$, and $P_\text{h}$ if the data are interleaved by character [21].

The absorbent particle size was too small to enable accurate effective diffusivities to be obtained [22].

Regrettably the limited operating conditions of the SISTAM and the unexpectedly large errors in measuring drum surface temperature have restricted the study of some of the more interesting aspects of the heat transfer process (…) The experimental work was cut short as it became increasingly difficult to measure drum surface temperature due to the increasing appearance of trapped air pockets between thermocouples and the drum surface. To cure this problem would have involved (…) These modifications would have been very expensive and time consuming [23].

However, in some cases even though authors do acknowledge such limitations, they go on to stress other good results of advantages of their method and point out that these limitations do not significantly affect their results, thus counterbalancing them.

This method does not guarantee the global maximum [STRATEGIC HEDGE], however, simulations indicate that the algorithm works well even when $Es/\delta$ is small [COUNTERBALANCE OF HEDGE] [24].

This author attempts to counterbalance the limitations mostly by attempting to justify their methodological choices, and by indicating that there were problems even though the necessary precautions were taken.
Acknowledgements of limitations in theses might thus be characterized more honest, as when starting a research project, students do not know in advance problems they might face, and the thesis needs to be completed within certain time limits and often with limited resources.

3.2 Limitations of scope of paper/thesis

According to Koutsantoni [9], this type of strategic hedge constitutes 25% of all strategic hedges in the article.

Examples:

Although available directly from the FDTD results, the distribution and magnitude of power losses within the biological tissue of the model are not discussed in this paper [25].

It is not our intention to present here a thorough investigation of the network as a communication system [26].

Our design method for MTQ’s differs substantially from that of ECTQ’s described earlier, but in the interest of brevity will only be sketched here [27].

In theses, these limitations seem to be mainly motivated by failed experiments and circumstances outside the students’ control.

3.3 Limitations of knowledge

These hedges acknowledge inability to offer explanations for phenomena and limitations of the scope of definitions and suggested models, make a reference to the uncertainty scientists face, and are used at 12.5% in the RAs [9].

Examples:

It must be emphasized, however, that there is no way in general to eliminate the window effects on instantaneous bandwidth and higher moments of the spectrogram [28].

However, we point out that our definition of m is neither universal nor complete [27].

The cause of the discrepancy is uncertain [22].

3.4 Agreement with other research

Findings of studies by Koutsantoni [9] show that agreement with other research comprises 12.5% of all strategic hedges in the articles, while it is a very frequent way of strategic hedging in the theses, with a significantly higher frequency in chemical engineering theses (54% as opposed to 21% in electronic and electrical engineering).

These results are consistent with the commonly used model for a permanent magnet with no equivalent volume current density corresponding to (20) [29].

There was good agreement between literature values and the measured diffusion coefficients obtained in this work [22].

Thus, hedging may be used through various linguistic devices in different parts of the research paper and thesis. In the Introduction hedging may serve both to establish the results within a wider research context and highlight the significance of a new study. The Results section hedges may be used to enhance the persuasive effects of the authors’ interpretations of the findings and the resulting claims. Authors’ use of hedges through modal verbs and adverbs, epistemic lexical verbs, indefinite quantifiers and admissions of limiting conditions seek to pre-empt rejections by the scientific community.

Conclusions

This paper has reviewed studies of rhetorical strategies for hedging employed by authors of engineering research articles and theses. The reasons for the use of hedges in science writing lie in the fact that this type of writing must be prepared to confront a possible critical response. Science writing should be able to enhance the author’s credibility constructing a reliable description of the researchers analysis.

Although precision is the most important goal in scientific language and vagueness should be avoided and guidelines for science writing point out that directness, precision and objectivity are crucial, hedges fulfil a number of functions, such as projecting an image of honesty, humility and proper caution. Hedging is the expression of tentativeness and possibility in language use and it is essential to science writing where statements are rarely made without subjective assessments of truth.

Without the presence of hedges, the science writer would be unable to formulate statements describing new information or creating different viewpoints through persuasion and negotiation of information. Thus, the primary communicative purposes of research articles would not be achieved if the absence of hedges were an obstacle to the information flow.

Analyses of scientific texts indicate that student researchers hedge more than research article writers and employ more strategic hedges than them. In terms of linguistic devices used for hedging, modal verbs and epistemic adverbs as well as deductive and performative verbs are of frequent occurrence. Strategic hedges have been found of high occurrence as well. Use of modal verbs and epistemic adverbs as well as strategic hedges is particularly frequent in theses.

Differences have been found in the frequency of certain types of limitations expressed by hedging devices in research article and theses. While article authors use a high percentage of limitations regarding the method (40%), agreement with other research comprises 49% of all strategic hedges in the theses writers. Differences have also been found in the use of different lexical hedges by native and nonnative writers.

Thus, hedging is regarded as a significant resource with a variety of realizations that the writers of articles and theses have to acquire to confirm their professional persona and to assist in the acceptance of their claims.
References