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“The datasets do not agree”: negation in research abstracts

Abstract

Few academic genres have received more attention than the research abstract. Its increasing importance, diverse functions and convenient length mean it has been dismembered and dissected by analysts in countless articles. This is a key genre, central to researchers’ reading decisions and therefore to the creation of new knowledge, and as a result writers use a variety of interactive resources to attract readers to the accompanying article. Despite this interest, however, negation has largely escaped EAP scrutiny. This study, therefore, seeks to correct this oversight by examining negation in research abstracts and the extent it contributes to rhetorical persuasion. Drawing on a diachronic corpus of research abstracts, we show how negation contributes to an interpersonal model of academic writing and describe the forms, functions and distribution of negation across time and disciplines. The results not only add to our knowledge of the rhetorical functions of negation but also raise important pedagogical implication for English for Academic Purposes.

Keywords: research abstracts; negation; textual interaction; academic persuasion

1. Introduction

Research abstracts are increasingly important in the academy. Faced with the massive proliferation of scientific literature, academics are increasingly reliant on abstracts to filter what they read, helping them to process and synthesise what is relevant and worth attention. Abstracts are often, together with titles and highlights, readers first encounter with a research article and are likely to influence their decisions to continue to the full paper or go elsewhere. Thus, unlike earlier accounts of the genre, which saw them as a neutral “summary” of an article (e.g. Bhatia, 1993; Kaplan et al., 1994), abstracts are highly promotional and designed to “hook the reader” (Hyland & Tse, 2005). This, then, is a high stakes genre where writers must foreground both the main claims of the paper and their importance demonstrating that they have something worthwhile to say (Hyland, 2004; Jiang & Hyland, 2017). Attitudinal and evaluative meanings are therefore likely to be key features of these texts as they are scanned by readers. For this reason, and the fact that they are a manageable length for analysis, abstracts have been a staple of linguistic research.

In one of the earliest accounts describing the linguistic features writers used to accomplish this rhetorical purpose, Graetz (1985, p. 125) argued that:

“The abstract is characterized by the use of past tense, third person, passive, and the non-use of negatives”.

But while tense, voice and personal pronouns have received considerable attention in the literature over the years (e.g. Huang, 2018; Hyland, 2004; van Bonn & Swales, 2007) , negation seems to have slipped through the cracks. Swales (2019), for example, suggests that Graetz’s description is “an early claim that has been left unconfirmed or disconfirmed” (p.79). This study, therefore, seeks to correct this oversight by addressing the following questions:

1. To what extent is clausal negation a feature of abstracts in research articles?
2. What are the most frequent forms and functions of negation?
3. How have these changed over the past 30 years?

4. Is negation principally intertextual or intratextual and has this changed?
5. What disciplinary changes have occurred in the use of negation?

To answer these questions we offer an interpersonal model of negation and track the form, function and distribution of negation across time and disciplines. We first review what is known about negation and how it relates to academic interaction.

2. Negation and academic persuasion

Negation is a phenomenon of semantic opposition, expressing “the opposite of something or an absence of something” (Sinclair et al., 2017, p. 648). Pored over for decades by those working in propositional logic, natural language processing, pragmatics and linguistics, negation has been examined and classified in numerous ways over the years.

The most common categorisations are formal with three main types of negative marking identified as morphological negation, negative particles and negative verbs (e.g. Payne, 1985). Tottie (1991) distinguishes between what she calls affixal and non-affixal negation. The former, also referred to as morphological negation (Dahl, 2010), is marked by the presence of a negative affix (e.g. *non-*, *dis-*, *un-*). The latter, on the other hand, also known as clausal negation (Biber et al., 1999), is attained either by negating the lexical verb or auxiliary (1), or by negating non-verbal constituents (2).

(1) This indicates that repeated editions do **not** always guarantee a higher level of formal correctness. (Biology, 2005)¹

(2) Patterns of international involvement differ by generation and by field, but **not** by gender. (Sociology, 2005)

Thus the entire proposition is denied or rejected, with the negative scope extending from the negative form to the end of the clause. Clausal negation thus represents what

¹ Examples are from our corpus discussed in section 4. Negative words are bolded, and the sources of discipline and year are marked in brackets.

Miestamo (2005) calls ‘standard negation’ (see Dahl, 2010 for a detailed discussion) and is a direct way of expressing a negative statement (Biber et al., 1999; Tottie, 1991).

Negation is not present in physical reality (Miestamo, 2009) and so is a marked linguistic option, projecting a mental world in which users anticipate a likely response from an interlocutor. Through negation, therefore, writers introduce “the alternative positive position into the dialogue, and hence acknowledging it, so as to reject it” (Martin & White, 2005, p. 118). Because of this complexity, negative sentences seem to appear later in children’s language development (Larsen-Freeman & Celce-Murcia, 2016) and take longer to process than affirmatives (Clark, 1976; Miestamo, 2009).

While perhaps twice as common in speech as in writing (Biber et al., 1999; Tottie, 1991), negation plays an important role in shaping academic arguments. This is because academic persuasion rests on

the writer’s careful assessment of his or her readers’ needs and the negotiation of a sustained dialogue which recognises the reader’s ability to reject the writer’s argument. (Hyland, 2014, pp. 1–2).

As the examples above indicate, negation helps writers to signal the strength of their certainty in statements while acknowledging other voices and the possibility of alternative opinions. This rhetorical function means that negation often clusters in the results and conclusion sections to provide validity for research findings in biomedical papers (Laso, Comelles, & Verdaguer, 2013) and is heavily used to negotiate interpersonal meanings in students’ writing (Herriman, 2019).

But while negation can be a useful rhetorical device for steering readers to agreement, analysts have found it difficult to untangle its varied roles. Tottie (1991), for example, claims that negation serves to reject suggestions and deny assertions. Pagano (1994), however, believes that we also need to distinguish between facts and opinions, so argues for a further distinction between denials of background and prior information, the

presentation of unfulfilled expectations, and the comparison of items. For Martin and White (2005), negation functions to disclaim alternative positions, proclaim authors' positions and entertain possible positions, while Swales (2019) understands negation to express either uncertain concepts or factual information. In her study of negation in the selected papers of a handful of celebrity applied linguists, Webber (2004) identified seven functions of negation: unfulfilled expectations, correcting assumptions, comparison, dissatisfaction, disagreement, wholehearted agreement and expression of cautious stance. However, while underlining the evaluative role of negation, Webber acknowledges "a certain amount of overlap between categories" which prevents detailed analysis, so that "it is not possible to quantify how frequently they occur" (2004, p. 195).

Negation is an important evaluative feature as it allows the writer to negatively comment both on what is explicitly stated in the text and what is attributed to others. Tottie (1991) made this useful distinction between *implicit and explicit* types of negation, referring to whether what is negated needs to be inferred from the context or is explicitly mentioned. Pagano (1994) sought to clarify this as denials of background information and of text-processed information, but we prefer Webber's (2004) terms *extratextual* and *intratextual* negation. Here we use these terms to characterize the negation of assumed or shared knowledge between writers and readers (3) and in-text information, anaphorically or cataphorically alluding to what has been or is about to be mentioned (4).

(3) **Few** terms in linguistics, however, are so widely used without proper justification. (Linguistics, 1990)

(4) These results show that both markers are reliable for the detection of proliferating cells in birds, but the numbers obtained with BrdU and EdU should **not** be compared. (Biology, 2020)

In this way the writer can create a virtual reader position and then go on to challenge that, so establishing a dialogic space between the writer and readers.

Despite the useful functional categorisations of negation offered by these analysts, none address the types of interaction around which academic writing is typically structured. The classifications make no clear distinction between the use of negation to create the textual cohesive links which help readers see relevant connections in the text, and the ways it is used to convey a writer stance and reader-sensitive tenor. One approach to interaction is discussed under the label of *metadiscourse* (Hyland, Wang & Jiang, 2021). This makes a distinction between *interactive* and *interactional* elements of texts to more clearly reveal the different rhetorical positions taken by writers towards their material and their audience (Hyland, 2005; Jiang, 2022). This also allows us to see how writers attribute to their readers certain assumptions and beliefs which they can challenge and rhetorically build their own positions (Hyland, 2005b).

From this social constructionist view of writing (Hyland, 2022), we develop an interpersonal model of negation which enables us to compare frequency and distribution patterns across relatively large bodies of data.

3. An interpersonal model of negation

Following the metadiscourse model, we see interaction as a core element of successful academic writing offering writers the means to comment on their unfolding text while “anticipating readers’ expectations and responses to participate in a virtual dialogue” (Hyland, 2009, p. 111). We seek to map negation onto Hyland’s (2005a) conception of metadiscourse which employs Thompson’s (2001) conceptions of interactive and interactional dimensions of communication. The former relates to the way discourse is organised into a coherent flow of ideas to “the writer’s assessment of readers’ comprehension capacity and understanding need for interpretative guidance” (Jiang, 2022, p.52). The latter presents the writer’s rhetorical efforts to “control the level of personality in a text” and construct a suitable relationship to material, arguments and

audience, “influencing the degree of intimacy, the expression of attitude, epistemic judgements, and commitments, and the degree of reader involvement” (Hyland & Tse, 2004, p.168).

By examining texts for the use of negation in these interactive and interactional contexts, we seek to better understand this feature and to suggest a model for researching negation in academic writing. Essentially, negation here concerns the writer’s efforts to clarify the exposition in opposition to what might otherwise be assumed and to distinguish his or her position from that of others. These functions, together with example realisations, are seen in both interactive and interactional uses.

The *Interactive dimension*, as mentioned, concerns the way discourse is shaped to assist readers in understanding the writer’s intended meaning. Here negation occurs in a context of creating connections between text elements to help make the flow of information both cohesive and persuasive. In the interactive component, negation is found where authors seek to progress the argument by marking comparative, additive and consequential relations, either between parts of the text or by highlighting a possibly unexpected connection.

Comparison: here instances of negation mark contrastive relations between elements in the text.

(5) Both of these facts can be straightforwardly accounted for in the X-skeletal theory but **not** in the moraic framework, regardless of the variant of the moraic theory. (Linguistics, 1990)

(6) Hospitality experiences create a halo effect of patient goodwill, while medical excellence and patient safety do **not**. (Sociology, 2020)

Addition: negation serves to add elements in an argument by presenting two related pieces of information as either surprising or unexpected in some way, often with the second being even more surprising than the first.

(7) The L-shaped bridge design on the EBG power plane **not** only broadens the stopband bandwidth, but also can increase the mutual coupling between the adjacent EBG cells by significantly decreasing the gap between the cells.

(Engineering, 2005)

(8) **Neither** free trade **nor** fair trade has transformed this system.

(Sociology, 2020)

Consequence: this kind of negation is employed to show something is not an outcome or effect of an argument or study.

(9) The results do **not** support the hypothesis. (Biology, 1990)

(10) By default they have been assumed to be the sensorimotor schemas described by Piaget. However, sensorimotor schemas are **not** concepts and are **not** the right sort of representation for learning language.

(Linguistics, 1990)

The *Interactional dimension* of negation focuses on the participants and displays the writer's persona and a tenor consistent with community norms. Here negation acts in a context of modality and affect, contributing to the writer's evaluation of material through hedging, boosting and attitude.

Hedging: the use of negation with hedges contributes to the writer's efforts to limit the full illocutionary force of a statement or evaluation, toning it down to either express reservations about the proposition or provide the reader with a sense their possible alternative view is respected.

(9) Many powerful approaches have been investigated, but **few** have been to make the threshold values adaptive to the changing statistics of images...

(Engineering, 2005)

(10) The objective threat of crime and subjective reactions in the population do **not** necessarily run parallel.

(Sociology, 1990)

Boosting: negation here seeks to emphasise the expressive force of a proposition, dialling up the commitment to a statement which would otherwise be weaker.

(11) School enrolment expansion in the United States was **never** constrained by a limited availability of educational opportunities.

(Sociology, 1990)

(12) I then argue that the resulting situation is by **no** means incompatible with the traditional approach to semantics.

(Linguistics, 2005)

Affect: here negation contributes to the writer's attitude to presented content, often to deny the accuracy, adequacy or clarity of a result of study.

(13) The existing DOA estimation algorithm for L-shaped array of coherent signals is **not** accurate.

(Engineering, 2020)

(14) the anterograde IFT velocity varies significantly in different organisms, but how this velocity affects ciliary length is **not** clear.

(Biology, 2020)

We believe that studying negation in this way contributes both to the interpersonal model of textual interaction, by adding an additional, more nuanced dimension to the descriptive apparatus, and to our understanding of how negation functions in discourse. It shows us something of how writers can both project their attitude to the truth and accuracy of propositions and acknowledge potentially diverging opinions. Less obviously, perhaps, it helps authors to construct what Thompson (2001) called the "reader in the text" by anticipating alternative views or projecting a probable common viewpoint shared with the reader to create a convergence of opinion.

4. Data and analysis

To quantify the use of negation in disciplinary research abstracts across time, we built three corpora, taking abstracts from journal articles published by the same 10 journals in four disciplines at three periods over the past 30 years: 1990, 2005 and 2020. The fact that journals appear and decline, that they morph into other, more specialised journals, and that they are replaced by new ones makes diachronic research challenging

(Hyland & Jiang, 2019). However, we selected long-lived journals at the top of their fields with enviable Impact Factors. Additionally, we made our selection to provide a relatively representative spread of research writing from disciplines in the humanities and social sciences (linguistics and sociology) and from the physical sciences (electronic engineering and biology), ensuring only unique authors were selected.

150 abstracts were taken at random from each of the 10 journals in each discipline which had achieved the top ranking in their field according to 5-year impact factor published by Thomson Reuters’s *Web of Knowledge ISI* in 2020. Both single and co-authored research abstracts were included in equal numbers. This meant we collected 500 abstracts from 10 journals in each discipline (50 from each journal for each year), totalling 6,000 abstracts of 976,681 words. Table 1 shows the characteristics of the corpus and, we should note, the increase in the length of abstracts over the period:

Table 1 Corpus characteristics

	1990			2005			2020		
	Total words	Mean length	Standard deviation	Total words	Mean length	Standard deviation	Total words	Mean length	Standard deviation
Sociology	65,796	131.59	11.24	75,814	151.63	13.28	83,419	166.84	13.05
Linguistics	75,153	150.31	13.91	74,968	149.94	13.88	77,623	155.25	13.76
Engineering	72,448	144.90	10.83	79,583	159.17	12.37	85,062	170.12	13.54
Biology	85,525	171.05	13.10	94,014	188.03	13.96	107,276	214.55	15.19
Overall	298,922	149.46	12.27	324,379	162.19	13.37	353,380	176.69	13.89

Focusing on non-affixal, or clausal negation, as noted above, we produced a list of the main negative markers discussed by Biber et al. (1999) as *no-negatives* and *not-negatives*, and what Carter et al. (2011) and Sinclair et al. (2017) refer to as *broad negatives* (e.g. *rarely* and *little*). The 17 typical negative markers are shown in Table 2.

Table 2 Typical negative markers

barely	little	few	not	no	nowhere	nobody	never	no one
neither	none	nor	nothing	seldom	rarely	hardly	scarcely	

Using *AntConc* (Anthony, 2019), we searched these items in the corpus, and then manually checked each concordance to ensure that the retrieved instance was functioning as negation (according to the model above), excluding extraneous cases (such as *yes and no questions*). Both authors worked independently and manually coded examples according to the interpersonal model, achieving a high inter-rater agreement of 97% in interactional and 98% in the interactive dimension of negation before resolving disagreements. To compare the use of negation across the sub-corpora of different sizes, we normalised all the results to 1000 words.

As indicated in our research questions, we were more concerned with inter-disciplinary differences across time than intra-group variation among individual writers and therefore focused on the broad group differences. By aggregating the practices of several hundred researchers in each field in this way we can reveal something of the unconscious rhetorical preferences of writers (Hyland, 2004) and disciplinary outcomes which have been legitimised by the editing and reviewing processes of each field (e.g. Englander, 2006). Therefore, we then applied the log-likelihood (*LL*) test using Rayson's (2016) log-likelihood calculator to determine statistical significances, following his suggestion that an *LL* score of 3.8 or higher is significant at a cut-off p-value of 0.05. We also considered the effect size for log-likelihood tests (*%DIFF*), which indicates the percent of the difference between the two normalised frequencies (see Gabrielatos, 2018 for more information about *%DIFF*). We now address the research questions in turn.

5. Negation in research abstracts: frequency, form and function

We identified 4,126 cases of negation in the corpus, occurring 4.22 cases per 1000 words. Clearly, this frequency is sufficient to contradict Graetz’s impression that negatives are not found in abstracts. Typically academic knowledge is achieved through a process of persuading peers to see and believe things in a certain way, and because this often means demonstrating hard evidence or logical outcomes, it is commonly assumed that negative statements play little role in this environment (Laso et al., 2013). We were therefore surprised to find two clausal negations in every three texts (assuming an even distribution of negation across texts) even in such a concise presentation of argument.

The five most frequently used negatives were *not*, *no*, *little*, *few* and *nor*. Diachronically, *hardly*, *seldom* and *rarely* showed a significant increase in frequency over the 30 years, with *no*, *nor* and *not* falling remarkably. Table 3 presents those negative markers which registered significant changes over the 30 years.

Table 3 Negative markers with significant changes across the period

markers	1990		2005		2020		% Change	LL	%DIFF	p
	raw	per 1000	raw	per 1000	raw	per 1000				
hardly	13	0.04	25	0.08	46	0.13	225.00	15.90	-66.59	<0.01
seldom	14	0.05	24	0.07	50	0.14	180.00	14.46	-66.90	<0.01
rarely	23	0.08	36	0.11	79	0.22	175.00	23.85	-65.58	<0.001
no	258	0.86	213	0.66	174	0.49	-43.02	33.52	75.29	<0.001
nor	54	0.18	48	0.15	42	0.12	-33.33	4.18	51.99	<0.05
not	860	2.88	743	2.29	702	1.99	-30.90	53.38	44.83	<0.001

Note: % change measures the change of normed frequency; LL values are calculated using the frequencies from 1990 and 2020.

Compared with *no* and *not*-negations, *hardly*, *rarely* and *seldom* indicate what Larsen-Freeman & Celce-Murcia (2016) refer to as “reduced intensity and non-prominent pitch” towards the accompanying statements, while helping to “mitigate disagreement,

presumably with the goal of maintaining social harmony” (p. 198). As seen in (15) and (16), *hardly* and *rarely* play down the critical tone of the author’s judgement regarding the adequacy of current research practices, hedging the view to a larger extent than *not* (17).

(15) The development of an Islamic infrastructure by Muslims with a migrant background in European contexts has **hardly** been addressed as expressing a sign of putting down local roots. (Sociology, 2020)

(16) However, thermal plasticity is **rarely** studied in response to thermal variability and is often measured in a single life stage. (Biology, 2020)

(17) As a wide range of functional cytoskeletons, how actin filaments respond to UV-B-induced root morphogenesis has **not** been reported.

(Biology, 2020)

As noted above, negation represents the writer’s decision to intrude at certain points to either offer a comment on what has been said or to ensure the reader can effectively recover how it is being said. Table 4 shows the distribution of interactive and interactional uses of negation in the overall corpus.

Table 4 Percentage of functional use of negation in the corpus

Functional categories	Raw frequency	%
Interactive dimension	2896	70.19
Consequence	1722	41.74
Addition	593	14.37
Comparison	581	14.08
Interactional dimension	1230	29.81
Hedging	650	15.75
Boosting	499	12.09
Affect	81	1.96

We can see that interactive uses dominate the frequencies, showing a focus on helping to guide readers through a text by both creating surface cohesion and influencing their understandings of propositional material. Over 40% of the cases of negation in the corpus, in fact, are used to construe consequential connections, indicating that the current research does not result in an expected outcome (18) or that the shortcomings of a particular method require highlighting (19).

(18) The distribution of realizations across lexical items and speakers does **not** support the proposed phonemic contrast. (Linguistics, 2020)

(19) This approach does **not** allow proper tradeoffs between cost and reliability due to the inelasticity of the fixed requirements. (Biology, 2020)

Interestingly, negation with interactional features comprise less than 30% of all forms in our corpus. This is in marked contrast to affirmative statements, where interactional markers dominate (Hyland & Jiang, 2016), as writers seek to present a relatively robust and unambiguous statement of their perspectives. The least common interpersonal use of negation is affect, appearing in contexts in which writers express their attitudinal, rather than epistemic, evaluations.

(20) Unfortunately, it was **not** carried out extensively. (Biology, 2020)

(21) The sociolinguistic models currently available in the codeswitching literature are **not** appropriate for the analysis of this bilingual phenomenon. (Linguistics, 1990)

As Biber et al (1999) and Hyland (2004) found, the emphatic expression of affect is relatively infrequent in academic research writing and tends to be implicitly *invoked* rather than openly *inscribed* (Martin & White, 2005). Negation here, then, accompanies a relatively infrequent feature which helps account for its restricted occurrence.

6. Diachronic patterns of negation

We also found an overall decrease in the normed frequency of negation over the 30 years, from 4.60 cases in 1990 to 4.01 in 2005 and 4.08 in 2020, a fall of 11.30%. This

is despite the substantial rise in the length of abstracts (Table 1) and presumably an increase in the opportunity to use this form. There seems, then, a growing desire by writers to provide an affirmative presentation of information where they can, although this is not uniform across all functions (Figure 1).

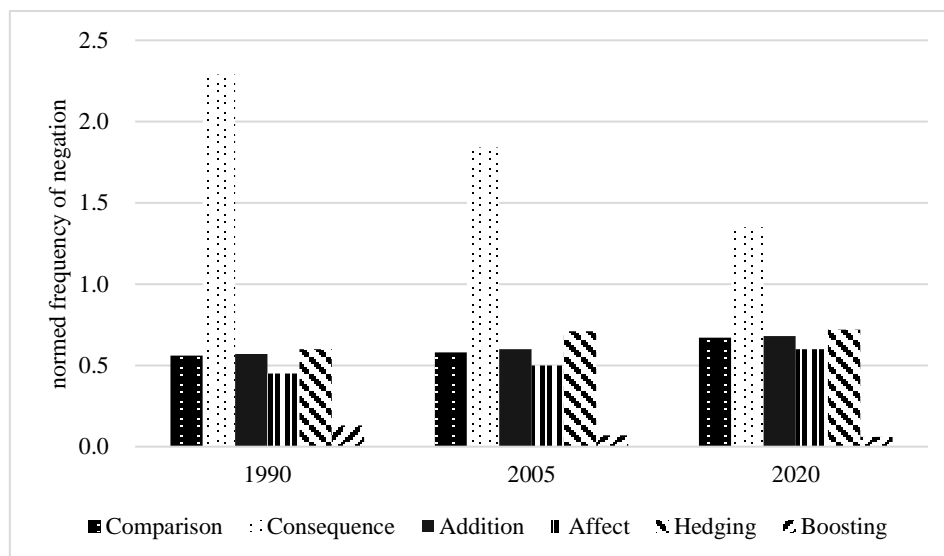


Figure 1 Changes of functional categories of negation over time (per 1000 words)

Leading this overall downturn in negations in abstracts we find those associated with boosting and consequence showing the heaviest falls, by 53.85% and 41.05% respectively. *Boosters* enable writers to “express conviction and assert a proposition with confidence, representing a strong claim about a state of affairs” (Hyland, 1998, p. 350). Negation plays a role here by both strengthening a proposition and adding a certain stylistic variation which can be arresting:

(22) However, glutamate receptor cluster formation has **never** been examined in *Drosophila* DLG mutants. (Biology, 2005)

(23) As such, managers can **no** longer rely on conventional well-established solution methods - the more unique the problem, the greater the need for creative solutions. (Engineering, 1990)

We see in these examples negation serving to reinforce authorial judgements. However, this degree of categorical assertion serves to shut down alternative voices and as such

tends to be somewhat face threatening to the reader. Because of this, Hyland and Jiang (2019) found a fall in the use of boosters in research articles in the last 50 years. They attribute this to a changing academic context in which writers are addressing new audiences “beyond an immediate group of informed insiders to promote both one’s research and oneself with tenure and promotion committees and commercial sponsors” (Hyland & Jiang, 2019, p. 146). We believe the decrease of negation in research abstracts has a similar motivation, helping to explain the low figures for this feature.

The decline in the use of negation to help express (non) *consequence* is harder to explain. Consequence expresses a relationship between elements and the use of negation in this context signals how a writer presents the absence of a positive result or a lack of a significant connection. So in (24) the writer denies a causal relationship between skeletal evidence and disease following colonial contact and in (25) the linguist excludes the relevance of corpus evidence in claims about verb inversion.

(24) The skeletal elements from Florida do **not** suggest that the disease changed dramatically following contact with Europeans. (Biology, 1990)

(25) A study of a large corpus of natural language data, however, indicates that these restrictions do **not** account for the full range of verbs found in inversions. (Linguistics, 1995)

The falling use of this rhetorical use of negation is in contrast to an increase in the frequency of explicitly affirmative consequential markers in research writing (Hyland & Jiang, 2020). This preference may be due to a sense that the causal connection is either clearer or more strongly conveyed when expressed as a positive relationship.

In contrast to boosters and consequence negation, the other functions we examined all increased over the period with forms associated with expressing affect (33.33% up), hedging (20.0%), comparison (19.64%) and addition (19.30%).

Affective negation contributes to the author’s assessment of the material under discussion, projecting an attitudinal perspective which is typically used to inject a note

of caution or criticism of previous explanations (26) or to comment on the current state of knowledge in an area (27 and 28).

(26) Therefore, this approach is **not** suited for studies of the development of housing problems. (Sociology, 1990)

(27) However, the underlying mechanism for the class II phenotype is **not** known. Here we demonstrate that all tested class II IN substitutions compromised IN-RNA binding in virions. (Biology, 2020)

(28) Unlike cities, however, disadvantaged rural regions are often seen as **not** conducive to innovation. This article will examine how innovations emerge in disadvantaged rural regions... (Sociology, 2020)

While the increase in this type of negation was not significant (0.45 cases in 1990 to 0.6 in 2020), it nevertheless affords writers a rhetorical option to create a research gap and identify a space to situate the current study, a role which helps explain its growing frequency.

Hedging has also seen an overall growth in normed frequency from 0.60 in 1990 to 0.72 cases in 2020, although this is also not significant. Hedging represents the writer's attempt to "withhold complete commitment to a proposition, allowing information to be presented as an opinion rather than accredited fact" (Hyland, 2005b, p. 178). Negation here, then, serves to weaken a categorical statement, either to indicate the state of knowledge on a topic or out of respect for the potentially opposing views of readers. Examples (29) and (30) are typical extracts from the corpus, serving to modulate the tone of the assertions:

(29) However, it does **not** necessarily refer to a global vector based on path integration of the outbound flight. (Biology, 2005)

(30) The battery could offer a solution to this problem as it is inherently enclosed by DC grid for power balancing, but the purpose may **not** be served completely due to high capital cost and maintenance.

(Engineering, 2020)

With the changing readership in the academy, which increasingly includes sponsors, commercial interests and other non-specialists, there is a growing need for writers to carefully calibrate the weight they give an assertion (Hyland & Jiang, 2016). The degree of reliability they attribute to their statements helps minimise potential criticism and may help persuade a wider audience.

We also note an (statistically insignificant) increase in the use of *Comparison* from 0.56 in 1990 to 0.67 cases per 1000 words in 2020. It is a discourse management resource to help guide readers through a text and the use of negation in this context contributes to textual relationships and a persuasive flow of information. Negation, however, not only helps rhetorically construct coherence, but also signals how the writer wants these connections to be understood. In the following examples, for instance, we see that negation does more than mark contrast with the preceding idea. In (31) it serves to highlight the significance of the second idea and in (32) it attributes a point of view to readers and then contradicts it.

(31) Homelessness and housing insecurity in the United States are **not** so much a housing problem or a poverty problem as a visible sign that growing wealth inequality has left millions of people unable to earn enough to afford adequate housing. (Sociology, 2020)

(32) Inhibition of enzymes responsible for GABA production and degradation led to increased mortality, supporting a role for GABA as an intermediate product and **not** a metabolic end-product. (Biology, 2020)

This helps readers make better sense of both connections in the argument and to previous, or potentially opposing, perspectives. Such a rhetorical investment to ensure explicitness and clarity seems essential when addressing an ever more diverse audience. As we have noted elsewhere, academics are increasingly required to “persuade readers beyond those in one’s immediate specialisation to reach lay people and interested members of other fields” (Hyland & Jiang, 2019, p.43).

Additive relations also saw an increase from 0.57 in 1990 to 0.68 cases in 2020 and while statistically insignificant, these help to build an argument by signalling an inter-propositional relation in which the propositions are seen to be closely related or built one on another. The use of a negative in this context typically takes the form of *neither ... nor* (33) and *not only* (34):

(33) However, **neither** economic development **nor** marketization at the province level is a significant predictor of postmaterialist work values.

(Sociology, 2020)

(34) Reducing losses of the latter **not** only improves return on investment **but also** reduces the required cooling effort and potentially enables higher power densities.

(Engineering, 2020)

Once again, the use of this negative construction does more than create cohesive connections. By building one element on another in this way it explicitly spells out that the writer is seeking to emphasise the cumulative nature of the propositions and therefore the combined strength of the elements.

7. Intratextual and extratextual uses of negation

It may have been apparent in some of the examples above that negation can refer to either explicitly stated propositions in the text (intratextual reference) or to propositions which need to be inferred from the context (extratextual). As mentioned in Section 2, Tottie (1991) calls these explicit and implicit denial. The difference can be seen in the examples below. In (35) and (36) we can see that what is negated is an affirmative position expressed in the preceding discourse. This is an intratextual response which establishes a dialogue within the text itself, with one statement acting to correct the other:

(35) An implementation is presented of an algorithm to solve large sequential decision analysis models. This implementation in the Pascal programming language does **not** use special features of Pascal...

(Engineering, 1990)

(36) Since the first phase involved **no** control variables, a second phase was conducted using multivariate analyses. (Sociology, 2005)

In contrast, in (37) and (38) the connection relates to affirmative propositions which lay outside the text and which the reader needs to recover. In both cases the negation requires readers to draw on their disciplinary knowledge to establish the connection:

(37) Several recent molecular studies have begun to clarify the phylogeny of Acanthomorpha (Teleostei), a wide clade of teleost fishes. However, different molecular datasets do **not** agree on a single history of the taxa, probably because of marker-specific biases. (Biology, 2005)

(38) Unfortunately, it was **not** carried out extensively... (Biology, 2020)

A close scrutiny of the corpus shows, perhaps unsurprisingly, that intratextual negation occupied a larger share of cases. It also revealed that while normed frequencies of intratextual uses fell slightly over the 30 years, extratextual examples registered a significant decrease ($LL=56.00$, $\%DIFF=61.73$, $p<0.001$). Figure 2 displays the changing distribution of these two types.

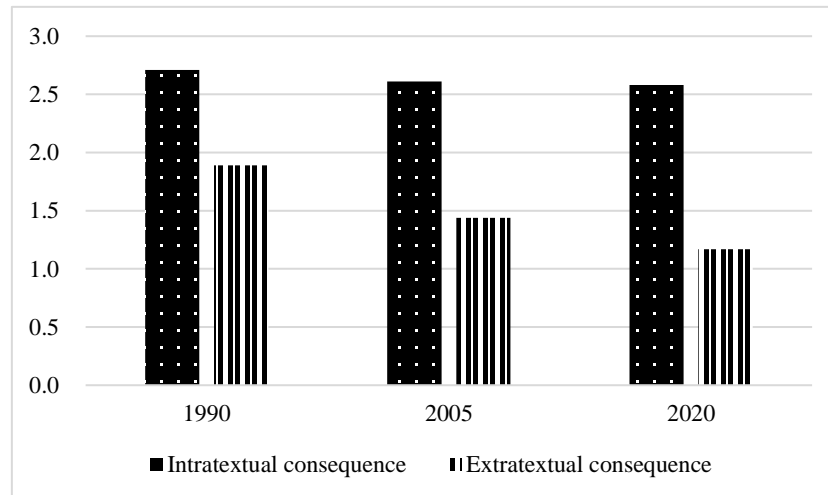


Figure 2 Distribution of intratextual and extratextual negations over time (per 1000 words)

Thus it seems intratextual negation is a consistent rhetorical preference, and by this intervention to contradict or deny “text-processed information” (Pagano, 1994, p. 260),

writers can prevent any possible misunderstanding by spelling out the relationship clearly. The fall in the use of extratextual negation is more striking, which relates to writers addressing the possibly mistaken ideas readers may entertain from their previous background knowledge. While 30 years is a relatively short time, much has altered in academic communication over these years and, in particular, the period has witnessed changes in audiences and material conditions. Today there is greater emphasis on academic-industrial partnerships and university outreach initiatives where research seeks to benefit the taxpayers who support research and the commercial institutions which can make use of it. Writers are encouraged to reach beyond the specialised disciplinary readers of the past to new and heterogeneous audiences who may be less familiar with extratextual references (Hyland & Jiang, 2019). As a result, the assumptions writers feel they may confidently make about their readers' knowledge may be more constrained.

The picture which emerges from our overall analysis of intratextual and extratextual negation in the abstract corpus shows it contributes to a rhetorical purpose seeking to influence authorial stance and reader interpretation. But unlike Hyland and Jiang's (2018) study of metadiscourse in research articles over 50 years, we failed to find the overall trend of significant increase in interactive metadiscourse and a significant decrease in interactional types. Negation accompanying boosters and consequence have fallen but those allied with other features have all risen.

8. Negation and disciplinary persuasion

Turning to disciplinary variations in the use of negation over time, we find falling uses in the use of negation in linguistics, rises in sociology and relative stability in the work of biology and engineering authors. Table 4 presents the findings by normed frequency.

Table 4 Functional distribution of negation across disciplines (per 1000 words)

Functional categories	Linguistics			Sociology			Biology			Engineering		
	1990	2005	2020	1990	2005	2020	1990	2005	2020	1990	2005	2020
Interactive	1.9	1.1	0.7	0.8	1.2	1.4	0.7	0.9	0.9	0.1	0.1	0.2
Consequence	1.3	0.5	0.2	0.2	0.5	0.7	0.3	0.5	0.6	0.0	0.0	0.1
Addition	0.3	0.3	0.3	0.3	0.4	0.4	0.1	0.1	0.1	0.1	0.1	0.1
Comparison	0.3	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.2	0.0	0.0	0.0
Interactional	0.5	0.5	0.4	0.6	0.8	0.9	0.7	0.5	0.5	0.2	0.1	0.1
Hedging	0.2	0.3	0.3	0.3	0.3	0.4	0.2	0.3	0.3	0.1	0.1	0.1
Boosting	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.0	0.0	0.1	0.0	0.0
Affect	0.2	0.1	0.0	0.1	0.3	0.3	0.4	0.2	0.2	0.0	0.0	0.1

The most striking aspect of the table is perhaps the increase of negation in both interactive and interactional dimensions in the sociology texts ($LL=12.06$, $\%DIFF=-42.86$, $p<0.001$; $LL=8.41$, $\%DIFF=-33.33$, $p<0.01$). These significant increases may be a response to a growing concern that sociology has lost touch with all but the most embedded specialist insiders and is unable to effectively communicate with a wider audience (e.g. Billig, 2013, Hyland & Jiang, 2020). Best (2003), for example, argues that “sociologists are clothing a paucity of thought in a smokescreen of verbiage” (p.2). Perhaps sociologists see the use of negation as a means to more effectively communicate “the ordinary affairs of ordinary people” and “convey ideas and information with enough clarity to be easily understood outside the narrow precincts of the discipline and yet with sufficient precision to allow for careful inspection and evaluation within it” (Erikson, 2008, p. 404).

The use of negation can assist sociologists to better express social issues more clearly and ensure that a wide range of readers can recover the writer’s intended meaning:

(39) Nonviolent protests have been at the center of minority interest advocacy for nearly a century While groups organize and demonstrate

in a peaceful manner, there is **no** guarantee that onlookers will perceive them as such. (Sociology, 2020)

(40) However, **neither** economic development **nor** marketization at the province level is a significant predictor of postmaterialist work values.

(Sociology, 2020)

Interestingly, and despite this overall increase, the sociology abstracts failed to show an increase in negation to boost epistemic judgements, perhaps to better smooth the way for the acceptance of their arguments with peers:

(39) However, the use of a weak tie is **never** associated with higher expected wages under the first formulation. (Sociology, 1990)

(40) Mexicans have long been involved in (in)formal community-making, yet long-term white residents perceive a “loss of community” because social relations are **no** longer structured around an agrarian culture.

(Sociology, 2005)

The use of negation in boosting expressions remained consistently low in all disciplines over the period. This reluctance to assert a firmly negative position parallels the falls found in affirmative boosters by Gillaerts and van de Velde (2010) and Hyland and Jiang (2016). This is attributed to a gradual replacement of less forthright judgements by “a deliberate, cautious expression of scientific claims, rather than by the authoritative stance of an ‘omniscient’ academic” (Gillaerts & van de Velde, 2010, p. 137). This may also help explain the increase in the use of negation to hedge statements in all disciplines except engineering. As noted above and shown in (41) and (42), negation is often employed as an interactional marker to create a research gap in the literature:

(41) English language research has tended to focus on elite communities and contexts, and **little** is known outside of these domains. (Linguistics, 2020)

(42) In neurosciences, they are often used consecutively in the same animal to detect neuronal populations arising at multiple time points, their

migration and incorporation. The effectivity of these markers, however, is **not** well established. (Biology, 2020)

They can also serve to weaken categorical claims and limit the scope of conclusions to avoid subsequent challenges:

(43) This seems to be a reasonable deduction but was **not** confirmed in this study. (Engineering 2005)

(44) While large-scale barcoding with NGS readout has facilitated cellular fitness assessment at the population level, this approach does **not** support characterization of clones prior to selection. (Biology, 2020)

We have also noted that linguistics saw a decrease in both the interactive and interactional uses of negation although only significant in interactive types ($LL=44.06$, $\%DIFF=171.43$, $p<0.001$). The change in the former category largely results from a substantial 84.61% fall in consequential expressions, such as (45), and the latter from a 100% decline in affective uses (46). Hyland and Jiang (2019) argue that linguists exhibit a certain rhetorical sensitivity designed to qualify “an ego-centric stance” (p.144). However, this fall in negation may be more a reflection of an increasing shift towards data-supported observation and research interpretation, as opposed to more personal recounts.

(45) They do **not** apply as easily to requests, however, in that they do **not** account for differences in force created by the negative in both languages. (Linguistics, 1990)

(46) This paper demonstrates that it is **not** an appropriate description of the phonetic correlates of the harmony system. (Linguistics, 1990)

Biology presents a different picture of functional change in the use of negation, recording slight decrease in interactional types and a slight increase in the interactive dimension. Hyland and Jiang (2016) found that attitudinal expressions declined in biology research articles the last 50 years and we see this repeated in abstracts where

negation is used. Thus fewer cases of affective negation (47) can be seen in today's biology writing. Also following the pattern of research articles, hedging seems to have seen a small increase in our corpus (48). Once again the changing audience for biological research may help explain this change:

(47) Simple models are **not** good for assessing contact tracing and detecting asymptomatic carriers. (Biology, 2020)

(48) The actin filaments were **hardly** filamentous in the maturation zone. (Biology, 2020)

We also found that biologists replaced comparison with consequence in the ways they used negation to organise a coherent discourse. Full reasons for this contrast are unknown, but the clarity which a negative can bring to establishing propositional relationships can be seen from these examples:

(49) There was **no** association between an individual's oxygen demand and its air-breathing frequency in a group. (Biology, 2020)

(50) Empagliflozin had **no** direct effects on disease progression in type 2 diabetic mice. (Biology, 2020)

Finally, engineering, and this discipline is noteworthy not for any substantial changes in use, but largely for its striking disinclination to use negation in research abstracts. Engineering seems to be similar to physics in this regard, attaching greater importance to affirming antecedent claims than denying alternative possibilities (Kolecki, 2004). There seems to be a relatively unexplored rhetoric here and the low frequencies might be explored in other engineering genres to confirm this. Most negations served to comment on the existing literature to carve out a research space (51) or to express limitations in the current research (52):

(51) Existing studies on distributed optimization algorithms for IEHSs have **seldom** addressed packet loss during the process of information exchange. (Engineering, 2020)

(52) However, the readout magnetoresistivity signals in simple antiferromagnetic films are weak, and reorientation of the magnetic order vector via optical excitation has **not** yet been achieved.

(Engineering, 2020)

10. Conclusions

The research abstract is an important academic genre central to what we choose to read and attend to in academic searches, helping readers to filter the profusion of literature. Conversely, they allow writers to promote their research and differentiate it from the torrent of published research available. This promotion of research encourages the writer to hook readers at the outset and encourage them to see the research as both relevant and convincing by presenting it in ways that peers will find familiar, plausible and persuasive. Discovering how this is achieved has become a major focus of applied linguistics research in recent years as analysts “search for evidence of interactivity in academic prose and identify the ways that writers craft an inclusive relationship with their readers” (Hyland & Jiang, 2017, p. 40). We have suggested here that negation contributes to this endeavour and is a neglected rhetorical resource in the EAP literature.

In this study, we show that negation plays both interactive and interactional roles in the rhetorical construction of research abstracts. It functions not only to organise coherent discourse by marking comparative, additive and consequential relations between arguments, but also by expressing the writer’s circumspection and certainty about claims and affective stance towards material. Our results show that negation is most often used to construe consequential connections and least often to convey personal affect. We also found that the use of negation to express affect, hedging, comparison and addition all increased in our sample of abstracts, with a fall in the use of boosting and consequential expression. Our diachronic results indicates a rhetorical shift in argumentation patterns, perhaps as a result of changes in the less specialised readership of academic research.

Clearly, negation is not simply an option available in the language and used randomly at the whim of individual writers. The distributions and changes we have recorded indicate patterns of diachronic and disciplinary uses which suggest the deliberate deployment of negation to achieve particular functions. Whether this is in response to calls for greater clarity and communicative effectiveness, as may be the case in sociology, or to engineering's strong antipathy, negation signals a writer's involvement in the rhetorical preferences of disciplinary practice. It would be instructive to determine the strength of these preferences by exploring whether these preferences in abstracts are repeated in other academic genres and disciplines and in larger samples of texts.

Our study also suggests the pedagogical value of giving greater attention to negation in English for Academic Purposes (EAP) and English for Research and Publication Purposes (ERRP) courses. Until now this has been a relatively overlooked aspect of the curriculum. The reason for this neglect is perhaps because it occurs less frequently than affirmative options or because students tend to struggle with learning it. It has been reported, for example, that negative sentences appear later in children's language use (Larsen-Freeman & Celce-Murcia, 2016) and is more difficult to process than affirmatives (Miestamo, 2009). Advanced students and novice academic writers may, however, benefit from an awareness of the role that negation can play in disciplinary writing. It seems helpful not only to teach students how to recognise the different functions of negation in their reading of academic texts, but also how they can use them to create effective and persuasive texts of their own.

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