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Quantification in conference talks and proceedings articles in engineering

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ABSTRACT

The quantification of phenomena and processes is a core activity in science and engineering and is therefore a prominent feature in the spoken and written research genres of hard sciences. The present study proposes a multimodal and genre-based analysis of a corpus of video filmed conference presentations and the corresponding Proceedings articles in hydraulics engineering in order to determine how measurable information is managed by the speakers and authors. The linguistic aspects considered are quantification by numbers, both precise and imprecise, and non-numerical quantification by quantifying determiners and the lexis of measurement. The analysis also covers the contribution of the visual mode to quantification and its interaction with the spoken commentary in the conference presentations. Results show that the way in which quantifiable data are handled in academic speech and writing is very different: numbers are less frequent in the talks, much less complex, and more often accompanied by approximators; quantification by determiners is preferred to lexical quantification. The complex numerical data omitted in the commentaries can be accessed however via the visuals. It is argued that the speaker's role is to accommodate the presentation of quantities to suit his communicative purpose and to facilitate cognitive processing by the audience, fulfilling an evaluative and interpersonal function.

1. Introduction

> "In physical science the first essential step in the direction of learning any subject is to find principles of numerical reckoning and practicable methods for measuring some quality connected with it. I often say that when you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely in your thoughts advanced to the state of *Science*, whatever the matter may be."
>
> [Sir William Thomson, Baron Kelvin of Largs, *Popular Lectures and Addresses* (1891–1894), vol. 1, "Electrical Units of Measurement"]

Quantification, which is founded on measurement, has come to play an increasingly prominent role in the natural sciences, and is now generally considered, as in the epigraph above by Lord Kelvin, to be a constitutive feature of science. This

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increasing importance of quantification is no doubt due in part to technological progress, which has made ever more precise measurements possible. Though the history of quantification in science can be traced much further back, it gathered huge momentum during the 20th century, a period when "society became statistical" (Hacking, 1990, p.1), and transformed certain disciplines such as medicine (Jorland, Weisz, & Opinel, 2005). Measurement is not just a technological affordance, however, but may also have a more profound epistemological impact. This was highlighted by Kuhn (1977), in an essay entitled "The Function of measurement in modern physical science" in which he showed that quantitative anomalies detected through measurement may lead to a paradigm shift. This epistemological leverage of quantification can be seen to stem from the value system of academic research. As Hunston and Thompson (2000, p. 24) point out, "In genres which build knowledge claims (…), the central function of evaluation is to assess the degree of certainty that can be attached to each part of the knowledge claim." Accurate and reproducible measurements enable scientific claims to be asserted with certainty. Indeed, Hood (2004) found that among the wide range of resources available for evaluation, there is a strong preference in academic discourse for quantification as the evaluative criterion of findings and claims. Moreover, in applied sciences such as engineering, quantitative accuracy is a crucial criterion in decision-making since "engineers need accurate solutions that are both unbiased and have high precision" (Ayyub & McCuen, 2011, p. 3).

Given this core role of quantification in science, it is, unsurprisingly, a prevalent feature of both written and spoken scientific genres. As an extensive body of research has made clear, however (see e.g. Halliday, 1985; Ventola, Shalom, & Thompson, 2002; Swales, 2004), research speech and writing differ in many important respects. The present study aims therefore to compare how scientists and engineers manage quantification in a spoken research genre (conference presentations) and the closely related written one (proceedings articles), and to propose explanations for the differences observed. The study is informed by genre analysis (Swales, 1990; 2004) and by Systemic Functional Linguistic theory that considers the multimodality of meaning-making across various semiotic modalities, notably visual communication (Kress & van Leeuwen, 2006) and its interaction with language, as it is well known that a great deal of quantitative information is communicated not verbally but visually in the research genres of hard sciences (Bazerman, 1988; Lemke, 1998). The contribution of the visuals to quantification will therefore be addressed.

In discourse, writers and speakers have several means at their disposal to quantify phenomena: numbers (both precise and imprecise), determiners or quantifiers (*many*, *few*, etc.), the lexis of measurement (*large/small*, *a reduction*, *to increase*), and, in science and engineering in particular, numerical visuals such as graphs, charts, and scatter-plots (see e.g. Ayyub & McCuen, 2011). While several of these features have been addressed by analysts of academic discourse, the aspect that has received the lion's share of attention so far is vagueness, or imprecision (Banks, 1998; Cutting, 2000, 2007; Channell, 1994; Dubois, 1987; Myers, 1996; Plo 2006; Ruzaite, 2004). Interest in vague language can be traced back to Lakoff's (1972) insight that language concepts have fuzzy, not precise boundaries (see also Rosch, 1973), and that the judicious use of vague language is a central aspect of communicative competence, enabling the expression of quantification to be adapted to the context and the shared knowledge of participants, thus forming an important feature of interpersonal meaning (see Cutting, 2007: 5 for a relevant summary).

A landmark study on imprecise quantification in science is Dubois (1987), on a spoken research genre, conference presentations in biomedicine. Dubois showed that the numerical expressions used are often approximate to such a degree that it would be more accurate, she claims, to talk of imprecision rather than approximation. Imprecision takes various forms: rounding, extreme rounding (to multiples of 5 or 10), ranges, fractions, and multiples, all of which can be made even less precise by the addition of adverbial approximators such as *about*, *approximately*, *or so*, etc. She adduces two main reasons to explain these findings: an extrinsic reason (the cognitive overload for the audience if very detailed numbers are frequently used), and intrinsic reasons, related to the scientific content itself (incomplete or imperfect data, backgrounding minor items of information, etc.). In subsequent work on vague quantification in academic speech the attention shifted, however, from the research genre of conference presentations to more dialogical, teaching-oriented communicative situations: conversational interaction between students (Cutting, 2000), teacher–pupil interaction in mathematics classrooms (Rowland, 2007), lectures (Cheng, 2007), or a range of academic settings covered by the Physics and Engineering division of the *Michigan Corpus of Academic Spoken English* (lectures, tutorials, office hours, etc.; Plo 2006).

Vague quantification has also been the focus of a limited number of studies on academic writing, in particular research articles (RA). Channell (1990) analyzed three RAs in economics from a goal-oriented approach – "The precise forms [of quantities] selected by writers are seen as the result of attempts to reach particular communicative goals" (1990: 98) – and related writers' choices to the Gricean Maxims (Grice, 1975) of Quantity (giving the appropriate amount of information for the purpose at hand), Quality (persuading the reader; lack of precise information), and Manner (downgrading or highlighting certain facts or claims). Banks (1998) studied six RAs in particle physics and marine biology and showed that vague quantification is an integral and essential element of the scientific RA: a form of hedging, it can be used to express incomplete or inconclusive data, to conform to expected style, or to avoid face-threatening behavior. Myers (1996) used a variety of academic texts in his study, but only tangentially addressed quantification, his main focus being on the use of vagueness in various forms as an argumentative strategy.

The motivation for this focus on vagueness is perhaps that it appears to be a "paradoxical use of vague language in the realms of accuracy – the hard science disciplines" (Plo, 2006, p.190), but it may also be part of the general constructivist movement to demystify specialized discourses and show their similarities with everyday language use. And indeed, the general conclusions to emerge from this body of work are that vague quantification is pervasive in academic discourse, as in everyday language use, and that writers and speakers purposefully or strategically choose precise or vaguer forms of expression based on their perception of what is appropriate to the communicative context and to their rhetorical goals. While