*Routledge Studies in Multimodality*

# ENGAGEMENT IN MEDICAL RESEARCH DISCOURSE

## A MULTISEMIOTIC APPROACH TO DIALOGIC POSITIONING

Daniel Lees Fryer

# Engagement in Medical Research Discourse

This book integrates insights from dialogic theory and systemic functional linguistics (SFL) to extend our understandings of engagement in medical research articles, going beyond notions of the role of verbal dialogue to encompass mathematical and visual semiotics and consider text not just as language but as multisemiosis.

The volume begins by outlining the engagement framework and offering a brief overview of historical developments in medical research discourse. This discussion culminates in the introduction of the corpus used for analysis, drawing on original research articles from key medical journals to explore verbal, mathematical, and visual engagement in turn. A subsequent chapter brings these perspectives together to demonstrate intersemiotic engagement across different stages and phases of the medical research article and how such resources work together to construe and maintain the authoritative position commonly associated with medical discourse. The book looks ahead to engagement in other related disciplinary fields and future directions for work on multisemiosis and medical research discourse more generally.

This book will be of particular interest to graduate students and researchers in multimodality, critical discourse analysis, applied linguistics, SFL, and science education.

**Daniel Lees Fryer** is Associate Professor of English at Østfold University College, Norway. His teaching and research interests include linguistics, multimodality, and discourse analysis, especially in the areas of scientific/medical discourse, the discourse of social movements, and human–nonhuman animal relations.

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# Engagement in Medical Research Discourse

## A Multisemiotic Approach to Dialogic Positioning

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**For mum and dad—Margaret Fryer and Doug Fryer, x**

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# 1 Introduction
## Engaging with Medical Research

### 1.1 Community

The motivation for writing a book like this comes from an interest in social relations, in how people form social bonds, how they maintain those bonds, and how those bonds might be threatened, damaged, broken, or repaired in various ways. It's all about community and how we get things done together.

When we talk about scientific communities, we might not always think of the social relations those communities imply. When we read a scientific text, we might not think first and foremost about what relations are encoded in and through the text. That's what this book is about; how texts bring into play and connect with other voices and other texts, and how they position themselves and their readers in relation to those other voices and other texts.

I've chosen to examine medical research articles for several reasons, some of which I'll explain in more detail in Chapter 3. Put simply, the field of medicine or medical research has a direct impact on more or less everyone's lives, it exerts an enormous influence on other fields of human experience (education, the media, politics, our social relations (!), etc.), and it represents a discipline and practice that seems to be a hybrid of the pure, natural, social, and human sciences.

My background is in linguistics and discourse analysis. I'm educated in science, too, but not in medicine. (I studied physics as an undergraduate.) I've worked with medical researchers and medical students for many years, mainly in a research, writing, or editing capacity. I'm not a central part of the medical community, in other words—I'm peripheral to it, an outsider perhaps—but this study isn't grounded in medical research per se. It's a study that's firmly rooted in discourse analysis and the analysis of texts in context. The focus here is on the *how* rather than the *what*, as Bernstein (1981, 342) puts it.

### 1.2 Why Engagement?

Part of understanding how texts work, or how they mean, involves understanding how they fit into a wider exchange or dialogue. This can have

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important pedagogical and epistemological implications. If you're a student or academic, someone who's new to or unfamiliar with the mores of a particular academic community, it might be useful to learn more about how members of that community typically (or atypically) engage with each other. Understanding how this academic conversation works might also tell us something important about how knowledge is negotiated and constructed in a particular field.

This book contributes to a growing body of discourse-analytic studies of medicine and medical research. I hope it will be of both practical and theoretical value to readers.

## 1.3 Aims and Organization of the Book

The aims of this book are fourfold. The first is to identify the resources medical research writers use to construe, engage with, and position themselves and their readers in relation to a background of other voices and texts. The second is to examine the roles or functions those resources have, and how they are typically integrated or combined. The third is to investigate how those resources are distributed across texts. And the fourth is to explore the extent to which the use of those resources might reflect some of the disciplinary practices of medical research. In order to do this, I adopt several interrelated theoretical approaches, drawing on concepts and frameworks from dialogic theory, social semiotics, systemic functional theory, and social-anthropological approaches to health and illness, as well as methods or analytic techniques from corpus linguistics. I explain and discuss these approaches at various points throughout the book.

The book is organized as follows.

Chapter 2 provides an overview of dialogic theory, social semiotics, and systemic functional theory, and discusses the complementarity of those traditions. This discussion serves as the basis for a presentation, discussion, and development of a conceptual framework for analysing types, means, and degrees of engagement, and how engagement resources serve to position or align the writer and the reader. The chapter argues for a multi- and intersemiotic understanding of texts that, in this case, includes verbal, mathematical, and visual resources.

Chapter 3 presents and discusses previous studies of medical research, situating the current work in a wider linguistic, multisemiotic, and discourse-analytic context. This includes a section on the medical research article as a genre, in which the characteristics and functions of the various stages and phases that comprise the genre are discussed. The chapter ends with a presentation of the material used for analysis and exemplification throughout the book, and the kinds of techniques used to identify engagement resources in medical research articles. A list of articles used in this study is provided in the appendix.

Chapters 4, 5, and 6 present findings for verbal, mathematical, and visual engagement, respectively. These chapters follow the same organizational structure: a presentation and discussion of the instantiation, realization, and interaction of different types of engagement, an account of their distribution across different stages and phases of the medical research article, and a discussion of the potential relations between engagement and the discipline or practice of scientific medical research.

Chapter 7 considers intersemiotic engagement, i.e. how verbal, mathematical, and visual resources work together to create complementary, divergent, or new kinds of engagement in the text. The chapter includes a close reading of a single text as well as a stage-by-stage analysis of the medical research article as a generic whole that draws together findings from the previous chapters. Chapter 7 concludes with a discussion of the possible relations between intersemiotically construed engagement and the disciplinary practices of scientific medical research.

The final chapter, Chapter 8, summarizes the findings of the previous chapters and compares engagement in medical research articles with engagement in other fields and other text-types. The chapter also discusses engagement as a system and makes proposals for how we might develop that system and the potential meanings it encodes. The chapter ends with some concluding remarks on engagement in medical research discourse.

## Reference

Bernstein, Basil. 1981. "Codes, modalities and the process of cultural reproduction: a model." *Language and Society* 10:327–363.

# 2 Voices in the Text
## Models of Engagement and Alignment

> The living utterance, having taken meaning and shape at a particular historical moment in a socially specific environment, cannot fail to brush up against thousands of living dialogic threads, woven by socio-ideological consciousness around the given object of an utterance; it cannot fail to become an active participant in social dialogue. After all, the utterance arises out of this dialogue as a continuation of it and as a rejoinder to it—it does not approach the object from the sidelines.
>
> (Bakhtin 1981 [1935], 276–277)

In this chapter, we look at different ways of conceptualizing the relations between texts and the relations between those who produce and engage with those texts. We begin with a presentation of dialogic theory and the work of the "Bakhtin Circle".[1] This is followed by a presentation and discussion of social semiotics and systemic functional theory, with a view to exploring how they might complement and elaborate upon dialogic theory. With this as our theoretical basis, the remainder of the chapter deals with how engagement might be modelled across different semiotic systems.

### 2.1 Dialogic Theory

According to Bakhtin (1981 [1935], 1986) and Vološinov (1973 [1929]), the meaning of any given utterance can only be understood against a background of prior and anticipated utterances, a background of potentially complementary, divergent, and ambivalent positions. Every utterance enters into dialogue with other utterances and is "filled with the echoes and reverberations of [those] utterances" (Bakhtin 1986, 91). Bakhtin uses the term "heteroglossia" (*raznorečie*, *raznojazyčie* in Russian; lit. "multi-speechedness" or "multi-voicedness"; heteroglossia = "other-voicedness" in English) to describe and account for the multiplicity and interrelation of voices in a given utterance.[2]

Utterances are units of meaning rather than formal units of language (Bakhtin 1986, 73). Encoded by words, phrases, and clauses, they correlate with "the extraverbal context of reality (situation, setting, pre-history)" and

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"with the utterances of other speakers" (Bakhtin 1986, 73), and "are determined by the particular *situation* [...] and its *audienc*e" (Vološinov 1973 [1929], 96, emphasis in original). Utterances can be grouped into utterance types, or speech genres, that share similarities in terms of their thematic content, style, and composition (Bakhtin 1986, 60). Basic or primary speech genres include questions, exclamations, commands, and requests (Vološinov 1973 [1929], 96). Complex or secondary speech genres include "short rejoinders", "commentary", "scientific statements", and "the multivolume novel" (Bakhtin 1986, 60–61).

For Bakhtin (1986, 62), secondary or complex speech genres are ideological. They reflect social and historical views of the world, a particular social group's "system of ideas" (Freedman and Ball 2004, 4–5), its "values and accents" (Dentith 1995, 105, see also Vološinov 1973 [1929], 21–22), and "the realized, materialized, externally expressed social consciousness" of the "ideological environment" (Bakhtin and Medvedev 1978 [1928], 14). Freedman and Ball (2004, 6) argue that this ideological environment mediates the "ideological self", i.e. "how we develop our way of viewing the world, our system of ideas" (Freedman and Ball 2004, 5), and that the ideological self is oriented to, determined by, and in turn determines the ideological environment (Bakhtin and Medvedev 1978 [1928], 14, Freedman and Ball 2004, 5). For Bakhtin, then, utterances are "ideologemes" that reveal something of the ideologies of the speaker—the "ideologue"—and the cultural sphere—the "ideological environment" (Bakhtin 1981 [1935], 333, Holquist in Bakhtin 1981 [1935], 429, Kristeva 1984, 36–38).

As an example, Vološinov (1973 [1929], 95) considers a book, and the kinds of prior and anticipated utterances, convergent and divergent positions, and potentially different world views such a text might imply. For Vološinov (1973 [1929], 95), a book is a verbal performance in print, one that "engages […] in ideological colloquy of large scale: it responds to something, objects to something, affirms something, anticipates possible responses and objections, seeks support, and so on". Understanding how texts, or the voices in those texts, engage in ideological colloquy with other texts and other voices is the primary aim of this book. To do this, as Vološinov (1973 [1929], 95) points out, we have to consider verbal and nonverbal interactions as well as the situations and broader contexts in which those interactions take place.

Some scholars, however, are critical of the "explanatory and descriptive power" of dialogic theory, suggesting that it does not provide an adequate framework for distinguishing different levels of abstraction, for understanding the relation between text and context, or for considering language as system (Hasan 1992). In the section that follows, we turn to social semiotics and systemic functional theory as a possible way of adding descriptive and explanatory power to some of the ideas of Bakhtin and Vološinov. The section also serves as the theoretical basis for the subsequent section on engagement and alignment, and for the book as a whole.

## 2.2 Social Semiotics and Systemic Functional Theory

Social semiotics is concerned with the study of signs in society (cf. Saussure's (1959 [1915]) *semiology*). It focuses on meaning-making as social practice (Hodge and Kress 1988, van Leeuwen 2005). Hodge and Kress (1988) and van Leeuwen (2005) acknowledge the importance of Vološinov's work in this regard. This includes Vološinov's rejection or negation of Saussurean linguistics (what Vološinov calls "abstract objectivism")—placing greater emphasis on *parole*—and Vološinov's conception of the utterance as a primarily social phenomenon rather than, or superordinate to, an individualized one. With an emphasis on the social (and material) aspects of signs, dialogic theory and social semiotics are both interested in the transformative potential of critical theory and analysis, seeing the study of language, and signs more generally, as a form of social action or intervention (Vološinov 1973 [1929], 23, Dentith 1995, 21, Martin 1992, 575, Halliday 2003 [1993], 223, 2013, 15).

Social semiotics usually emphasizes the multisemiotic or multimodal nature of communication and interaction, examining the deployment and integration of different semiotic resources in the process of meaning-making (e.g. O'Halloran 2005, Kress 2010, Painter et al. 2013, see also Vološinov 1973 [1929], 15). These different systems or modes, which Kress (2010, 79) defines as "socially shaped and culturally given semiotic resource[s] for making meaning", include "[i]mage, writing, layout, music, gesture, speech, moving image, soundtrack and 3D objects".

Studies of multisemiotic artefacts often explore language–image relations (e.g. Royce 2002, 2007, Lim 2004, Painter et al. 2013). There is also a growing body of work that examines the resources of other meaning-making systems from a social-semiotic perspective (e.g. van Leeuwen 1999 on sound, O'Halloran 2005 on mathematics, Bezemer and Kress 2014 on touch). Common to most of these approaches is their application or adaptation of systemic functional theory. Systemic functional theory models language and other semiotic resources as systems of choices where function or meaning is determined by the selection of one option rather than another in a particular eco-social environment (Halliday 1978, 1994, Halliday and Hasan 1985, Halliday and Matthiessen 2004).

Systemic functional theory proposes a number of semiotic dimensions, or forms of order, that together define the organization of language and (as some postulate) other semiotic systems.[3] These are generally referred to as stratification, instantiation, and metafunction (see Figure 2.1, Halliday and Matthiessen 2004, Matthiessen 2007, Matthiessen et al. 2010). In the case of language, stratification deals with how language and context are organized or stratified into different levels of symbolic abstraction, such as lexicogrammar and semantics. It also deals with how constituent elements are arranged within those strata, e.g. morpheme – word – group/phrase – clause (the rank scale for lexicogrammar; see Figure 2.1), the kinds

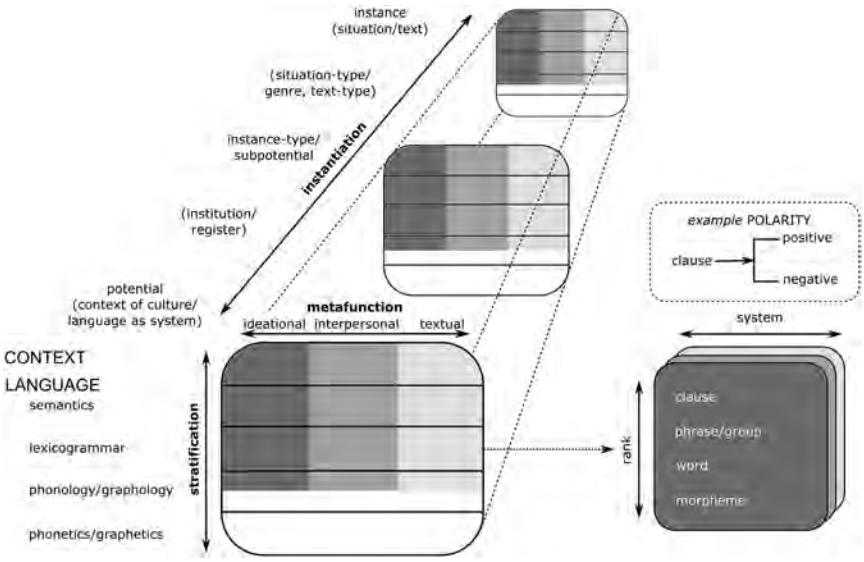


*Figure 2.1* Semiotic dimensions of language in context (adapted from Halliday and Matthiessen 2004, 21, as well as Halliday 2007 [1991], 275, Matthiessen 2015, Mwinlaaru 2017).

of systems and systemic choices available, and the structures derived from making selections in those systems (cf. Saussure's associative/paradigmatic and syntagmatic relations).[4] Instantiation concerns the relation between language as system and language as an instance of text, and between context as culture and context as situation. This dimension is organized along a cline—rather than hierarchically in the case of stratification—with system and instance at each pole and instance types (e.g. text-types or situation-types) between those poles (see Figure 2.1). Metafunction deals with how language has evolved over time to function or mean in certain fundamental ways: language construes our experiences of the world, it enacts our social relations, and it organizes the expression of those experiences and relations into coherent units. These are usually referred to as the ideational, interpersonal, and textual metafunctions, respectively, strands of meaning that are simultaneously encoded in language, by different systems, across different strata (see Figure 2.1). The lexicogrammatical systems of TRANSITIVITY, MOOD, and THEME, for example, construe ideational, interpersonal, and textual meanings, respectively.

As an example of how systemic functional theory might be applied to an instance of language, consider a clause like *The nurse was helping a patient*. Metafunctionally, we might say that (1) the clause is about a nurse and a patient (two participants) and a particular action or activity taking

place at some time in the past, (2) it is a declarative (subject followed by finite) that functions as a statement in an exchange (in this case, the giving of information), and (3) *the nurse* as subject is the theme of the clause, its point of departure, connecting presumably to a wider co-text and context in which these participants and activities can be further traced. We might also be interested in looking at the clause interstratally—from above, from below, and from "round about" (Halliday 2002 [1996], 408)—considering the time and place in which it was written or read (produced or consumed) and by whom, its phonologic or graphologic realization, and the clause's co-textual environment. Similarly, from the perspective of instantiation, we might be interested in the type of text this clause belongs to or its meaning or function in a specific situation or institutional setting. All of these perspectives tell us something different but interrelated about the clause. How and where we focus our analyses depends to a large extent on what we're looking for, and why. In this study, as will become clearer in Section 2.4, we are examining texts and text excerpts primarily from an interpersonal discourse-semantic perspective—considering how social relations are encoded through text—variously shifting focus between textual and contextual variables, from systemic choices at the level of the clause or proposition to the kinds of codes or principles that regulate those choices and how people interact in certain social and institutional settings.

## 2.3 Multisemiosis and Intersemiosis

The model of semiosis described above applies primarily to language, but the dimensions of stratification, instantiation, and metafunction might usefully be applied to other semiotic systems. Metafunctional diversity, inter- and intra-stratal realization, and scales of instantiation are all variously posited for images and mathematical symbolism, the two semiotics (other than language) that are most relevant to this study.

Kress and van Leeuwen (2006, 42–43), for example, argue that images can mean in three basic ways: they can represent the inner and outer worlds of our experience; they can enact certain social relations between the producer, the viewer, and the depicted; and they can be organized or arranged in ways that connect with other images or depictions and with the wider context. Within each of these three metafunctions, Kress and van Leeuwen (2006) propose a series of systems that includes NARRATIVE and ANALYTIC STRUCTURES; CONTACT, SOCIAL DISTANCE, ATTITUDE, and MODALITY; and INFORMATION VALUE, SALIENCE, and FRAMING, respectively. O'Toole (1994) proposes a similar set of metafunctionally motivated systems for the description and analysis of visual art, including RHYTHM, GAZE, MODALITY, NARRATIVE THEME, PORTRAYAL, POSITION, and PROPORTION. O'Toole (1994) also offers a visual rank scale, i.e. member – figure – episode – work (cf. rank scale for lexicogrammar in Section 2.2), within and across which different systems are at play.

Lemke (2002) and O'Halloran (2005) make similar claims with regard to mathematics, arguing that the language, visual-graphical representation, and symbolism of mathematics exhibit metafunctional diversity. In the case of mathematical symbolism, O'Halloran (2005) notes, historically, a relative expansion of certain ideational meanings and a relative narrowing of interpersonal meanings compared with language as mathematics evolved, extending its construal of "relations and patterns of variation" (O'Halloran 2005, 103) and reducing the ostensibly "superficial" need to enact intersubjective positions (O'Halloran 2005, 114).[5] O'Halloran's (2005) model for mathematical symbolism is similar to that of language and images, with metafunctionally organised systems of meaning such as SPEECH FUNCTION, MOOD, TRANSITIVITY, THEME, and CONJUNCTION distributed across different strata (e.g. grammar and discourse semantics). O'Halloran (2005) also proposes a rank scale for the grammar of mathematical symbolism: component – expression – clause – statement. If we take Pythagoras's theorem as an example, $a^2 + b^2 = c^2$ would be a mathematical statement consisting of a single clause that contains several expressions (e.g. $a^2$ and $b^2$) that are in turn made up of various components or functional elements (e.g. $a$, +, and =).

Applying a systemic functional framework to semiotics other than language gives us a shared ontology to account for differences and similarities within and across meaning-making systems. We can examine and compare verbally, visually, and mathematically construed meanings in text, and explore how the resources of those semiotic systems are co-deployed and integrated to make meanings that may be more than the sum of their monosemiotic parts (Lemke 1998, see also Baldry and Thibault 2006, 18–19).

Exactly where and how that integration takes place may vary. For example, if we consider text on a printed page, the integration is both material and socio-semiotic (see Lim 2004). Visual, verbal, and other resources are bound together physically on paper and in print; they may complement each other semantically; and they may be integrated contextually through the activities and social relations of a particular situation or culture.

## 2.4 Engagement and Alignment

One of the most explicit connections between the work of the Bakhtin Circle and social semiotics or systemic functional theory is offered by Martin and White (2005) and others (White 1998, 2003, 2012, Hood 2004, 2010, Martin and Rose 2003, 2007, Martin 2008). We'll begin by looking at Martin and White's (2005) ENGAGEMENT system for language before discussing how this and related models have been or could be adapted for images and mathematics.

### *2.4.1 Verbal Engagement*

Martin and White's (2005) system of ENGAGEMENT is part of a wider framework for modelling evaluative language, known as APPRAISAL. The APPRAISAL

system comprises three simultaneously available subsystems: ATTITUDE, ENGAGEMENT, and GRADUATION. A system network for APPRAISAL is shown in Figure 2.2.[6]

ATTITUDE models "our feelings, including emotional reactions, judgements of behaviour and evaluation of things" (Martin and White 2005, 35), while GRADUATION deals with the ways in which evaluative meanings can be scaled or graded, by adjusting the force or amplitude of those meanings, or by sharpening or softening the focus on them (Martin and Rose 2003, 42–48, 2007, 37–43, Martin and White 2005, 135–153). ENGAGEMENT attempts to account for the ways in which a verbal text—or the voice represented by that text—refers to, responds to, and is influenced by prior and anticipated utterances. The ENGAGEMENT system also models how the textual voice attempts to 'align' or 'disalign' itself and the reader with regard to the other voices and positions "construed as being in play in the current communicative context" (Martin and White 2005, 94). White (2003) and Martin and White (2005) refer to this '(dis)alignment' as intersubjective stance or dialogistic positioning.[7, 8]

Within the architecture of systemic functional theory, ENGAGEMENT is an interpersonal system of meaning in the stratum of semantics (see Section 2.2). A detailed system network for ENGAGEMENT is shown in Figure 2.3. In addition to showing typological relations between features or options in the system, Figure 2.3 gives example realizations of those features (in italics), i.e. "from below" in the lexicogrammar (Halliday 2003 [1997], 250).

The basic choice in the ENGAGEMENT system is whether an utterance is considered 'monoglossic' (single-voiced), in which no overt reference is made to other voices or viewpoints in the discourse, or 'heteroglossic' (other- or different-voiced), in which the textual voice invokes, allows for, or in some way challenges other voices or viewpoints in the communicative context

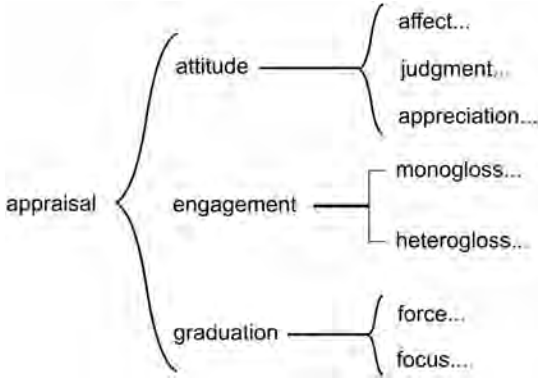


*Figure 2.2* System network for APPRAISAL (adapted from Martin and Rose 2003, 55, 2007, 59).

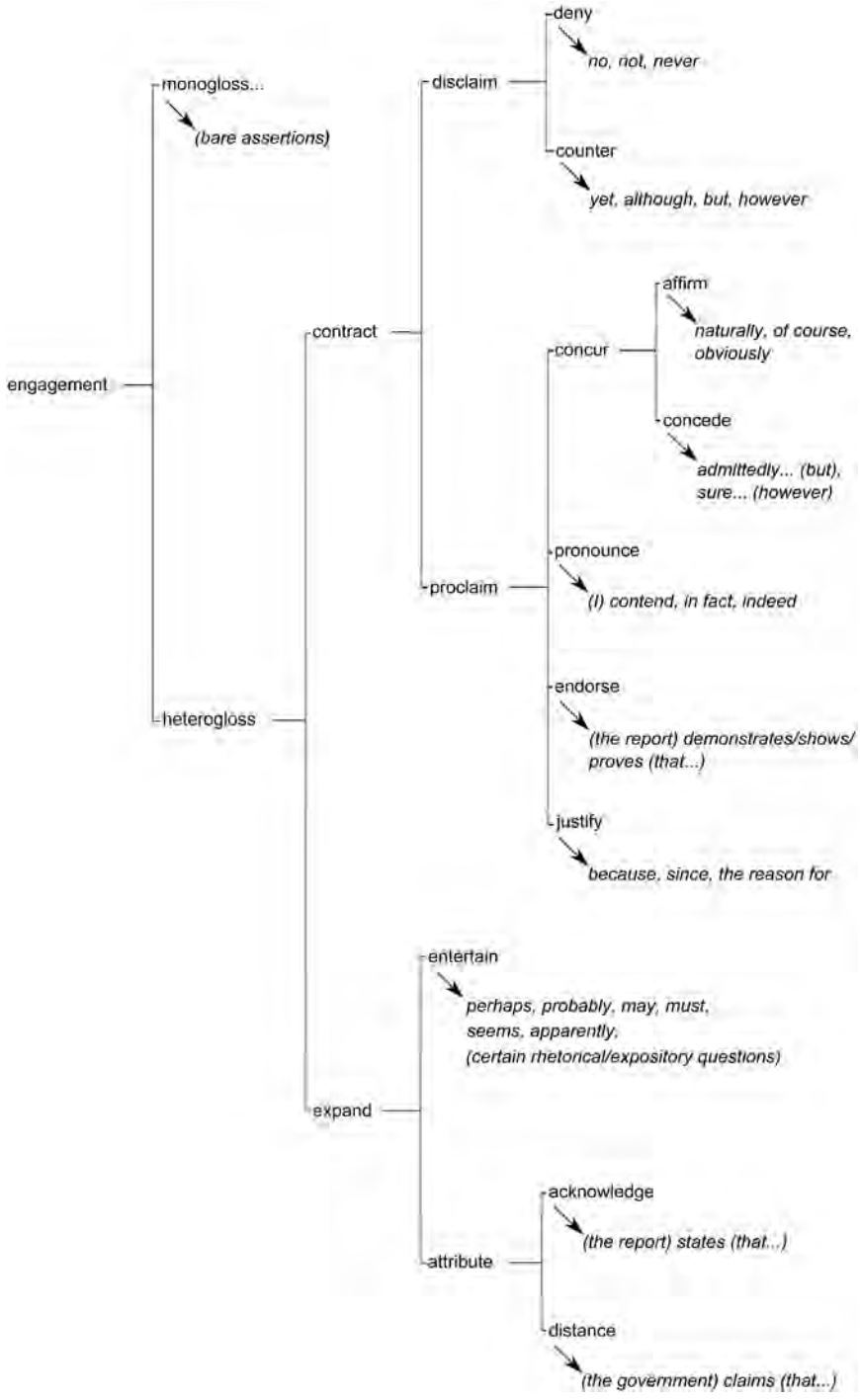


*Figure 2.3* System network for verbal ENGAGEMENT (adapted from Martin and White 2005, 134, White 2003, 2012, 65, Martin 2008, White and Don 2012).

(cf. Bakhtin 1981 [1935], 281, in Section 2.1). Both of these features function dialogically to 'align' or 'disalign' readers with the position or proposition advanced by the textual voice.

In the case of 'monoglossic' utterances, the textual voice presents a position or proposition as one that has no dialogic alternatives that need to be recognized or engaged with, at least for the brief textual moment (White 2003, 262–265; Martin and White 2005, 99). Bakhtin (1981 [1935], 342–343) refers to this type of utterance as "authoritative […] permit[ting] no play with the context framing it, no play with its borders". A bare assertion like *The banks have been greedy* (example from Martin and White 2005, 100) may, on the one hand, be assumed to be 'taken for granted' (Martin and White 2005, 98–102).[9] That is, the assertion construes for the text an addressee who shares or is expected to share a particular position with the writer or speaker, a position of 'alignment' or alliance that may not need further clarification or justification. On the other hand, the same proposition may be 'at issue' or 'open for discussion', perhaps as part of a controversial claim or polemic. In that case, the utterance might construe for the text a 'disalignment' or antagonism between the position of the audience and that of the textual voice, one that may require further support or clarification as the text unfolds (Martin and White 2005, 101–102).

'Heteroglossic' utterances, in contrast, invoke dialogic alternatives, variously opening up ('expanding') or closing down ('contracting') the dialogic space for other voices in the text. 'Expansive' resources generally indicate that propositions are grounded in the subjectivity of the textual voice and are therefore one among a number of actual or possible alternatives ([expand: entertain]); they can also signal that a particular proposition belongs to or is associated with some external source ([expand: attribute]). 'Contractive' resources 'deny' or 'counter' alternative positions or propositions ([contract: disclaim]); they may also 'endorse', 'justify', 'pronounce', or 'concur' with a particular proposition ([contract: proclaim]), maximizing its validity or warrantability in comparison with alternatives. Examples of these 'heteroglossic' resources are shown in (2.1)–(2.7).[10] For further examples, see Figure 2.3.

(2.1) Difficult, grumpy babies who cry a lot are a challenge and this *may* affect bonding. [entertain]

(2.2) *One study reported* an association between Pb and BMI (*Zagrodzki et al. 2003*). [attribute: acknowledge]

(2.3) This difference, *however*, was *not* translated to an increased velocity *nor* an improved energy expenditure during free walking. [disclaim: counter] [disclaim: deny]

(2.4) This result was *obviously* of considerable concern. [proclaim: concur]

(2.5) Attempts have been made to deal with the issue of violence in the past, but these initiatives appear to have had little or no long term impact. *In fact* it seems to be getting worse. [proclaim: pronounce]

(2.6) *Various studies show* these sugars are considerable triggers of gastrointestinal symptoms in patients with IBS individually or in combination. [proclaim: endorse]

(2.7) Letters X and Y were skipped *because* of confusion with human chromosomes and letter O *because* of visual similarity with 0 (zero). [proclaim: justify]

Like [monogloss], 'heteroglossic' resources can variously 'align' or 'disalign' the textual voice and the reader. The type and degree of 'alignment' depends largely on the interplay of co-text and context as well as the individual experiences, beliefs, and values of the reader. If a writer anticipates that a proposition will be problematic for the reader, additional resources may be deployed to mitigate the threat of 'disalignment' and to help build or maintain writer–reader solidarity. In other cases, the textual voice may actively seek to 'disalign' itself from the reader, perhaps as part of a polemic or controversial argument. Such moments of 'disalignment' may be fleeting if the writer wants to convince the reader of the merits of a particular position or point of view. While all instances of [engagement], individually or in combination with other resources, can serve to 'align' or 'disalign' the writer and reader, the potential for 'disalignment' is likely to be greatest for those [engagement] resources that imply a relatively high level of personal commitment to, support for, or rejection of particular positions, such as [disclaim], [concur], [pronounce], [endorse], and [distance].

### *2.4.2 The Lexicogrammar of Engagement: Projection, Modality, and Concession*

A diverse set of verbal resources can be used to construe [engagement], as can be seen from examples (2.1)–(2.7) and Figure 2.3. In their analyses of evaluative language, Martin and Rose (2003, 2007) and Hood (2010) organize these seemingly disparate lexicogrammatical resources into three basic categories: projection, modality, and concession.

Projection allows us to quote, summarize, or paraphrase what we or others have said or thought, most typically using reporting clauses like that in (2.6). Projections can also take the form of integral and nonintegral references (see (2.2)), quotation marks or scare quotes (see (2.8), from Martin and Rose (2007, 52)), and nominalized projections (see (2.9), from Hood (2010, 182)).

(2.8) The role of 'those at the top', the 'cliques' and 'our men' who simply had to carry out their bloody orders.

(2.9) Anderson (2004) offers a number of *suggestions*. First, … . Secondly, … . Finally, … .

Modality—the expression of probability, usuality, obligation, and inclination—is typically realized by modal auxiliaries and other modalizing or

modulating resources. Martin and Rose (2003, 2007) and Hood (2010) also include the resources of polarity (negation, bare assertions), where polarity represents the outer limits or poles of the modal space. From a dialogic perspective, modality allows us to introduce additional voices into a text (Martin and Rose 2007, 53) by acknowledging or rejecting alternative propositions and positions in the discourse (see examples (2.1) and (2.3)). In the case of 'monoglossic' bare assertions, potential alternatives are ignored.

Under the heading of concession, Martin and Rose (2003, 2007) and Hood (2010) group together resources that express counterexpectancy. These include certain conjunctions, conjuncts, and adjuncts (e.g. *but*, *however*) as well as continuatives (e.g. *still*, *only*, *just*). Examples of concession can be seen in (2.3) and (2.5) above.

The dialogic functionality of projection, modality, and concession varies, as do their effects on writer–reader 'alignment'. However, organizing verbal [engagement] resources in this way allows for a more systematic comparison with previous studies that may have examined modality, projection, or concession in medical research discourse, but may not have done so from an explicitly dialogic perspective (see Section 3.1 in Chapter 3).

### *2.4.3 Visual Engagement*

Several studies adapt the work of White (2003), Martin and Rose (2003, 2007), and/or Martin and White (2005) to account for the visual construal of [engagement] (e.g. Chen 2008, 2009, 2010, Economou 2009, Tan 2010, Feng and Wignell 2011). Most of those studies also draw upon the work of O'Toole (1994) and/or Kress and van Leeuwen (1996, 2006) (see Section 2.3).[11]

Economou (2009), for example, proposes a system of ENGAGEMENT based on the meaning potential of newspaper photographs. The system recognizes as 'monoglossic' those news photographs that are unmarked "naturalistic congruent visual representations of material reality", in which the subjectivity of the textual voice (the image-producer) or any external voices is backgrounded and the image is presented as more or less "objective and true" (Economou 2009, 203). With regard to other-voicedness, newspaper photography does not generally construe the [heterogloss: contract] feature/subsystem of verbal [engagement] (see Economou 2009, 202, 215) (cf. Figure 2.3). It can, however, express [heterogloss: expand]. Images can [attribute] certain meanings to other sources in two basic ways according to Economou (2009, 204–209): (1) by 'incorporating' the visual attitude of represented participants (e.g. clapping as a realization of approval) or the visual quote of an embedded visual/verbal text (e.g. a placard held by a demonstrator), or (2) by 'substituting' the entire news photograph for another external image. (A naturalistic photograph of a painting might be a typical example of this.) News photographs can also construe [entertain], by foregrounding the subjectivity of the textual voice. This can be done, according

to Economou (2009, 214), through "marked ideation", where depictions of people, objects, or places are represented in "atypical or unrepresentative" ways, or through "marked expression", where certain textural or spatial choices give a sense of the unreal or surreal—basically anything that diverges from a naturalistic or typical-for-news representation. Economou (2009) also extends the ENGAGEMENT system to include photographs that, in some way, [suggest] another type of text or image, e.g. those suggestive of art photography or frames from popular cinema or television drama (Economou 2009, 236).[12]

Other studies, e.g. Lemke (1998), O'Halloran (2005), Chen (2008, 2009, 2010), Tan (2010), Feng and Wignell (2011), and Painter et al. (2013), provide additional examples of visual dialogic resources, from a variety of fields and text-types (mathematics, school textbooks, advertising, and children's picture books). They include speech/thought bubbles that [expand: attribute], interactive hypertext objects and graph error-bars that [expand: entertain], various colour/font highlights, verbal labels, and "positive" facial expressions that [contract: proclaim: pronounce/endorse], and depiction styles that construe varying degrees of emotional distance.[13,14] Some images, or parts thereof, can also construe [contract: disclaim], by depicting and then rejecting or countering certain inappropriate or undesired behaviour, e.g. the widely recognized no-smoking sign with its red line across a smoking cigarette. All these options are presented in the form of a system network, in Figure 2.4. Like Figure 2.3, the system network shows typological relations between features or options in the system, as well as examples

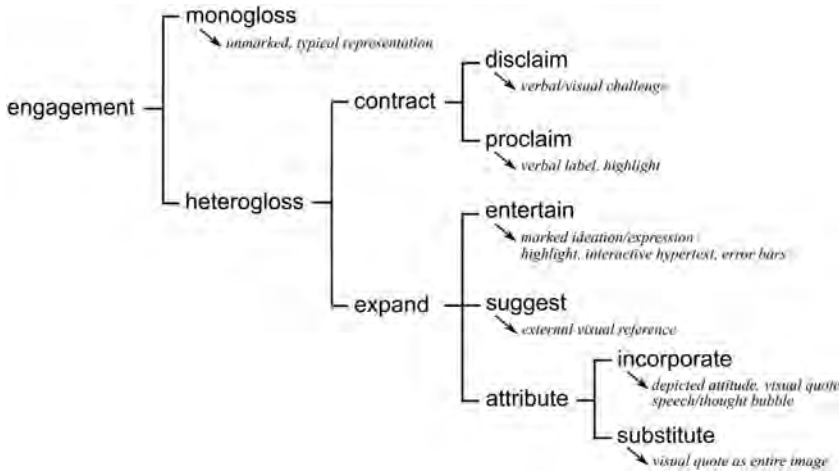


*Figure 2.4* System network for visual ENGAGEMENT (adapted from Economou (2009), Lemke (1998), O'Halloran (2005), Chen (2008, 2009, 2010), Tan (2010), and Feng and Wignell (2011)).

of their realization (in italics), i.e. "from below" in the visual grammar or expression plane.

### *2.4.4 Mathematical Engagement*

O'Halloran's (2005) systemic-functional analysis of mathematical discourse examines the verbal, visual, and symbolic construal of mathematical meanings (see Section 2.3) and includes an account of mathematical-visual [engagement] (cf. previous section on visual [engagement]). Based on the work of O'Toole (1994) and Martin and Rose (2003), O'Halloran (2005, 139–142) argues that choices of colour and shading, line widths and styles, labels, perspective, positioning, and size contribute to the relative salience or 'prominence' of certain figures or episodes within a work. These are choices that direct the reader's attention to particular parts of the visual display, those that the textual voice regards as being most warrantable or important (cf. verbal [pronounce]). O'Halloran (2005, 141–142) also argues that "[t]he perfection and exactness of the visual displays, the lack of contextual information, the Style of Production and the metaphorical and abstract nature of the Episodes, Figures and their Parts" give mathematical-visual representations high modality and a level of certainty that may be "difficult to counter".

Mathematical-verbal and mathematical-symbolic [engagement] are not explicitly discussed by O'Halloran (2005). However, the book's treatment of interpersonal meaning in general in mathematical language and mathematical symbolism provides useful insights into how mathematical-verbal and mathematical-symbolic [engagement] might be enacted. The language of mathematics, for example, generally lacks the kind of modalization or modulation discussed in Sections 2.4.1 and 2.4.2, preferring instead polar-positive and polar-negative statements (cf. verbal [monogloss] and [disclaim: deny], respectively) and construing for the discourse "an unqualified level of certainty" (O'Halloran 2005, 72) and a sense of rational truth (O'Halloran 2005, 74). Similarly, mathematical symbolism "is concerned largely with descriptive statements and a more restricted sense of commands" (O'Halloran 2005, 114), and modal meanings referring to probability, usuality, obligation, and inclination "are typically excluded" (O'Halloran 2005, 115). However,

> choices for MODALITY in the form of probability may be realized through symbolic statements for measures of probability; for example, levels of significance: $p<0.5$ (where the notion of uncertainty is quantified) and different forms of approximations.
>
> O'Halloran (2005, 115)

Symbols like $p$ and $\approx$ encode [entertain], opening up the dialogic space for alternatives, albeit in a potentially narrower sense than that construed by language and images (see Sections 2.4.1–2.4.3). Extending these ideas to other

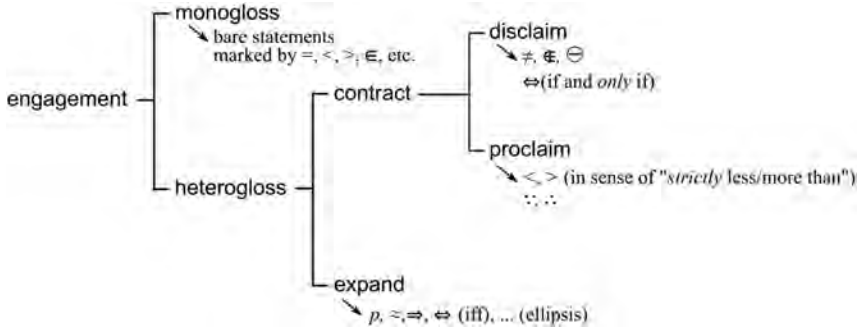


*Figure 2.5* System network for mathematical-symbolic ENGAGEMENT.

mathematical symbols, the negative polarity expressed by a slash through a process symbol, e.g. ≠, could be taken to construe [contract: disclaim], and logical relations such as *because/since* (∵) and *therefore/hence* (∴) may construe [contract: proclaim]. Mathematical-symbolic statements or clauses without those resources—i.e. binary relations or bare assertions typically marked with process symbols such as = and ∈—are considered 'monoglossic'. A system network for mathematical-symbolic ENGAGEMENT is proposed in Figure 2.5.[15]

## Notes

1 The "Bakhtin Circle" is a term commonly used to refer to the collective intellectual activities and works of Bakhtin, Vološinov, Medvedev, and others in 1920s and 1930s Soviet Russia (see Dentith 1995, Holquist 2002, Freedman and Ball 2004). The term also refers, at least obliquely, to an ongoing debate regarding the origin of certain works published under the names of Vološinov and Medvedev, and the disputed claim that those works may have been written by Bakhtin. For further discussion, see Dentith (1995, 8–10), Titunik (1986, 93–95, Preface in Vološinov 2012 [1976], xvii–xxi), Holquist (2002, 2, 207–209), and Clark and Holquist (1984, Chapter 6), among others.

2 Bakhtin also uses the terms "monoglossia" (*odnojazyčie*) and "polyglossia" (*mnogojazyčie*) to account for utterances that appear to be single- or multivoiced, respectively. According to Holquist, Bakhtin's use of polyglossia refers primarily to "[t]he simultaneous presence of two or more national languages interacting within a single cultural system" and differs from heteroglossia in type and quantity, although the two terms are often used together (Holquist in Bakhtin 1981 [1935], 430–431). Other terms related to and sometimes used interchangeably with heteroglossia are intertextuality and polyphony (see, for example, Kristeva 1984 and Nølke 1993, respectively).

3 The influence of systemic functional theory and other theories of language (e.g. cognitive linguistics) on the study of multisemiotic artefacts has prompted Bateman and others (Bateman, Delin, and Henschel 2004, Bateman 2008) to describe the field as "multimodal linguistics".

4 The example in Figure 2.1 shows the system network for POLARITY and the options of whether or not, in English at least, a clause is polar positive or polar negative (e.g. *X is/does* vs. *X isn't/doesn't*). POLARITY in English is more complicated than is suggested by the system network here—at increasing levels of delicacy, it includes where and how any negation is expressed (see Halliday and Matthiessen 2004, 23)—but these two entry-level choices (positive/negative) should suffice for exemplifying the axial relations of system and structure. (Note that systemic functional theory typically indicates system names using small caps. I follow this convention throughout the book.)

5 Doran (2016, 166–169) takes this observation a step further by arguing that there is no evidence for distinct interpersonal paradigmatic systems for mathematical symbolism, and that "what is interpersonal in language can be seen as quantified and ideationalised in mathematics" (Doran 2016, 168).

6 In Figure 2.2, curly brackets indicate potentially simultaneous options or subsystems at the same level of delicacy; square brackets indicate alternatives from which only a single option or subsystem can be selected; ellipses indicate that the option leads to further suboptions or subsystems of increasing delicacy, but they have been elided, usually for the sake of simplicity. Selections within system networks are often represented as a series of interrelated choices, as movement through the system. The selection or instantiation of a heteroglossic resource can be represented as [appraisal: engagement: heterogloss], or more simply as [heterogloss] or 'heterogloss'. I follow this convention throughout the book.

7 Lemke (1998, 105–106) and Baldry and Thibault (2006, 89–90) identify three types of stance or positioning: (1) the stance a text adopts towards its own presentational content (e.g. importance, warrantability, usuality/typicality); (2) the stance a text adopts towards its prospective readers (e.g. solidarity, antagonism, deference, condescension); and (3) the stance a text adopts towards the other texts that it invokes (e.g. opposition, alliance, complementarity). Although this chapter focuses primarily on the work of Martin and White (2005), Lemke's (1988, 1995, 1998, 2002) discussions of heteroglossia, heteroglossic relations, and intertextual thematic formations provide a useful supplementary and complementary perspective.

8 Note the potential similarities here between alignment/disalignment and compliant/resistant readings (see Martin and Rose 2007, 310).

9 In terms of ATTITUDE, *greedy* instantiates negative [judgment: propriety] or negative [appreciation].

10 Extracts (2.1)–(2.7) are selected from the academic-medicine section of the Corpus of Contemporary American English (see Davies 2008).

11 In O'Toole's (1994) study of the language of visual art (see Section 2.3), *all* interpersonal meaning is essentially a mode of engagement: a painting, for example, *engages* our attention, thoughts, and emotions, "drawing us into the world of the painting, and colouring our view of that world" (O'Toole 1994, 5). A number of interpersonal systems are potentially in operation when an artist or a work "engage[s] the attention and emotional involvement of the viewer" (O'Toole 1994, 12). For O'Toole, these include the RHYTHM, GAZE, FRAME, LIGHT, PERSPECTIVE, COLOUR, and MODALITY of the painting or parts thereof.

12 O'Toole (1994, 105) suggests a similar function, 'intertextuality' (cf. Kristeva 1984), in which "the design knowingly refers to, mimics or contrasts with other 'texts' of its genre".

13 In Halloran's (2005) study of mathematics, colours and other graphic highlights are said to give 'prominence', indicating which episodes or figures a reader ought to pay most attention to (treated as approximately equivalent to [contract: proclaim] in this book). In Chen's (2009) study of EFL school textbooks, however, the use of colour or bold in verbal texts is dialogically 'expansive' rather than

'contractive', indicating possible options for answers (i.e. [entertain]) or the presence of the editor's voice (i.e. [attribute]) (Chen 2009, 117–118).

14 Painter, Martin, and Unsworth's (2013, 30–35) account of depiction styles in children's picture books is part of a system they refer to as PATHOS. Depiction styles vary from minimalistic to hyper-real and help to construe different types of emotional engagement or alignment with the reader.

15 In Figure 2.5, the symbol $\ominus$ describes a relation between sets that includes the objects that belong to those sets but not their intersections, usually referred to as symmetric difference. The symbols $\therefore$ and $\because$ generally represent the logical relations *therefore* and *because*. The symbols $\in$ and $\notin$ indicate membership or non-membership of a group, i.e. the relation *is (not) an element of*. The symbols $\Rightarrow$ and $\Leftrightarrow$ represent *implies* (or *if... then*) and *iff* (or *if and only if*), respectively.

## References


Bakhtin, Mikhail Mikhailovich. 1981 [1935]. *The Dialogic Imagination: Four Essays*. Translated by Caryl Emerson and Michael Holquist. Edited by Michael Holquist. Austin, TX: University of Texas Press.

Bakhtin, Mikhail Mikhailovich. 1986. *Speech Genres and Other Late Essays*. Translated by Vern W. McGee. Austin, TX: University of Texas Press.

Bakhtin, Mikhail Mikhailovich, and Pavel Nikolaevich Medvedev. 1978 [1928]. *The Formal Method in Literary Scholarship: A Critical Introduction to Sociological Poetics*. Translated by Albert J. Wehrle. Baltimore, MD: Johns Hopkins University Press.

Baldry, Anthony, and Paul J. Thibault. 2006. *Multimodal Transcription and Text Analysis*. London: Equinox.

Bateman, John A. 2008. *Multimodality and Genre: A Foundation for the Systematic Analysis of Multimodal Documents*. Basingstoke: Palgrave Macmillan.

Bateman, John, Judy Delin, and Renate Henschel. 2004. "Multimodality and empiricism: preparing for a corpus-based approach to the study of multimodal meaning-making." In *Perspectives on Multimodality*, edited by Eija Ventola, Cassily Charles and Martin Kaltenbacher, 65–87. Amsterdam: John Benjamins.

Bezemer, Jeff, and Gunther Kress. 2014. "Touch: a resource for making meaning." *Australian Journal of Language and Literacy* 37 (2):77–85.

Chen, Yumin. 2008. "Heteroglossic harmony: multimodal ENGAGEMENT resources and their gradability in China's EFL context." In *Proceedings of ISFC 35: Voices around the World*, edited by Canzhong Wu, Christian M. I. M. Matthiessen and Maria Herke, 296–301. Sydney: The 35th ISFC Organizing Committee.

Chen, Yumin. 2009. "Interpersonal meaning in textbooks for teaching English as a foreign language in China: a multimodal approach." PhD thesis, University of Sydney.

Chen, Yumin. 2010. "Exploring dialogic engagement with readers in multimodal EFL textbooks in China." *Visual Communication* 9 (4):485–506.

Clark, Katerina, and Michael Holquist. 1984. *Mikhail Bakhtin*. Cambridge, MA: Belknap Press of Harvard University Press.

Davies, Mark. 2008. "The Corpus of Contemporary American English (COCA)." https://www.english-corpora.org/coca/.

Dentith, Simon. 1995. *Bakhtinian Thought: An Introductory Reader*. London: Routledge.

Doran, Yaegan John. 2016. "Knowledge in physics through mathematics, image and language." PhD thesis, Department of Linguistics, University of Sydney.

Economou, Dorothy. 2009. "Photos in the news: appraisal analysis of visual semiosis and verbal-visual intersemiosis." PhD thesis, University of Sydney.

Feng, Dezheng, and Peter Wignell. 2011. "Intertextual voices and engagement in TV advertisements." *Visual Communication* 10 (4):565–588.

Freedman, Sarah Warshauer, and Arnetha F. Ball. 2004. "Ideological becoming: Bakhtinian concepts to guide the study of language, literacy, and learning." In *Bakhtinian Perspectives on Language, Literacy, and Learning*, edited by Arnetha F. Ball and Sarah Warshauer Freedman, 3–33. Cambridge: Cambridge University Press.

Halliday, M. A. K. 1978. *Language as Social Semiotic: The Social Interpretation of Language and Meaning*. London: Edward Arnold.

Halliday, M. A. K. 1994. *An Introduction to Functional Grammar*. 2nd ed. London: Arnold.

Halliday, M. A. K. 2002 [1996]. "On grammar and grammatics." In *On Grammar. Volume 1 in the Collected Works of M. A. K. Halliday*, edited by Jonathan J. Webster, 384–417. London: Continuum.

Halliday, M. A. K. 2003 [1993]. "Language in a changing world." In *Volume 3 in the Collected Works of M. A. K. Halliday. On Language and Linguistics*, edited by Jonathan J. Webster, 213–231. London: Continuum.

Halliday, M. A. K. 2007 [1991]. "The notion of 'context' in language education." In *Language and Education. Volume 9 in the Collected Works of M. A. K. Halliday*, edited by Jonathan J. Webster, 269–290. London: Continuum.

Halliday, M. A. K. 2013. "Meaning as choice." In *Systemic Functional Linguistics: Exploring Choice*, edited by Lise Fontaine, Tom Bartlett and Gerard O'Grady, 15–36. Cambridge: Cambridge University Press.

Halliday, M. A. K., and Ruqaiya Hasan. 1985. *Language, Context, and Text: Aspects of Language in a Social-Semiotic Perspective*. Geelong: Deakin University.

Halliday, M. A. K., and Christian M. I. M. Matthiessen. 2004. *Introduction to Functional Grammar*. 3rd ed. London: Arnold.

Hasan, Ruqaiya. 1992. "Speech genre, semiotic mediation and the development of higher mental functions." *Language Sciences* 14 (4):489–528.

Hodge, Robert, and Gunther Kress. 1988. *Social Semiotics*. Cambridge: Polity Press.

Holquist, Michael. 2002. *Dialogism: Bakhtin and His World*. 2nd ed. London: Routledge.

Hood, Susan. 2004. "Appraising Research: Taking a Stance in Academic Writing." PhD thesis, Faculty of Education, University of Technology.

Hood, Susan. 2010. *Appraising Research: Evaluation in Academic Writing*. Basingstoke: Palgrave Macmillan.

Kress, Gunther. 2010. *Multimodality: A Social Semiotic Approach to Contemporary Communication*. Abingdon: Routledge.

Kress, Gunther, and Theo van Leeuwen. 1996. *Reading Images: The Grammar of Visual Design*. London: Routledge.

Kress, Gunther, and Theo van Leeuwen. 2006. *Reading Images: The Grammar of Visual Design*. 2nd ed. Abingdon: Routledge.

Kristeva, Julia. 1984. *Desire in Language: A Semiotic Approach to Literature and Art*. London: Blackwell.

Lemke, Jay L. 1998. "Multiplying meaning: visual and verbal semiotics in scientific text." In *Reading Science: Critical and Functional Perspectives on Discourses of Science*, edited by J. R. Martin and Robert Veel, 87–113. London: Routledge.

Lemke, Jay L. 2002. "Mathematics in the middle: measure, picture, gesture, sign, and word." In *Educational Perspectives on Mathematics as Semiosis: From Thinking to Interpreting to Knowing*, edited by M. Anderson, A. Saenz-Ludlow, S. Zellweger and V. Cifarelli, 215–234. Ottawa: Legas Publishing.

Lim, Victor Fei. 2004. "Developing an integrative multi-semiotic model." In *Multimodal Discourse Analysis: Systemic Functional Perspectives*, edited by Kay L. O'Halloran, 220–246. London: Continuum.

Martin, J. R. 1992. *English Text: System and Structure*. Amsterdam: John Benjamins.

Martin, J. R. 2008. "Innocence: realization, instantiation and individuation in a Botswanan town." In *Questioning Linguistics*, edited by A. Mahboob and N. K. Knight, 32–76. Newcastle: Cambridge Scholars.

Martin, J. R., and David Rose. 2003. *Working with Discourse: Meaning Beyond the Clause*. London: Continuum.

Martin, J. R., and David Rose. 2007. *Working with Discourse: Meaning Beyond the Clause*. 2nd ed. London: Continuum.

Martin, J. R., and P. R. R. White. 2005. *The Language of Evaluation: Appraisal in English*. Basingstoke: Palgrave Macmillan.

Matthiessen, Christian M. I. M. 2007. "The 'architecture' of language according to systemic functional theory: developments since the 1970s." In *Continuing Discourse on Language: A Functional Perspective*, edited by Ruqaiya Hasan, Christian Matthiessen and Jonathan Webster, 505–561. London: Equinox.

Matthiessen, Christian M. I. M. 2015. "Register in the round: registerial cartography." *Functional Linguistics* 2 (1):1–48. doi: 10.1186/s40554-015-0015-8.

Matthiessen, Christian M. I. M., Kazuhiro Teruya, and Marvin Lam. 2010. *Key Terms in Systemic Functional Linguistics*. London: Continuum.

Mwinlaaru, Isaac Nuokyaa-Ire. 2017. "Bridging boundaries across genre traditions: a systemic functional account of generic patterns in biodata." *Functions of Language* 24 (3):259–293. doi: 10.1075/fol.15017.mwi.

Nølke, Henning. 1993. *Le regard du locuteur: Pour une linguistique des traces énonciatives*. Paris: Editions Kimé.

O'Halloran, Kay L. 2005. *Mathematical Discourse: Language, Symbolism and Visual Images*. London: Continuum.

O'Toole, Michael. 1994. *The Language of Displayed Art*. London: Continuum.

Painter, Claire, J. R. Martin, and Len Unsworth. 2013. *Reading Visual Narratives: Image Analysis of Children's Picture Books*. Sheffield: Equinox.

Royce, Terry D. 2002. "Multimodality in the TESOL classroom: exploring visual-verbal synergy." *TESOL Quarterly* 36 (2):191–205. doi: 10.2307/3588330.

Royce, Terry D. 2007. "Intersemiotic complementarity: a framework for multimodal discourse analysis." In *New Directions in the Analysis of Multimodal Discourse*, edited by Terry D. Royce and Wendy L. Bowcher, 63–109. Mahwah, NJ: Lawrence Erlbaum Associates.

Saussure, Ferdinand de. 1959 [1915]. *Course in General Linguistics*. Translated by Wade Baskin. New York: Philosophical Library.

Tan, Sabine. 2010. "Modelling engagement in a web-based advertising campaign." *Visual Communication* 9 (1):91–115. doi: 10.1177/1470357209352949.

Titunik, I. R. 1986. "The Baxtin problem: concerning Katerina Clark and Michael Holquist's *Mikhail Bakhtin*." *The Slavic and East European Journal* 30 (1):91–95. doi: 10.2307/307282.

van Leeuwen, Theo. 1999. *Speech, Music, Sound*. Basingstoke: Macmillan.

van Leeuwen, Theo. 2005. *Introducing Social Semiotics*. Abingdon: Routledge.

Vološinov, Valentin N. 1973 [1929]. *Marxism and the Philosophy of Language*. Translated by Ladislav Matejka and I. R. Titunik. Cambridge, MA: Harvard University Press.

White, Peter R. R. 1998. "Telling media tales: the news story as rhetoric." PhD thesis, Department of Linguistics, University of Sydney.

White, Peter R. R. 2003. "Beyond modality and hedging: a dialogic view of the language of intersubjective stance." *Text* 23 (2):259–284.

White, Peter R. R. 2012. "Exploring the axiological workings of 'reporter voice' news stories: attribution and attitudinal positioning." *Discourse, Context & Media* 1:57–67.

White, Peter R. R., and Alexanne Don. 2012. "The appraisal website." accessed February 9, 2015, last modified June 15, 2012. http://www.grammatics.com/appraisal/index.html.

# 3 Medical Research Discourse
## An Overview

Medicine and medical science play a central role in most societies. There are few disciplines and practices that can be said to have such a fundamental social, political, and economic influence on human lives and livelihoods. As Lock (1988, 8) notes, "the study of health, illness, and medicine provides us with one of the most revealing mirrors for understanding the relationship between individuals, society, and culture". This chapter presents and discusses some of those relationships by examining more closely the discourse of scientific medical research. We'll focus in particular on the construal of dialogue, disciplinarity, and ideology in medical research and practice.

### 3.1 Knowledge and Knowers in Medical Research

Modern medicine appears to be at the intersection of the formal, natural, social, and human sciences (Matthiessen 2013, 459–461). Its disciplinary boundaries traverse traditional knowledge-community categories such as "hard", "soft", "pure", and "applied" (Biglan 1973, Kolb 1981, Becher 1987, 1990, 1994, Becher and Trowler 2001), making medicine a potentially multi- or cross-disciplinary field. Scientific-medical research draws on the discoursal practices of other fields or disciplines, singular discourses such as biology, chemistry, and mathematics (Bernstein 1996, 23, 65–66), creating an interface between those disciplines and their practical and technological application or "exploitation", and creating new objects of analysis (Habermas 1987 [1968], Wright and Treacher 1982, 7, Osborne 1998, 261, cf. the "hard-applied" categorization of Becher and Trowler 2001, 35–36). Moreover, medicine is often referred to as both a science and an art (*ars medica*), involving systematic experimentation and observation as well as personal experience, intuition, and interpretation (see, for example, Gordon 1988a, Herman 2001, Malterud 2001, Gotti and Salager-Meyer 2006, 9). This potential hybridity may represent a challenge when describing and analysing the disciplinarity of medicine and the mechanisms involved in the social construction of knowledge in this field. Applied-linguistic, discourse-analytic, and social- and cultural-anthropological studies of medical discourse variably describe medicine as a "hard" or "soft" science—or

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something in-between—depending on the features under investigation and, in certain studies, the kinds of fields or discourses being compared.

Hu and Wang's (2014) cross-disciplinary and cross-linguistic study of citation practices, for example, suggests that medical research discourse operates in a relatively narrow dialogic space, where the scope for alternative voices and propositions is generally restricted. Hu and Wang (2014) and others (e.g. Dahl 2004, Fløttum et al. 2006) argue that the use of non-integral references—in which authors or studies are referred to parenthetically or in footnotes/endnotes—and the choice of reporting verb when citing others—e.g. *report*, *show*, *find*, and *demonstrate* (compared with, say, *argue*, *claim*, *propose*, and *suggest*)—reflect a predominantly positivist epistemology in which propositions are framed as more or less factual information and human agency is downplayed. Historically, the development of citation practices in medicine (as with science more generally) is suggestive of increasingly specialized and objectified ways of knowing and meaning (Salager-Meyer 1999).

Studies of personal pronouns, negative polarity, and concession (e.g. Breivega et al. 2002, Fløttum 2006, Fløttum et al. 2006) suggest a similarly "hard" science, with relatively little explicit reference to authors and researchers, and less multi-voiced negation and concession compared with other fields. The use (or relative "underuse") of those resources implies a discourse in which the presence of other voices and propositions is generally minimized.

Some studies of modality and hedging, on the other hand, suggest a somewhat "softer" science and a dialogic space that is generally more 'expansive' and more inclusive of alternative voices and propositions. Yang et al. (2015), for example, argue that the frequent use of low- and median-modality resources in medical research writing (e.g. *may*, *suggest*, and *probably*) is indicative of a general need to mitigate claims, highlighting what might be a relative lack of precision and reliability in medical data compared with "hard sciences" (Yang et al. 2015, 6). In a study of pronominal references across several disciplines, including a specific branch of medicine (urology), Lafuente Millán (2010, 41–42) notes that the relatively high frequency of third-person plural references in medicine may not conform with the "impersonal and objective writing style" typically associated with the hard sciences. Similarly, Li and Gi (2009) observe that the use of third-person plural pronouns has increased over time in medical research writing. They argue, among other things, that this development could reflect changes in medical research practice, in which agency and responsibility are made more explicit and connectivity and solidarity with the discourse community are given greater emphasis (Li and Ge 2009, 102).

In terms of the visual construal of meaning, several studies examine the use of graphs and other visual inscriptions in scientific-medical discourse. For example, based on the work of Latour (e.g. Latour and Woolgar 1986, Latour 1986, 1987, 1990)—and Latour's (1990) claim that graphs and

other visuals not only play a central role in the construction and communication of scientific knowledge, but are also part of what defines and distinguishes science from other forms of intellectual activity—Smith et al. (2000) and Arsenault et al. (2006) note that "graph use" corresponds with perceived scientific hardness; that is, the more graphs, and the more space for those graphs, the harder the scientific field. Medicine uses more graphs and other visual inscriptions than psychology, economics, and sociology, but generally fewer than physics, chemistry, and biology—although "table use" alone is greater in medicine than any of those other disciplines (Arsenault et al. 2006, 398). Visual display (or "graphism", as Latour calls it) is crucial to the construction of (hard) scientific knowledge, and is an important part of "the visual impulse in science – the drive for ocular proof, to show how things are, even when those things cannot actually be seen" (Golinski 2005 [1998], 145–146, also cited in Arsenault et al. 2006, 377). Lynch (1985, 37) describes visual inscriptions such as photographs, diagrams, and graphs as "documents which enable objects of study to be initially perceived and analyzed". They "systematically transform specimen materials into observable and mathematically analyzable data" (Lynch 1985, 37). They allow researchers to identify and interpret patterns in the data in ways that are not always possible (or far more difficult) verbally and/or numerically, but they can also suggest relations that are not necessarily part of the data, e.g. the kinds of relations implied by consecutive data-points in a line-graph (see Jones 2013, 54). Hirschauer (1991) notes a similar kind of transformation or abstraction in a study comparing visual representations of the human body with the actual patient-bodies of the operating theatre. Hirschauer (1991) considers, among other things, the anatomical bodies in textbooks and research articles not only as abstractions of patient-bodies, but as possible "aesthetic model[s]" (Hirschauer 1991, 312) for what the patient-body should look like and how it should be treated.

Other studies of the visuality of scientific-medical discourse include the use of colour, layout and spacing, and other visual parameters such as size and verisimilitude. Rowley-Jolivet's (2002, 2004) analyses of conference papers, for example, identify greatest image use (cf. "graph use" above) among medical research papers, compared with geology and physics papers. More of the images in medicine are figurative (e.g. photographs, X-rays, magnetic resonance images) rather than graphic or numerical (i.e. graphs, diagrams, and tables) and more are reproduced in colour compared with geology and physics. Rowley-Jolivet (2004, 153) notes that the use of colour in science is generally reserved for the coding of graphs or computer-modelled images, and that its use may otherwise be "felt to be merely ornamental" and more typical of scientific popularizations (cf. Kress and van Leeuwen 2006, 164). Scientific-medical discourse, however, seems to exploit certain interpersonal meanings associated with colour—creating visually attractive images for readers to engage with, for example—more explicitly than hard sciences like physics (see Dubois 1985, 42, Hirschauer

1991, 309, Rowley-Jolivet 2002, 26, 2004, Lupton 2003, 79). Size and lifelikeness are also important in this respect. Patients and experimental equipment are sometimes represented iconically at varying degrees of verisimilitude; sometimes they are visualized symbolically as circles, squares, or other geometric or abstract forms (Hirschauer 1991, 289, Vihla 1999, 109). The relative sizes of those representations may serve to foreground or background visual elements, together with other markers of saliency such as colour, placement, and framing (Dubois 1985, 42, cf. Kress and van Leeuwen 2006, 177). Reasons for these kinds of choices vary, but likely depend on the extent to which visual elements are meant to be understood as generalizations or as specific representations, and what relevance they might have for reproducibility and replication by the wider research community (Fryer 2019, 168–169).

As noted above, contemporary medical research is often concerned with quantifiable data and the mathematical modelling of those data. Mathematical terms and symbols like *confidence interval* and *p(-value)*, and the quantification of those terms, can play an important role in construing the uncertainty and provisionality of scientific-medical knowledge (Vihla 1999, 96), opening up dialogic space for alternative propositions (Fryer 2013, 199). Those same terms, symbols, and numbers can also imbue research with a certain "epistemological authority" (Danisch and Mudry 2008, 130, cited in Jones 2013, 40), one that appears to be ideologically neutral and relatively free from human bias, and thus dialogically 'contractive' or 'monoglossic' (cf. Bakhtin's authoritative discourse, Chapter 2, Section 2.4.1; Bakhtin 1981 [1935], 342). Historically, the process of quantification and mathematization in medical research is relatively recent (Jones 2013, 40), developing it seems with the institutionalization of medicine—the establishment of largescale teaching hospitals or clinics—and new ways of seeing the body and disease, what Foucault (1973 [1963]) calls the "medical gaze" (see also Lupton 2003, 25–26).

For Bernstein (1999, 171), the medical gaze transforms or recontextualizes the body into a "positivist object", allowing it to be seen in ways that are specific to scientific-medical discourse and that differ from other discourses and contexts. This positivist view of medicine is widely held, as several of the examples described above seem to attest, and may be useful as a way of understanding how medical science construes the world. From such a perspective, health and illness are largely considered natural phenomena, physical and biological processes or states that can be isolated, identified, studied, and managed. These processes and states can be measured empirically, through experimentation and observation, and investigated as rules or laws of nature. This is a world in which medical science represents a relatively objective and value-free body of knowledge, a dialogically 'contractive', 'monoglossic', or authoritative discourse. Social and political-economic aspects of health and disease are largely ignored or downplayed. When they do feature in scientific-medical studies, they generally appear as

quantifiable independent variables (Navarro 1980, 200, Comaroff 1982, 61, Gordon 1988b, 27).

Modern medicine, it seems, is dominated by the positivist or natural-science paradigm (Gordon 1988b, 22). For some scholars (Illich 1976, Navarro 1976a, b, 1980, Lock 1988, 3, inter alia), this paradigm intersects with an industrial-capitalist worldview in which (good) health is not only defined as "a state of complete physical, mental and social well-being" (WHO 1948), but also by a person's ability to work and their productivity (Waitzkin 1989). Lupton (2003, 65–70) sees these and other worldviews encoded in the kinds of metaphors used in medicine: the body as machine, disease as invasion, treatment as war, and so on (see also Navarro 1980, 199, Hirschauer 1991, 281–282, Jones 2013, 38–39). These metaphors are not only rhetorical devices, comparing the unfamiliar with the familiar; they are also "epistemological devices" that help shape the way we understand health, illness, and medicine, and the participants and processes involved in them (Lupton 2003, 61).

## 3.2 The Medical Research Article as Multisemiotic (Macro) Genre

The paradigmatic site for the contextualization of knowledge in modern medicine is the medical research article (MacDonald 2002) and, increasingly, the *English-language* medical research article (see Maher 1986, and Ferguson 2007 more generally for English as the current "language of science"). This particular text-type, with its highly formalized generic structure (see Sollaci and Pereira 2004), is sometimes described as "a direct reflection of the process of scientific discovery" (ICMJE 2008, 11). "It [the medical research article] creates the 'intellectual field' of medical epistemology in which knowledge is produced" (MacDonald 2002, 451) and is thus a primary site through which expert knowers engage (Maton 2007, 2014).

### *3.2.1 IMRaD: Introduction, Methods, Results, and Discussion*

Different parts of the medical research article perform different functions (MacDonald 2002, 453), and contemporary medical research articles tend to follow a standard format, usually referred to as IMRaD: Introduction, Methods, Results, and Discussion (see Sollaci and Pereira 2004).[1] This particular format is recommended by the International Committee of Medical Journal Editors (ICMJE 2008, 2010, 2013), commonly known as the Vancouver Group, a committee whose guidelines are endorsed by the editorial boards of more than 2000 medical research journals (ICMJE 2020).[2]

The 2008 *Uniform Requirements for Manuscripts Submitted to Biomedical Journals: Writing and Editing for Biomedical Publication* (ICMJE 2008, 12–13) recommends inclusion of the following in each of the four main sections of the medical research article.[3]

**[Introduction]**
Provide a context or background for the study (that is, the nature of the problem and its significance). State the specific purpose or research objective of, or hypothesis tested by, the study or observation; the research objective is often more sharply focused when stated as a question. Both the main and secondary objectives should be clear, and any prespecified subgroup analyses should be described. Provide only directly pertinent references, and do not include data or conclusions from the work being reported.

**[Methods]**
Describe your selection of the observational or experimental participants (patients or laboratory animals, including controls) clearly, including eligibility and exclusion criteria and a description of the source population. […] Identify the methods, apparatus (give the manufacturer's name and address in parentheses), and procedures in sufficient detail to allow others to reproduce the results. Give references to established methods, including statistical methods […]; provide references and brief descriptions for methods that have been published but are not well-known; describe new or substantially modified methods, give the reasons for using them, and evaluate their limitations. Identify precisely all drugs and chemicals used, including generic name(s), dose(s), and route(s) of administration. […] Describe statistical methods with enough detail to enable a knowledgeable reader with access to the original data to verify the reported results. When possible, quantify findings and present them with appropriate indicators of measurement error or uncertainty (such as confidence intervals). Avoid relying solely on statistical hypothesis testing, such as *P* values, which fail to convey important information about effect size. […] Define statistical terms, abbreviations, and most symbols. Specify the computer software used.

**[Results]**
Present your results in logical sequence in the text, tables, and illustrations, giving the main or most important findings first. Do not repeat all the data in the tables or illustrations in the text; emphasize or summarize only the most important observations. Extra or supplementary materials and technical detail can be placed in an appendix where they will be accessible but will not interrupt the flow of the text, or they can be published solely in the electronic version of the journal. […] When data are summarized in the Results section, give numeric results not only as derivatives (for example, percentages) but also as the absolute numbers from which the derivatives were calculated, and specify the statistical methods used to analyze them. Restrict tables and figures to those needed to explain the argument of the paper and to assess supporting data. Use graphs as an alternative to tables with many entries; do not

> duplicate data in graphs and tables. Avoid nontechnical uses of technical terms in statistics, such as "random" (which implies a randomizing device), "normal," "significant," "correlations," and "sample."
>
> **[Discussion]**
> Emphasize the new and important aspects of the study and the conclusions that follow from them. […] For experimental studies, it is useful to begin the discussion by summarizing briefly the main findings, then explore possible mechanisms or explanations for these findings, compare and contrast the results with other relevant studies, state the limitations of the study, and explore the implications of the findings for future research and for clinical practice. […] Link the conclusions with the goals of the study but avoid unqualified statements and conclusions not adequately supported by the data. […] Avoid claiming priority or alluding to work that has not been completed. State new hypotheses when warranted, but label them clearly as such.

Genre analyses of medical research articles (e.g. Skelton 1994, Nwogu 1997, Fryer 2012, Davis 2015) reveal similar stages and phases to those recommended by the ICMJE. Some of those stages or phases are considered obligatory; others are optional.

Introduction sections orient the reader to the object of study: they describe the field of study, identify a gap or niche in the field, and state the main research purpose(s). Despite the recommendations of the ICMJE (see above), some Introductions describe or highlight specific methods or results (see Nwogu 1997, 128, Fryer 2012, 14, Davis 2015, 86); some also explain the rationale or importance of the study (Skelton 1994, 456–457, Fryer 2012, 12–13).

Methods sections describe the material and explain how (and why) it was selected. They also recount the experimental and data-analysis procedures. Some, more recent articles include a conflict-of-interest statement (Fryer 2012, 20, Davis 2015, 90–92) in which authors declare any financial or personal relationships that may "inappropriately influence (bias) his or her actions" (ICMJE 2008, 4). Not all conflict-of-interest statements are part of the Methods section, however; some are dealt with under separate sections at the end of articles (Fryer 2012, 20).

Results sections report the main findings and their (in)consistencies with the aims or hypotheses of the study. The section includes references to and presentation of nonverbal or multisemiotic resources, usually in the form of graphs and/or tables. It may also include a description of any adjustments made to the data or data analysis (Skelton 1994, 457, Fryer 2012, 22) as well as an explanation or evaluation of selected findings (Skelton 1994, 457–458).

Discussion sections compare the study's findings with those of previous studies, offer explanations and discussions as to possible/probable

mechanisms and causes, and discuss the study's strengths and weaknesses. They also make recommendations for future research and/or practice-based activities or interventions. Some articles conclude with an overall summary of the study (see Nwogu 1997, 133–134).

A summary of the main stages and phases identified in Skelton (1994), Nwogu (1997), Fryer (2012), and Davis (2015), and their equivalent recommendations in the ICMJE (2008) guidelines, is provided in Table 3.1. As this summary shows, the generic structure of medical research articles is not fixed. Research articles exhibit individual variation, and the genre itself evolves over time, in response it seems to the changing needs of the discourse community (see Li and Ge 2009).

### *3.2.2 Other Stages of the Medical Research Article*

Although most genre studies of the medical research article focus on the stages described above, some also examine titles (Gledhill 1995b, León and Divasson 2006, Soler 2007, Wang and Bai 2007), abstracts (Salager-Meyer 1992, Gledhill 1995a, b, León and Divasson 2006), and acknowledgments (Salager-Meyer et al. 2006).

Titles summarize the main content of a research article; they play a key role in the organizing and retrieving of data; and they are an important factor in persuading readers to continue reading (Soler 2007, 91, Wang and Bai 2007, 389). Medical research article titles are typically nominal groups with relatively long or complex pre- and/or postmodification, e.g. *Acute liver failure caused by diffuse hepatic melanoma infiltration* (Soler 2007, 94). Nominal groups in titles are often longer and more complex than those in the Introduction, Methods, Results, and Discussion sections, a consequence it seems of the high conceptual density required of this short, obligatory generic segment (León and Divasson 2006). Less commonly, titles are "compounded" using a colon, and tend to follow what Swales and Feak (2004) call a general–specific structure, where "authors make a general presentation of the object of study and simultaneously indicate a specificity of such study" (Soler 2007, 99). Titles may also be formulated as declarative or interrogative clauses, or as a combination of "compounded" and clausal types, e.g. *Viral infection, inflammation, and the risk of idiopathic dilated cardiomyopathy: can the fire be extinguished?* (Soler 2007, 100). Clausal or full-sentence titles appear to be becoming more common, perhaps because of the "increasing independence of the title and abstract as 'stand-alone' text types" (Jaime-Sis 1993, in Gledhill 1995b, 33). This phenomenon is more typical of medical and biological research articles than it is of other disciplines such as linguistics, psychology, and anthropology; medical research article titles also tend to be longer (Soler 2007).

Abstracts can be considered "a 'péritexte', a disembodied and self-standing reference tool" (Lane 1992, in Gledhill 1995a) that seems to perform two basic functions: to summarize the research, and to promote the research (León and Divasson 2006, 302–303). It does so through a sequence

*Table 3.1* Summary of generic stages and phases in English-language medical research articles

| *Generic stage/phase* | *Skelton (1994)* | *Nwogu (1997)* | *Fryer (2012)* | *Davis (2015)* | *ICMJE (2008)* |
|---|---|---|---|---|---|
| **Introduction (Orientation, Evaluation, Description)** | | | | | |
| Introducing background/object of study | x | x | x | x | x |
| Explaining rationale, importance | x | – | x | – | x |
| Identifying gap/need in field | x | x | x | x | x |
| Stating research purpose | x | x | x | opt. | x |
| Describing main methods/results | – | opt. | opt. | opt. | – |
| **Methods (Recount, Description, Explanation)** | | | | | |
| Describing conflict of interest | – | – | opt. | opt. | x |
| Describing material | x | x | x | x | x |
| Explaining inclusion/exclusion criteria | opt. | x | x | x | x |
| Recounting experimental procedure | x | x | x | x | x |
| Recounting data-analysis procedure | x | x | x | x | x |
| **Results (Report, Evaluation)** | | | | | |
| Reporting main findings | x | x | x | x | x |
| Reporting consistent observations | – | x | x | – | – |
| Reporting non-consistent observations | – | x | x | – | – |
| Presenting non-verbal material | x | x | x | x | x |
| Describing/recounting adjustments | x | – | x | – | x |
| Explaining/evaluating the data | x | – | opt. | opt. | – |
| **Discussion (Exposition, Explanation, Discussion, Exploration, Recommendation)** | | | | | |
| Reporting main findings | x | x | x | x | x |
| Explaining specific outcomes | x | x | x | x | x |
| Exploring connections with literature | x | x | x | x | x |
| Explaining/discussing (possible) mechanisms/causes, implications, importance | – | x | x | x | x |
| Explaining/discussing limitations | x | x | x | opt. | x |
| Recommending (applicability, future research) | x | x | x | x | x |
| Concluding, summarizing | – | x | x | – | x |

"x" indicates that stage/phase is mandatory; "opt." indicates that stage/phase is optional; "–" indicates no stage/phase identified.

of generic phases that closely resemble the four main stages of the article. Salager-Meyer (1992, 96) identifies four obligatory phases—purpose, methods, results, and conclusions—as well as two non-obligatory phases—statement of the problem and recommendation. Compared with the main body of the research article, abstracts are characterized by a relatively high number of "semantically dense nominal units" (León and Divasson 2006, 302; cf. titles above) and fewer instances of modality and author comment (Adams Smith 1984; see also Section 3.1).

Acknowledgments are a common feature of medical research articles. They usually appear towards the end of articles, but they may not always be explicitly labelled as acknowledgments (Salager-Meyer et al. 2006, 413). Acknowledgments function, in a sense, as academic "thank-you notes" (Salager-Meyer et al. 2009, Salager-Meyer et al. 2011). They give credit for moral, technical, financial, academic, administrative, and/or editorial support (Salager-Meyer et al. 2006, 414–415). They are also an important part of the democratization and transparency of science, since they list and specify the roles and relations of different participants in the research. This is especially important in medical science, in which the numbers of authors and funding bodies have increased dramatically in recent years (Salager-Meyer et al. 2006). For Salager-Meyer et al. (2006, 425), acknowledgments are also "the only place where science is portrayed as a dialogic process that reveals the complex web of interpersonal debts implicit in the construction of knowledge".

## 3.3 The Medical Research Article Corpus, MRAC

All the examples presented and discussed in this book, unless otherwise stated, are excerpted from a collection of 50 original research articles published in the years 1991 to 2010 in the "big four" general medical journals, namely the *New England Journal of Medicine*, *JAMA: The Journal of the American Medical Association*, *The BMJ* (*British Medical Journal*), and *The Lancet*.[4] The 50 most highly cited articles from those four journals during that 20-year period were selected using citation data from the Thomson-Reuters Web of Knowledge database. The articles in the corpus cover a range of medical and medicine-related topics, including heart failure and heart disease, hypertension, diabetes mellitus types 1 and 2, obesity/overweight, and human immunodeficiency virus (HIV) and acquired immune deficiency syndrome (AIDS). A full list of articles is provided in the appendix.

The Medical Research Article Corpus, MRAC, comprises 298,152 word-tokens (18,845 word-types), with an average of 5,963 words per research article (range 2,112–9,515 words). MRAC includes 194 tables and 159 figures, with roughly four tables and three figures per research article (range 1–9 and 0–11, respectively). Six tables and 23 figures are reproduced in colour; the rest are in black and white or grey-tone. All research articles in MRAC are organized according to the IMRaD format (see Section 3.2.1)

Each article is coded individually, using the labels MRAC_01 through MRAC_50 (see appendix). These codes are used to identify extracts throughout the book.

The 50 articles in MRAC are published in three formats: paper, portable document format (PDF), and hypertext markup language (HTML). I refer to these three format-types at various points in the book, especially with regard to their potential differences in the construal of [engagement].

Articles in MRAC were annotated manually according to the models laid out in Chapter 2. They were also annotated for generic stage and phase, based on the descriptions in Section 3.2. Annotations for part-of-speech or word class were automated using the Stanford Parser. All annotations were done in UAM CorpusTool (Wagsoft 2015).

## Notes

1 The IMRaD structure developed in part, it seems, from the need for seventeenth-century empiricists to distinguish "empirical fact" from "human speculation" in reports of experiments and observations (Atkinson 1992, 339, see also Bazerman 1988, 63, 75–77).
2 As of October 2020, only 12 of those 2000-plus journals are official members of the ICMJE: *Annals of Internal Medicine*, *British Medical Journal*, *Bulletin of the World Health Organization*, *Deutsches Ärzteblatt* (*German Medical Journal*), *Ethiopian Journal of Health Sciences*, *JAMA* (*Journal of the American Medical Association*), *Journal of Korean Medical Science*, *New England Journal of Medicine*, *New Zealand Medical Journal*, *The Lancet*, *Revista Médica de Chile* (*Medical Journal of Chile*), and *Ugeskrift for Laeger* (*Danish Medical Journal*).
3 In 2013, the ICMJE *Uniform Requirements for Manuscripts Submitted to Biomedical Journals: Writing and Editing for Biomedical Publication* was renamed *Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly Work in Medical Journals*.
4 All four of these journals are official members of the ICMJE (see Section 3.2.1).

## References

Adams Smith, Diana E. 1984. "Medical discourse: aspects of author's comment." *ESP Journal* 3:25–36.

Arsenault, Darin J., Laurence D. Smith, and Edith A. Beauchamp. 2006. "Visual inscriptions in the scientific hierarchy: mapping the 'treasures of science'." *Science Communication* 27 (3):376–428. doi: 10.1177/1075547005285030.

Atkinson, Dwight. 1992. "The evolution of medical research writing from 1735 to 1985: the case of the Edinburgh Medical Journal." *Applied Linguistics* 13 (4):337–374.

Bakhtin, Mikhail Mikhailovich. 1981 [1935]. *The Dialogic Imagination: Four Essays*. Translated by Caryl Emerson and Michael Holquist. Edited by Michael Holquist. Austin, TX: University of Texas Press.

Bazerman, Charles. 1988. *Shaping Written Knowledge: The Genre and Activity of the Experimental Article in Science*. Madison, WI: University of Wisconsin Press.

Becher, Tony. 1987. "Disciplinary discourse." *Studies in Higher Education* 12 (3):261–274.

Becher, Tony. 1990. "The counter-culture of specialisation." *European Journal of Education* 25 (3):333–346.

Becher, Tony. 1994. "The significance of disciplinary differences." *Studies in Higher Education* 19 (2):151–161.

Becher, Tony, and Paul R. Trowler. 2001. *Academic Tribes and Territories: Intellectual Enquiry and the Culture of Disciplines*. 2nd ed. Maidenhead: Open University Press.

Bernstein, Basil. 1996. *Pedagogy, Symbolic Control and Identity: Theory, Research, Critique*. London: Taylor & Francis.

Bernstein, Basil. 1999. "Vertical and horizontal discourse: an essay." *British Journal of Sociology of Education* 20 (2):157–173.

Biglan, Anthony. 1973. "The characteristics of subject matter in different academic areas." *Journal of Applied Psychology* 57 (3):195–203. doi: 10.1037/h0034701.

Breivega, Kjersti Rongen, Trine Dahl, and Kjersti Fløttum. 2002. "Traces of self and others in research articles. A comparative pilot study of English, French and Norwegian research articles in medicine, economics and linguistics." *International Journal of Applied Linguistics* 12 (2):218–239.

Comaroff, Jean. 1982. "Medicine: symbol and ideology." In *The Problem with Medical Knowledge: Examining the Social Construction of Medicine*, edited by Peter Wright and Andrew Treacher, 49–68. Edinburgh: Edinburgh University Press.

Dahl, Trine. 2004. "Textual metadiscourse in research articles: a marker of national culture or of academic discipline?" *Journal of Pragmatics* 36:1807–1825.

Davis, Richard Hill. 2015. "A genre analysis of medical research articles." PhD thesis, English Language, School of Critical Studies, University of Glasgow.

Dubois, Betty Lou. 1985. "Poster sessions at biomedical meetings: design and presentation." *The ESP Journal* 4 (1):37–48. doi: http://dx.doi.org/10.1016/0272-2380(85)90005-8.

Ferguson, Gibson. 2007. "The global spread of English, scientific communication and ESP: questions of equity, access and domain loss." *Ibérica* 13:7–38.

Fløttum, Kjersti. 2006. "Medical research articles in the comparative perspectives of discipline and language." In *Advances in Medical Discourse Analysis: Oral and Written Contexts*, edited by Maurizio Gotti and Françoise Salager-Meyer, 251–269. Bern: Peter Lang.

Fløttum, Kjersti, Trine Dahl, and Torodd Kinn. 2006. *Academic Voices: Across Languages and Disciplines*. Amsterdam: John Benjamins.

Foucault, Michel. 1973 [1963]. *The Birth of the Clinic: An Archaeology of Medical Perception*. Basingstoke: Routledge.

Fryer, Daniel Lees. 2012. "Analysis of the generic discourse features of the medical research article: a systemic-functional approach." *Functions of Language* 19 (1):5–37.

Fryer, Daniel Lees. 2013. "Exploring the dialogism of academic discourse: heteroglossic engagement in medical research articles." In *English Corpus Linguistics: Variation in Time, Space and Genre. Selected Papers from ICAME 32*, edited by Gisle Andersen and Kristin Bech, 183–207. Amsterdam: Rodopi.

Fryer, Daniel Lees. 2019. "Multiplying engagement: visual-verbal intersemiosis in an online medical research article." In *Engagement in Professional Genres: Deference and Disclosure*, edited by Carmen Sancho Guinda, 157–178. Amsterdam: John Benjamins.

Gledhill, Chris. 1995a. "Collocation and genre analysis. The phraseology of grammatical items in cancer research articles and abstracts." *Zeitschrift für Anglistik und Amerikanistik* XLIII (1):11–36.

Gledhill, Chris. 1995b. "Scientific innovation and the phraseology of rhetoric. Posture, reformulation and collocation in cancer research articles." PhD thesis, University of Aston in Birmingham.

Golinski, Jan. 2005 [1998]. *Making Natural Knowledge: Constructivism and the History of Science*. 2nd ed. Chicago, IL: University of Chicago Press.

Gordon, Deborah R. 1988a. "Clinical science and clinical expertise: changing boundaries between art and science in medicine." In *Biomedicine Examined*, edited by Margaret Lock and Deborah R. Gordon, 257–295. Dordrecht: Kluwer Academic Publishers.

Gordon, Deborah R. 1988b. "Tenacious assumptions in western medicine." In *Biomedicine Examined*, edited by Margaret Lock and Deborah R. Gordon, 19–56. Dordrecht: Kluwer Academic Publishers.

Gotti, Maurizio, and Françoise Salager-Meyer, eds. 2006. *Advances in Medical Discourse Analysis: Oral and Written Contexts*. Edited by Maurizio Gotti. Vol. 45, *Linguistic Insights: Studies in Language and Communication*. Bern: Peter Lang.

Habermas, Jürgen. 1987 [1968]. *Knowledge and Human Interests*. Translated by Jeremy J. Shapiro. Cambridge: Polity Press.

Herman, Joseph. 2001. "Medicine: the science and the art." *Medical Humanities* 27 (1):42–46. doi: 10.1136/mh.27.1.42.

Hirschauer, Stefan. 1991. "The manufacture of bodies in surgery." *Social Studies of Science* 21:279–319.

Hu, Guangwei, and Guihua Wang. 2014. "Disciplinary and ethnolinguistic influences on citation in research articles." *Journal of English for Academic Purposes* 14:14–28.

International Committee of Medical Journal Editors (ICMJE). 2008. *Uniform Requirements for Manuscripts Submitted to Biomedical Journals: Writing and Editing for Biomedical Publication*. Vancouver: International Committee of Medical Journal Editors.

ICMJE. 2010. *Uniform Requirements for Manuscripts Submitted to Biomedical Journals: Writing and Editing for Biomedical Publication*. Vancouver: International Committee of Medical Journal Editors.

ICMJE. 2013. *Uniform Requirements for Manuscripts Submitted to Biomedical Journals: Writing and Editing for Biomedical Publication*. Vancouver: International Committee of Medical Journal Editors.

ICMJE. 2020. "Journals stating that they follow the ICMJE Recommendations." accessed 1 October 2020. http://www.icmje.org/journals-following-the-icmje-recommendations/.

Illich, Ivan. 1976. *Medical Nemesis: The Expropriation of Health*. New York: Pantheon Books.

Jones, Rodney H. 2013. *Health and Risk Communication: An Applied Linguistic Perspective*. Abingdon: Routledge.

Kolb, David A. 1981. "Learning styles and disciplinary differences." In *The Modern American College: Responding to the New Realities of Diverse Students and a Changing Society*, edited by Arthur W. Chickering, 232–255. San Francisco: Jossey-Bass.

Kress, Gunther, and Theo van Leeuwen. 2006. *Reading Images: The Grammar of Visual Design*. 2nd ed. Abingdon: Routledge.

Lafuente Millán, Enrique. 2010. "'Extending this claim, we propose…' The writer's presence in research articles from different disciplines." *Ibérica* 20:35–56.

Latour, Bruno. 1986. "Visualization and cognition: thinking with eyes and hands." *Knowledge and Society: Studies in the Sociology of Culture Past and Present* 6:1–40.

Latour, Bruno. 1987. *Science in Action*. Cambridge, MA: Harvard University Press.

Latour, Bruno. 1990. "Drawing things together." In *Representation in Scientific Practice*, edited by Michael Lynch and Steve Woolgar, 19–68. Cambridge, MA: MIT Press.

Latour, Bruno, and Steve Woolgar. 1986. *Laboratory Life: The Construction of Scientific Facts*. Princeton, NJ: Princeton University Press.

León, Isabel K., and Lourdes Divasson. 2006. "Nominal domain in the biomedical research paper: a grammatico-rhetorical study of postmodification." In *Advances in Medical Discourse Analysis: Oral and Written Contexts*, edited by Maurizio Gotti and Françoise Salager-Meyer, 289–309. Bern: Peter Lang.

Li, Li-Juan, and Guang-Chun Ge. 2009. "Genre analysis: structural and linguistic evolution of the English-medium medical research article (1985–2004)." *English for Specific Purposes* 28:93–104.

Lock, Margaret. 1988. "Introduction." In *Biomedicine Examined*, edited by Margaret Lock and Deborah R. Gordon, 3–10. Dordrecht: Kluwer Academic Publishers.

Lupton, Deborah. 2003. *Medicine as Culture: Illness, Disease and the Body in Western Societies*. 2nd ed. London: Sage.

Lynch, Michael. 1985. "Discipline and the material form of images: an analysis of scientific visibility." *Social Studies of Science* 15 (37–66).

MacDonald, Malcolm N. 2002. "Pedagogy, pathology and ideology: the production, transmission and reproduction of medical discourse." *Discourse & Society* 13 (4):447–467.

Maher, John. 1986. "The development of English as an international language of medicine." *Applied Linguistics* 7 (2):206–220.

Malterud, Kirsti. 2001. "The art and science of clinical knowledge: evidence beyond measures and numbers." *The Lancet* 358 (9279):397–400.

Maton, Karl. 2007. "Knowledge-knower structures in intellectual and educational fields." In *Language, Knowledge and Pedagogy: Functional Linguistic and Sociological Perspectives*, edited by Frances Christie and J. R. Martin, 87–108. London: Continuum.

Maton, Karl. 2014. *Knowledge and Knowers: Towards a Realist Sociology of Education*. Abingdon: Routledge.

Matthiessen, Christian M. I. M. 2013. "Applying systemic functional linguistics in healthcare contexts." *Text & Talk* 33 (4–5):437–467.

Navarro, Vicente. 1976a. *Medicine Under Capitalism*. New York: Prodist.

Navarro, Vicente. 1976b. "Social class, political power and the state and their implications in medicine." *Social Science and Medicine* 10:437–457.

Navarro, Vicente. 1980. "Work, ideology, and science: the case of medicine." *Social Science and Medicine* 14:191–205.

Nwogu, Kevin Ngozi. 1997. "The medical research paper: structure and functions." *English for Specific Purposes* 16 (2):119–138.

Osborne, Thomas. 1998. "Medicine and ideology." *Economy and Society* 27 (2–3):259–273.

Rowley-Jolivet, Elizabeth. 2002. "Visual discourse in scientific conference papers: a genre-based study." *English for Specific Purposes* 21:19–40.

Rowley-Jolivet, Elizabeth. 2004. "Different visions, different visuals: a social semiotic analysis of field-specific visual composition in scientific conference presentations." *Visual Communication* 3 (2):145–175. doi: 10.1177/147035704043038.

Salager-Meyer, Françoise. 1992. "A text-type and move analysis study of verb tense and modality distribution in medical English abstracts." *English for Specific Purposes* 11:93–113.

Salager-Meyer, Françoise. 1999. "Referential behavior in scientific writing: a diachronic study (1810–1995)." *English for Specific Purposes* 18 (3):279–305.

Salager-Meyer, Françoise, María Ángeles Alcaraz Ariza, Maryelis Pabón, and Nahirana Zambrano. 2006. "Paying one's intellectual debt: acknowledgments in scientific/conventional and complementary/alternative medical research." In *Advances in Medical Discourse Analysis: Oral and Written Contexts*, edited by Maurizio Gotti and Françoise Salager-Meyer, 407–430. Bern: Peter Lang.

Salager-Meyer, Françoise, María Ángeles Alcaraz Ariza, and Maryelis Pabón Berbesí. 2009. "'Backstage solidarity' in Spanish- and English-written medical research papers: publication context and the acknowledgment paratext." *JASIST (Journal of the American Association of Information Science and Technology)* 60 (2):307–317.

Salager-Meyer, Françoise, María Ángeles Alcaraz Ariza, Marianela Luzardo Briceño, and Georges Jabbour. 2011. "Scholarly gratitude in five geographical contexts: a diachronic and cross-generic approach of the acknowledgment paratext in medical discourse (1950–2010)." *Scientometrics* 86:763–784.

Skelton, John. 1994. "Analysis of the structure of original research papers: an aid to writing original papers for publication." *British Journal of General Practice* 44:455–459.

Smith, Laurence D., Lisa A. Best, D. Alan Stubbs, John Johnston, and Andrea Bastiani Archibald. 2000. "Scientific graphs and the hierarchy of the sciences: a Latourian survey of inscription practices." *Social Studies of Science* 30 (1):73–94.

Soler, Viviana. 2007. "Writing titles in science: an exploratory study." *English for Specific Purposes* 26:90–102.

Sollaci, Luciana B., and Mauricio G. Pereira. 2004. "The introduction, methods, results, and discussion (IMRAD) structure: a fifty-year survey." *Journal of the Medical Library Association* 92 (3):364–367.

Swales, John M., and Christine B. Feak. 2004. *Academic Writing for Graduate Students: Essential Tasks and Skills*. 2nd ed. Ann Arbor, MI: University of Michigan Press.

Vihla, Minna. 1999. *Medical Writing: Modality in Focus*. Amsterdam: Rodopi.

Wagsoft. 2015. UAM CorpusTool 3.2.

Waitzkin, Howard. 1989. "A critical theory of medical discourse: ideology, social control, and the processing of social context in medical encounters." *Journal of Health and Social Behavior* 30 (June):220–239.

Wang, Yan, and Yongquan Bai. 2007. "A corpus-based syntactic study of medical research article titles." *System* 35:388–399.

WHO. 1948. *Preamble to the Constitution of the World Health Organization as Adopted by the International Health Conference, New York, 19–22 June, 1946; Signed on 22 July 1946 by the Representatives of 61 States (Official Records of the World Health Organization, no. 2, p. 100) and Entered into Force on 7 April 1948*. New York: World Health Organization.

Wright, Peter, and Andrew Treacher. 1982. "Introduction." In *The Problem with Medical Knowledge: Examining the Social Construction of Medicine*, edited by Peter Wright and Andrew Treacher, 1–22. Edinburgh: Edinburgh University Press.

Yang, An, Shu-yuan Zheng, and Guang-chun Ge. 2015. "Epistemic modality in English-medium medical research articles: a systemic functional perspective." *English for Specific Purposes* 38:1–10.

# 4 Verbal Engagement in Medical Research Articles

This chapter presents and discusses verbal [engagement]. It begins by examining the verbal resources that are used to instantiate each feature or option in the verbal ENGAGEMENT system. It then looks at the scope and interaction of those features before examining their distribution across different generic stages and phases of the medical research article. The chapter concludes with a discussion of the potential relations between verbal [engagement] and the discipline of medical research.

## 4.1 Realizing and Instantiating Verbal Engagement

For a summary of how verbal [engagement] is typically instantiated and realized in text, see Section 2.4.1. For convenience, I include here the system network for verbal ENGAGEMENT (see Figure 4.1, reproduced earlier as Figure 2.3).

### *4.1.1 Heterogloss*

'Heteroglossic' utterances make reference to other voices or viewpoints in the discourse, variously 'contracting' or 'expanding' the space for dialogic alternatives. In (4.1), the textual voice invokes and rejects some alternative, presupposed or possible proposition, in this case that trends *did* or *might* differ significantly by age or racial/ethnic group. In (4.2), the proposition is marked as overtly subjective, as one among a set of possible alternatives that might include other reasons or explanations for infection not made explicit by the textual voice.

(4.1) Trends did *not* differ significantly by age or racial/ethnic group. (MRAC_26)

(4.2) These infections *may* have occurred as a result of (1) HIV transmission before treatment, (2) inefficient suppression of maternal viral replication by zidovudine, (3) noncompliance with the treatment regimen, or (4) unique characteristics of the infecting maternal strain of HIV, such as decreased susceptibility to zidovudine. (MRAC_04)

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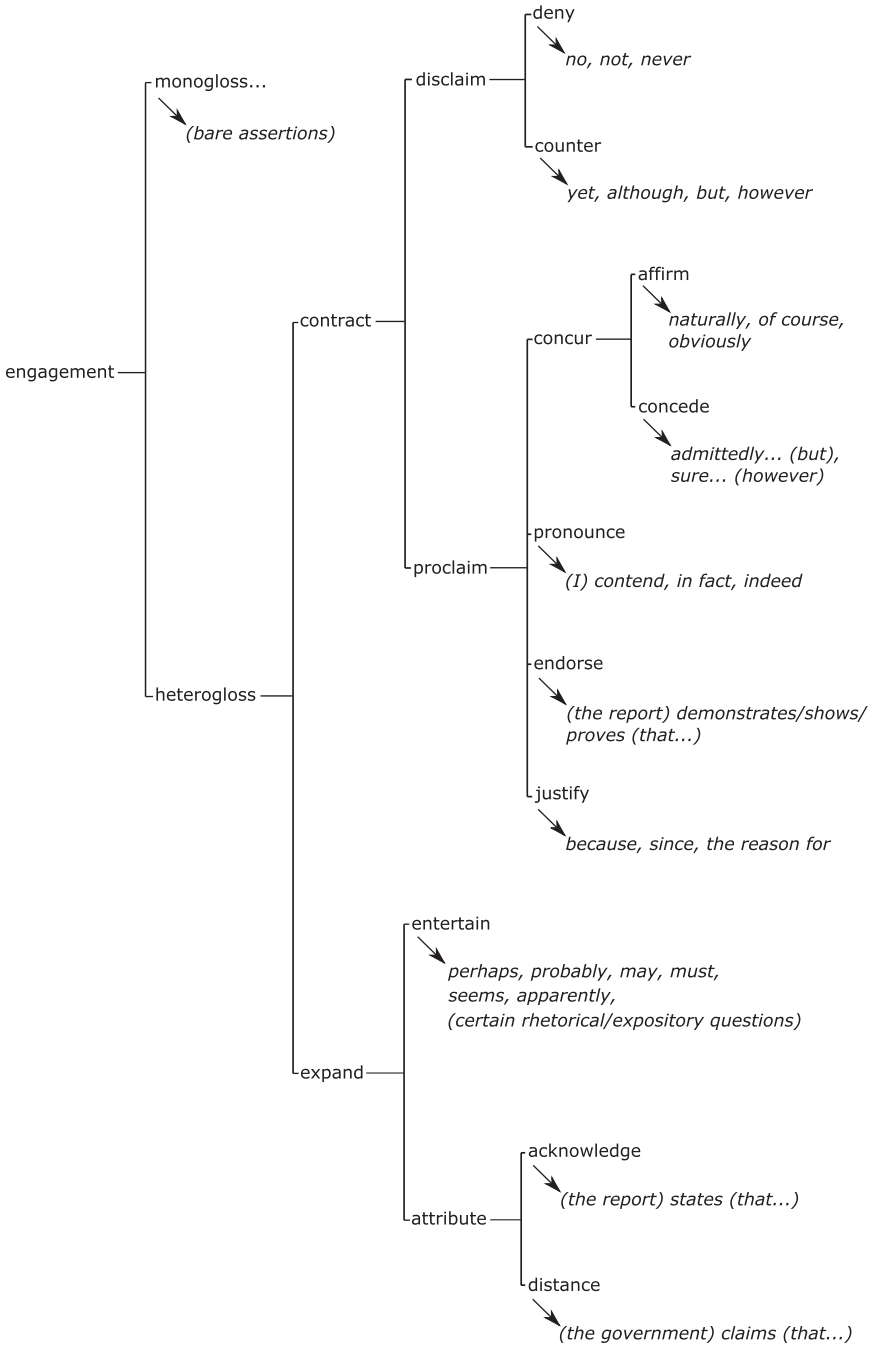


*Figure 4.1* System network for verbal ENGAGEMENT (adapted from Martin and White 2005, 134, White 2003, 2012, 65, Martin 2008, White and Don 2012).

The examples above draw on the verbal resources of negation and modality, respectively. In the sections that follow, I present and discuss how these and other verbal resources help to enact different dialogic positions in the text.

#### *4.1.1.1 Contract*

'Contractive' verbal resources close down dialogic space by rejecting, replacing, or excluding alternative positions or propositions in the discourse. This can be done by 'denying' or 'countering' alternatives, collectively known as 'disclaiming', or by 'concurring' with, 'pronouncing', 'endorsing', or 'justifying' certain propositions (and thus excluding others), collectively known as 'proclaiming'.

##### *4.1.1.1.1 Disclaim*

The two main options for 'disclaiming' are [deny] and [counter]. 'Deny' resources reject alternative positions or propositions; 'counter' resources overturn or replace them.

*4.1.1.1.1.1 Deny* The [contract: disclaim: deny] feature is realized through a wide range of verbal resources. Most typical are the negative operator *not*, the negative prefixes *non-* and *un-*, and the negative determiner *no*.

Interpersonally, the negative operator *not* generally serves to invoke and reject certain assumptions or presuppositions. It can operate clausally, as in (4.3), or locally, as in (4.4)–(4.6). Clausal negation extends over an entire clause or clause-complex, 'denying' one or several propositions. Local negation is restricted in scope to constituents further down the rank scale, for example in nominal or adverb groups. All forms of local negation construe [deny], albeit in a potentially less congruent form (semantic element vs. proposition) than that construed by clausal negation (cf. White 2003, 271).

(4.3) This trial did *not* address the short-term risks and benefits of hormones given for the treatment of menopausal symptoms. (MRAC_34)

(4.4) [...] the benefit of spironolactone in these patients was similar to that in patients who did *not* use potassium supplements. (MRAC_31)

(4.5) Obesity is a risk factor for these conditions; however, *not* everyone with these conditions is obese, and *not* all obese people have these conditions.[26–27] (MRAC_11)

(4.6) *Not* unexpectedly, the incidence of major bleeding complications was significantly higher in the stent group (13.5 percent) than in the angioplasty group (3.1 percent). (MRAC_36)

The negative prefixes *non-* and *un-*, as well as the less commonly used *in-*, *dis-*, and *a-*, are highly productive in scientific-medical discourse, often used

in names of medical conditions, e.g. *non-small-cell lung cancer*, as well as more general descriptors, e.g. *noncompliance* or *non-Hispanic*. This affixal or morphologic negation is a form of local negation that operates at a level below the main clause. It invokes some polar-positive group or phrase, e.g. "one who complies" or "small-cell lung carcinoma", and negates it, defining someone or something partly in terms of what it is not. This type of negation, like that of local *not*-negation, construes [deny] but usually less congruently than clausal negation. Certain uses of affixal negation, however, may be more readily understood as more or less equivalent to clausal negation, as in the case of *unknown* in (4.7), where the distinction between locally construed [deny] and clausally construed [deny] (*unknown* vs. "not known") may be minimal (Quirk et al. 1985, 776, for example, treats these local and clausal negations as "approximately synonymous").

(4.7) The reasons why pulmonary veins become arrhythmogenic are *un*known. (MRAC_15)

The negative determiner *no* functions in a similar way to local-*not* and affixal negation. In *No patient was lost to follow-up* (MRAC_41), the negation is at a level below the clause, i.e. the nominal group functioning as subject. Dialogically, this negation acknowledges that, typically, *some* patients are or might be uncontactable at this stage of a study, but rejects or 'denies' this particular possibility or presupposition.

Other verbally construed [deny] resources include a limited set of semantically negative verbs (and their nominalizations), as well as certain nouns and adjectives that express semantic or inherent negation (Fairclough 1992, 122, Givón 2001, 395 ff.). For example, *exclude* and *exclusion* are frequently used to indicate which variables are not included in a study or statistical analysis. Similarly, *absence* and *absent*, *lack* (as noun or verb), *fail* and *failure*, *rule out*, *refuse*, *refusal*, and *refuser* (i.e. "one who refuses"), and *refute* and *refutation* are all used to reject or 'deny' some opposing polar-positive presupposition, i.e. the possible or actual expectation of "presence", "abundance", and so on. In the case of *exclude* (see (4.8) and (4.9)), the presupposition is that a particular factor or variable should, could, or might have been included but was not. This 'denial' is sometimes followed by an explicit reason or reasons for exclusion, forming a [deny] + [justify] pairing (see (4.9) and [contract: proclaim: justify], Section 4.1.1.1.2.4).

(4.8) We *excluded* volunteers with uncontrolled hypertension, secondary hyperlipidemia, or type 1 or type 2 diabetes mellitus that was either managed with insulin or associated with a glycohemoglobin level of at least 10% (20% above the upper limit of normal). (MRAC_08)

(4.9) Forty-six infants were *excluded* from the analysis *because* no data on HIV culture were available in the data base at the time of this interim analysis (Table 1). (MRAC_04)

In terms of 'alignment', Martin and White (2005, 118–119) suggest two types of 'denial': one that is directed outwards, away from the writer–reader relation, towards some 'disaligned' third party; and one that is directed at the reader, usually as a means of correction. The 'denial' expressed in medical research discourse, however, is generally less polemic than that discussed by Martin and White (2005), whose focus is on mass media. Medical research discourse (and perhaps academic or scientific discourse more generally) suggests a third type of 'denial', one that appears to be a hybrid of the other two, directed not at the reader or some third party, but at the textual voice itself. The actual or potential propositions that are rejected or 'denied' are set up elsewhere in the text, usually as part of the Introduction or Methods (see Sections 4.2.1 and 4.2.2). For example, the 'denial' in (4.1), reproduced as (4.11) below, is a response to an earlier proposition in the same text (see (4.10)). This and other examples of text-internal 'denial' are unlikely to challenge the reader's knowledge, beliefs, or values, unless the methods that lead to such a rejection are thought to be at fault.

(4.10) To test for trends, the NHANES survey years were included as an ordinal variable in logistic regression models that included age group and race/ethnicity. (MRAC_26)

(4.11) Trends did *not* differ significantly by age or racial/ethnic group. (MRAC_26)

As the examples above suggest, solidarity between the writer and reader is rarely threatened by instances of verbal 'denial' in medical research discourse. In cases of potential 'disalignment', 'denial' is carefully negotiated so as to minimize interpersonal risk. In (4.12), for example, 'denial' is directed at "those who commonly argue", an unnamed third party that likely includes certain readers. The use of the agentless passive, the [entertain] resources *commonly* and *may*, and the invoked 'justification' in the second sentence, however, mitigate potential conflict and make 'disalignment' unlikely. Similarly, the frequent use of local negation (e.g. local-*not* and affixal negation) further minimizes the risk of 'disalignment' by enacting 'denial' at a level below the proposition—as a semantic element that may need to be unpacked—thereby reducing its potential arguability (Halliday and Matthiessen 2004, 120, Martin and White 2005, 73).

(4.12) It is commonly argued that it is difficult to change the lifestyle of obese and sedentary people, but such pessimism may *not* be justified. The reasonably low dropout rate in our study also indicates that subjects with impaired glucose tolerance are willing and able to participate in a demanding intervention program if it is made available to them. (MRAC_43)

*4.1.1.1.1.2 Counter* The [contract: disclaim: counter] feature can be realized through a wide range of verbal resources. The most common are *but*, *only*, *however*, and *although* (see examples (4.13)–(4.16) below). Dialogically, these resources replace, supplant, or 'counter' some otherwise expected claim or position.

(4.13) In two patients who received intensive insulin therapy, hypoglycemia was associated with sweating and agitation, *but* there were no instances of hemodynamic deterioration or convulsions. (MRAC_46)

(4.14) Treatment was begun in the hospital for *only* 1.2 percent of patients. (MRAC_49)

(4.15) Prospective studies of the effect of strict blood glucose control in patients with type 1 or type 2 diabetes have not shown a reduction in mortality[45,46]. During pregnancy, *however*, this approach has been shown to prevent intrauterine and perinatal death.[47] (MRAC_46)

(4.16) *Although* dyslipidemia, diabetes, smoking, and hypertension are major risk factors for cardiovascular disease, they do not fully account for the risk. (MRAC_50)

'Counter' is primarily realized by contrastive and adversative conjunctions and adverbs. In addition to those mentioned above, *whereas*, *regardless*, *still*, *unless*, *while*, *yet*, and *though* are frequently used. Less commonly, [counter] can be realized by a limited set of verbs—*remain*, *persist*, and *continue*—as well as the emphatic *do* auxiliary. Adjectives and adverbs like *even*, *actual/actually*, *real*, and *true*, and the prepositional phrase *in fact*, perform a similar counterexpectant function. Examples of some of these [counter] resources are provided below. (Note that *in fact* in (4.20) can also express [proclaim: pronounce], serving to "emphasize the truth of an assertion" as well as indicating that it is "contrary to what might be expected" (Oxford English Dictionary). The same can be said of *actually* in (4.21). See Section 4.1.1.1.2.2.)

(4.17) Finally, bleeding and vascular complications and the prolonged hospitalization *remain* major drawbacks of stent implantation and *continue* to hamper its acceptance in clinical practice. (MRAC_36)

(4.18) The lower rate of CHD [coronary heart disease] in hormone users compared with nonusers *persists* after statistical adjustment for differences in CHD risk factors,[22] but differences in unmeasured factors *remain* a possible explanation. (MRAC_17)

(4.19) The WHI [Women's Health Initiative] is the first randomized control trial to confirm that combined estrogen plus progestin *does* increase the risk of incident breast cancer and to quantify the degree of risk. (MRAC_34)

(4.20) The ribavirin dose of 800 mg/day was selected because of concern that the higher dose of peginterferon alfa-2b might be associated with anaemia that would be additive to the anaemia associated with ribavirin. *In fact*, this did not occur, and perhaps a higher dose of ribavirin could have been used safely, as is suggested in our weight-based dosing analysis and profile. (MRAC_23)

(4.21) Within Finland, rates of coronary heart disease vary widely,[23] ranging from very high in eastern Finland (Kuopio) to lower in western Finland (Turku). In Turku, the rate of coronary heart disease in men is somewhat higher than that in men in the United States, whereas the rate of coronary heart disease in women in Turku is *actually* lower than that in women in the United States.[23] (MRAC_14)

Of particular note with regard to [counter] is its close relation to [deny]. Several of the examples above include [counter] + [deny] pairings, in which some 'denied' proposition (or semantic element) is considered counterexpectational, e.g. *but there were no instances of hemodynamic deterioration or convulsions* in (4.13) or *in fact, this did not occur* in (4.20). This phenomenon is seen in other discourses, as noted by Martin and White (2005, 120), and the close semantic relation (and close proximity) of [counter] and [deny] may explain why these features are sometimes dealt with together under broader headings of "negation" or "denial" (see Kress and Hodge 1979, 140 ff., Tottie 1987, 160). Here, dialogically, they are of course subcategories of the same feature, [disclaim].

The [counter] feature, like other categories of [engagement], is most congruently realized at the clausal level, but can also be expressed further down the rank scale. 'Counter' construed by resources like *but* and *however* typically extends over one or more propositions, while 'counter' construed by *only* and *actual* is restricted to a semantic element within a proposition.

The 'countering' of certain claims or propositions may conflict with the expectations, beliefs, or values of the reader and can 'disalign' the textual voice from its readership. However, as White (2003, 271) notes, 'countering' can also enhance writer–reader solidarity if the supplanted or overturned proposition is "to some degree understandable or even logical [...] based on a not unreasonable expectation". It is this latter type of [counter] that predominates in medical research discourse. Many of the propositions that are 'countered' are set up internally within the text itself. The rejection and overturning of those propositions may be central to the study (if they are hypotheses, for example), and 'countering' is likely to be seen as "logical" or "reasonable", especially within the framework of the scientific method. Interpersonal risk increases in cases of text-external 'countering', such as (4.22), where 'disclaiming' ('countering' and 'denying') may call into question a position or belief held by the reader.

(4.22) In addition, concerns have been expressed that too vigorous reduction in blood pressure may be associated with increased cardiovascular risk—the so-called J-curve concept.[9, 10, 11 and 12] The issue of how far blood pressure should be lowered to achieve the greatest benefit, in terms of reduced cardiovascular morbidity and mortality, has been a matter of scientific debate.[13] The *real* issue is *not* whether the relation between achieved blood pressure and cardiovascular events is J-shaped (it must be), *but* whether there are additional benefits, or risks, in lowering blood pressure of patients with hypertension to fully normotensive levels—ie, between 70 mm Hg and 85 mm Hg diastolic blood pressure—or whether there is little further benefit in lowering diastolic blood pressure much below 90 mm Hg.[14] This issue needed to be addressed in a randomised and prospective trial and this was one of the reasons for doing the present study. (MRAC_16)

*4.1.1.1.2 Proclaim*

The four main options for 'proclaiming' are [concur], [pronounce], [endorse], and [justify]. 'Concur' announces the textual voice as being in agreement or sharing a certain position with some projected dialogic partner; 'pronounce' adds explicit, subjective emphasis to some assumed or directly referenced counter-position; 'endorse' expresses approval or support for a particular position or proposition; and 'justify' argues for or substantiates a particular position, one that may be deemed contentious if left unsupported.

*4.1.1.1.2.1 Concur* The [contract: proclaim: concur] feature is realized by a relatively limited set of adjectives and adverbs: *clear/clearly*, *evident/evidently*, *obvious/obviously*, *logical/logically*, and *inevitable/inevitably*. Examples of these are shown in (4.23)–(4.28).

(4.23) Obesity *clearly* has an important role in sleep-disordered breathing. (MRAC_48)

(4.24) The investigation of the effects of a small dose of acetylsalicylic acid versus placebo in treated patients with hypertension, as we did in this study, provide very *clear* evidence of a substantial beneficial action of acetylsalicylic acid on fatal and non-fatal acute myocardial infarctions [...]. (MRAC_16)

(4.25) This difference was *evident* in both the subgroup that received an anthracycline, cyclophosphamide, and trastuzumab [...] and the subgroup that received paclitaxel and trastuzumab [...]. (MRAC_39)

(4.26) However, it is *obvious* that treated patients with hypertension remain at a greater risk of developing cardiovascular complications than matched normotensive individuals.[4 and 5] (MRAC_16)

(4.27) Previous trials tested the effect of lowering cholesterol levels in patients with hypercholesterolemia. This approach was *logical*, since the relation between blood cholesterol levels and coronary artery events is stronger, and rates of coronary events are greater, in patients with elevated, rather than average, values.[1–4] (MRAC_35)

(4.28) This approach was considered most objective, but it *inevitably* reduced the APACHE II scores.[27] (MRAC_46)

In all the above examples, the textual voice appears to affirm a particular position or proposition that is assumed to be shared with the reader, e.g. "that obesity has an important role in sleep-disordered breathing" (see (4.23)). Positioning the reader in this way carries a certain interpersonal risk if that position conflicts with the reader's knowledge or beliefs (White 2003, 269). To avoid or reduce this risk, 'justification' or 'acknowledgment' may be used. In (4.27), for example, tests conducted by previous studies are characterized as *logical* ("natural or sensible given the circumstances" rather than "according to the rules of logic or formal argument", Oxford English Dictionary). By clarifying and referencing this position (note the resources *since* and *[1–4]*), the textual voice avoids or minimizes the potential for 'disalignment'.

'Concur' is rarely instantiated in medical research discourse. When it is used, it tends to be of the [concur: affirm] subtype rather than [concur: concede] and is often mitigated by [justify] or [acknowledge] resources. It seems that the risk of 'disalignment' associated with 'concur' limits its use in medical research articles, which tend to be less polemic than the kinds of mass-communicative texts studied by Martin and White (2005).

*4.1.1.1.2.2 Pronounce* The [contract: proclaim: pronounce] feature is realized by a relatively small set of verbal resources. It is most commonly realized by the adverb *indeed*, hypotactic clauses serving as qualifiers of the noun *fact* ("fact clauses", Halliday and Matthiessen 2004, 470 ff.), postposed clauses with carrier *to note* and attribute *important* (and variants including noun *note* and adjective *noteworthy*), and the prepositional phrase *in fact*. Examples of these are given in (4.29)–(4.32).

(4.29) The initial rationale for our study was the hypothesis that the attenuation of ventricular enlargement would result in clinical benefit. A quantitative echocardiographic study in a subgroup of the study patients was designed to determine whether the proposed benefit of captopril therapy in terms of clinical outcome could be attributed to such an attenuation. Ventricular size, quantitated as the echocardiographically determined area of the chamber in either systole or diastole, at base line, was *indeed* the most powerful independent predictor of adverse cardiovascular outcome.[31] (MRAC_30)

(4.30) In the two multicenter studies,[19,20] treatment with metoprolol or bisoprolol did not significantly decrease the risk of death. One of

the trials retrospectively noted a reduction in mortality only among patients with nonischemic dilated cardiomyopathy.[20] In contrast, in our study, carvedilol therapy was associated with a decrease in mortality, and the benefits of the drug were apparent in all the subgroups we examined, including patients with underlying ischemic heart disease. *The fact that* two earlier multicenter studies did not find an effect on survival may have been related to the sample sizes, to the study designs, or to chance. (MRAC_27)

(4.31) These cutoff points are widely used to describe sleep apnea, but it is *important to note* that the clinical importance of any particular cutoff point has not been adequately determined. (MRAC_48)

(4.32) The ribavirin dose of 800 mg/day was selected because of concern that the higher dose of peginterferon alfa-2b might be associated with anaemia that would be additive to the anaemia associated with ribavirin. *In fact*, this did not occur, and perhaps a higher dose of ribavirin could have been used safely, as is suggested in our weight-based dosing analysis and profile. (MRAC_23)

'Pronouncements' add explicit, subjective emphasis to propositions that are "directed against some assumed or directly referenced counter-position (Martin and White 2005, 129). In the examples above, all but one of those 'pronouncements' are directed towards counter-positions that are explicitly 'denied', i.e. *did not find an effect*, *has not been adequately determined*, and *did not occur* (see (4.30), (4.31), and (4.32), respectively). Only *indeed* is consistently directed towards some polar-positive position (see (4.29)).

Other verbal realizations of [pronounce] include the adjective *true* and the verbs *emphasize*, *merit*, and *deserve*. Examples (4.33)–(4.36) show how these resources act in various ways to add subjective emphasis to propositions directed towards perceived counter-positions.

(4.33) There were some differences in demographic factors between patients for whom combination therapy was prescribed and those for whom it was not prescribed (this was especially *true* for combination regimens that included protease inhibitors), but demographic factors were found to have no significant effect on morbidity or mortality. (MRAC_28)

(4.34) The most feared side effect of beta-blockade — worsening heart failure during the initiation of therapy — was not an important limitation of treatment; 5.9 percent of the patients had this side effect during the open-label period, and an additional 5.1 percent in the carvedilol group and 4.1 percent in the placebo group had this reaction after increases in dose during the early phases of double-blind therapy. It must be *emphasized*, however, that carvedilol therapy was initiated in the study with extreme care by physicians experienced in the management of heart failure, who followed specific

guidelines that encouraged changes in concomitant medications to ensure the safety of the patient. (MRAC_27)

(4.35) Several mechanisms *merit* discussion. (MRAC_06)

(4.36) Four patients *deserve* special emphasis. (MRAC_47)

There are relatively few instances of verbal [pronounce] in medical research articles. 'Pronounce', like 'concur', conveys a sense of "heightened personal investment" (White 2003, 269) and carries with it a certain amount of interpersonal risk. Such positioning is generally avoided, it seems, in this particular text-type.

*4.1.1.1.2.3 Endorse* The [contract: proclaim: endorse] feature can be realized by a variety of verbal resources. Verbs like *show*, *indicate*, *find*, *determine*, *demonstrate*, and *confirm*, and nouns like *finding* and *evidence* are frequently deployed in support of some position that is assumed to be correct or highly warrantable (Martin and White 2005, 126). Selected examples of these realizations are presented below in (4.37)–(4.42). Note that the polysemy of the verb *indicate* ("show" or "strongly suggest", Oxford English Dictionary) means that, in (4.38), it can express either or both [endorse] and [entertain] (see Section 4.1.1.2.1).

(4.37) Previous studies with interferon alfa-2b plus ribavirin have *shown* that, in general, if patients do not respond by treatment week 24, an SVR will not be achieved; a similar pattern is observed with peginterferon alfa-2b plus ribavirin. (MRAC_23)

(4.38) Laboratory studies *indicate* that amplification of HER2 has a direct role in the pathogenesis of these cancers,[13–17] thereby providing investigators with an opportunity to target a therapeutic agent directly against the alteration. (MRAC_39)

(4.39) Animal models of retroviral infection *demonstrate* that zidovudine may prevent or alter the course of maternally transmitted HIV infection[12–16]. (MRAC_04)

(4.40) Data from a survey in 1994[2] and a public opinion poll in 1997[3] *confirmed* the extensive use of alternative medical therapies in the United States. (MRAC_09)

(4.41) However, follow-up studies have *found* that levels of hs-CRP are stable over long periods, as long as measurements are not made within two to three weeks of an acute infection.[21,23] (MRAC_32)

(4.42) The WHI *findings* for CHD and VTE are supported by *findings* from HERS, but there is no other evidence from clinical trials for breast cancer and colorectal cancer, and only limited data from trials concerning fractures. (MRAC_34)

Most realizations of [endorse] fall under two main categories: (1) verbs that, experientially, express mental or relational processes of identification

(Halliday and Matthiessen 2004, 197–248) and (2) nouns and adjectives that, for the most part, are derived from those verbs. *Find* and *finding* is one example (see (4.41) and (4.42) above); others include *indicate–indication*, *demonstrate–demonstration*, and *confirm–confirmation*, as well as the past participles *established*, *proven*, and *known*. The first category expresses [endorse] at the level of the clause; the second category expresses [endorse] at a level below the clause.

Most of the examples above [endorse] some kind of text-external position (*previous studies*, *follow-up studies*, *HERS* [Heart and Estrogen/progestin Replacement Study], etc.), but the same verbs, nouns, and adjectives that [endorse] the work of others can also be used to [endorse] text-internal propositions. In (4.42), the first use of *findings*, *WHI findings*, refers to the study or text itself; the second applies to an external study, *HERS*. Examples (4.43) and (4.44) show how two of the most commonly used verbs for text-external 'endorsement', *show* and *find*, can also be used for text-internal 'endorsements'. Approximately one-third of all instances of [endorse] are of this text-internal type; the other two-thirds are text-external.

(4.43) Like the Coronary Angioplasty versus Excisional Atherectomy Trial (CAVEAT),[7] our study *shows* that the most important determinant of the luminal diameter at six months was the luminal diameter achieved immediately after the procedure. (MRAC_10)

(4.44) We *found* that treatment with spironolactone reduced the risk of death from all causes, death from cardiac causes, hospitalization for cardiac causes, and the combined end point of death from cardiac causes or hospitalization for cardiac causes among patients who had severe heart failure as a result of left ventricular systolic dysfunction and who were receiving standard therapy including an ACE inhibitor. (MRAC_31)

By endorsing some text-external or text-internal proposition, the textual voice positions itself as being in agreement with some projected dialogic partner. This implies a certain interpersonal risk, since the reader may disagree with what has been "shown", "demonstrated", or "proven" by others. This potential for disagreement or 'disalignment', however, can be negotiated through the deployment of other [engagement] resources. For example, in (4.37) and (4.39), the 'endorsements' construed by *shown* and *demonstrate* are tempered or mitigated by the [entertain] resources *in general* and *may*, respectively (see Section 4.1.1.2.1), presenting the projected clause or proposition as being one among several possible alternatives.

*4.1.1.1.2.4 Justify* The [contract: proclaim: justify] feature is realized by a variety of verbal resources, most commonly in the form of finite or nonfinite adverbial clauses of reason. These are typically introduced by conjunctions

such as *because* and *since*, and by the infinitive marker *to*. 'Justify' can also be realized by verbal resources further down the rank scale, by prepositional phrases that function as adjuncts of cause or reason. Examples of all these resources are provided below in (4.45)–(4.49).

(4.45) We chose to study a regimen that combined antepartum, intrapartum, and neonatal therapy, *because* the timing of maternal-infant HIV transmission is uncertain. (MRAC_04)

(4.46) An increase in atherosclerosis with insulin treatment has also been suggested, *since* plasma insulin concentrations are supraphysiological.[11 and 12] (MRAC_50)

(4.47) Data from longitudinal studies of asymptomatic, untreated sleep-disordered breathing are needed *to* determine its progression, acute and chronic pathophysiologic sequelae, and other vital aspects of its natural history. (MRAC_48)

(4.48) *Because of* the factorial design, all analyses were stratified for the randomization to vitamin E or placebo. (MRAC_50)

(4.49) Our findings should be interpreted with the knowledge that the trial program had several unusual characteristics for a study of the effect of a drug on survival. Most such trials are designed as long-term studies in which nonfatal events are considered to be secondary end points. In our program, however, the individual protocols were designed first to evaluate nonfatal end points as components of a single stratified trial program, and then mortality was specified a priori to assess safety and potential benefit. *As a result*, the duration of follow-up was short and fixed. (MRAC_27)

Dialogically, 'justifications' acknowledge or anticipate an addressee whose position may not be 'aligned' with the textual voice. For White (2012, 64), whose work examines newspaper reports, [justify] attempts to persuade or "win over those who might be dubious or resistant" to certain claims. In scientific-medical discourse (or science more generally), [justify] seems to be a response to the sceptical or critical reader and helps to convey some kind of scientific credibility. It construes for the text a sense of openness and accountability, and generally plays an important role in 'aligning' the textual voice and the reader.

#### *4.1.1.2 Expand*

Dialogically 'expansive' verbal resources open up dialogic space by grounding propositions in the subjective voice of the text or some other external source, referred to as [entertain] and [attribute], respectively. Both features construe for the text a position or proposition that may be considered one among several alternatives.

*4.1.1.2.1 Entertain*

The [expand: entertain] feature is realized by a large set of verbal resources typically associated with modality, hedging, and evidentiality. Those resources include modal auxiliaries such as *may*, *could*, *can*, *will*, and *should*, as well as reporting verbs such *suggest*, *indicate*, and *estimate*. Nominalizations such as *suggestion*, *indication*, and *estimation*, and adjectives and adverbs such as *possible/possibly* and *usual/usually* function in a similar manner. Expressions of exemplification and approximation such as *e.g.*, *for example*, and *such as* and approximators of quantity, degree, frequency, and time such as *at least*, *about*, *most*, and *many* can also be used to construe a dialogic space in which other examples and different, more or less precise quantities, degrees, frequencies, and times can be 'entertained' as possible alternatives (cf. Salager-Meyer 1994). Examples of these resources are highlighted in (4.50)–(4.54).

(4.50) The prevascular phase, which has been elucidated in studies of carcinoma of the cervix,[7] bladder,[8] and breast,[9 10 11 12] *may* persist for years and is *usually* associated with limited tumor growth (*e.g.*, restricted thickness of melanoma[13]) and few or no metastases. The vascular phase is *usually* followed by rapid tumor growth, bleeding, and the potential for metastasis. (MRAC_47)

(4.51) The clear demonstration of a reduction in ischaemic stroke, without any evidence of an adverse effect on haemorrhagic stroke, also *suggests* that statin therapy *could* produce substantial benefits among high-risk individuals in populations (*such as* China) where the risks of ischaemic stroke are *relatively* high, but LDL cholesterol concentrations and coronary disease risk are *relatively* low.[3 and 52] (MRAC_03)

(4.52) The significant correlation between the serum leptin concentration and the percentage of body fat *suggests* that adipocytes are signaling the brain about the size of the adipose-tissue depot. *If* the action of leptin in humans is similar to that in rodents,[2–4] appetite *should* decrease and energy expenditure *should* increase, which together *should* result in weight loss. (MRAC_05)

(4.53) The present findings *indicate* that the effect of aspirin in preventing a first myocardial infarction was greatest among the men with the highest base-line C-reactive protein concentrations and that the benefit diminished significantly with decreasing concentrations of this inflammatory marker. Thus, although the antiplatelet effects of aspirin *may* be modified by underlying inflammation, these data also *suggest* the *possibility* that the benefit of aspirin *may* have been due, *at least in part*, to antiinflammatory effects.[31] (MRAC_32)

(4.54) The discrepancy between the findings of HERS and the observational studies *may* also reflect important differences between the study populations and treatments. *Most* of the observational studies of postmenopausal hormone therapy enrolled

> postmenopausal women who were *relatively* young and healthy and who took unopposed estrogen.[1–3,23] In contrast, participants in HERS were older, had coronary disease at the outset, and were treated with estrogen plus progestin. However, *some* observational studies did examine women with prior CHD, and all of these reported a beneficial association with postmenopausal hormone.[6–12] (MRAC_17)

As can be seen in examples (4.50)–(4.54), there are differences in the scope of verbal [entertain]. Some realizations or instantiations extend across or beyond the level of the clause or proposition, e.g. *may*, *suggest*, *if*. Others are restricted to groups/phrases or semantic elements, e.g. *such as*, *possibility*, *some*. 'Entertain' resources play an important dialogical role, mitigating the potential 'disalignment' of 'deny', 'counter', or 'pronounce' resources. In (4.12), reproduced as (4.55) below, [entertain *may*] tempers the potential 'disalignment' of [counter *but*] and [deny *not*] that is directed at some commonly held position or belief.

(4.55) It is commonly argued that it is difficult to change the lifestyle of obese and sedentary people, but such pessimism *may* not be justified. The reasonably low dropout rate in our study also indicates that subjects with impaired glucose tolerance are willing and able to participate in a demanding intervention program if it is made available to them. (MRAC_43)

*4.1.1.2.2 Attribute*

The two main options for 'attributing' are [acknowledge] and [distance]. Both mark a particular position or proposition as belonging to some external source, but they differ in terms of the stance or position assumed by the textual voice. 'Acknowledge' presents the textual voice as taking a relatively neutral stance towards the content or values expressed; 'distance' dissociates the textual voice from the externally sourced proposition. (Note how stance-neutral [acknowledge] and stance-negative [distance] compare with stance-positive [endorse]; Section 4.1.1.1.2.3.)

*4.1.1.2.2.1 Acknowledge* The [expand: attribute: acknowledge] feature is realized by a diverse set of resources. By far the most common of these is the numerical-endnote referencing system ([1], [2], [3], etc.). Superscript numerals refer the reader to a numbered reference list at the end of the text and are generally used to identify the source or sources of a particular idea, claim, or proposition. Typically, the proposition being 'acknowledged' summarizes or paraphrases some source text; direct quotes are rare. In some cases, 'acknowledged' propositions are ostensibly 'monoglossic' (see Section 4.1.2), offering no overt reference to other voices other than sentence-final superscript numbers (see (4.56) and last sentence of (4.59)). In

others, reporting verbs such as *report*, *recommend*, and *propose* (or their nominal forms) are deployed alone or in combination with numerical references (see (4.57)–(4.59)).

(4.56) The ob gene is an adipocyte-specific gene that encodes leptin, a protein that regulates body weight.[1] In mice, mutations in the ob gene that result in a lack of circulating leptin cause obesity. The administration of recombinant leptin causes weight loss in these mice.[2–4] (MRAC_05)

(4.57) The UK Prospective Diabetes Study *reported* that intensive blood-glucose control with sulphonylureas or insulin substantially reduced the risk of complications but not macrovascular disease.[1] (MRAC_45)

(4.58) Following a review of the second interim analysis (data from 267 participants who had experienced a primary end point event), the Data and Safety Monitoring Board *recommended* that the trial be stopped early for efficacy. The voting members of the steering committee agreed unanimously on July 3, 1997, to accept the *recommendation* for early termination. (MRAC_08)

(4.59) In previous *reports*, the excess risk of coronary events in patients with prior myocardial infarction (a six-to-sevenfold difference)[5,6] was higher than the excess risk in diabetic patients (a two-to-fourfold difference).[1–4] However, comparisons across populations are difficult. Furthermore, diabetic patients are overrepresented among patients with myocardial infarction,[1–4] and diabetic patients with myocardial infarction have a worse prognosis than nondiabetic patients with myocardial infarction.[14–16] (MRAC_14)

Some of the reporting verbs used to construe [acknowledge] are the same as those used to construe [entertain] (see Section 4.1.1.2.1). A distinction between the two, however, can usually be made by considering the framer of the proposition. For example, in (4.60), the first instance of *suggest* is grounded in the subjecthood of the textual voice and enacts [entertain], while the second refers to some external source and enacts [acknowledge] or [distance] (see next section).

(4.60) This phenomenon is uncommon in patients who are treated with interferon alone, which *suggests* [to us] that stopping therapy at week 12 because of persist viremia, as recently *suggested* [by others],[1,18,30] may not be appropriate in the case of therapy with interferon and ribavirin. (MRAC_25)

An interesting discourse-specific instance of [acknowledge] is realized by the nominal group *informed consent*. This term, standardized across much of the medical research discourse, refers to permission given by patients and

other participants to be included in studies. Permission is based on information given by researchers to prospective participants about the aims, methods, and possible outcomes of the study. In terms of [engagement], *informed consent* 'acknowledges' the participant(s) as the source of permission and the study or researchers as the source of information. The italicized examples in (4.61) and (4.62)—despite differences in "giving" and "getting" and the use of active and passive voice, respectively—can be reformulated to highlight this potential 'double acknowledgment'. Both essentially say that "participants said yes to inclusion in the study after researchers (or we) told them what the study was about", but the 'acknowledgment' is encoded as a nominal group (… *informed consent*) rather than a clause or clauses (i.e. "researchers inform", "participants consent").

(4.61) The study was approved by the ethics committees of Kuopio University Hospital and the Turku University Central Hospital. All subjects gave *informed consent*. (MRAC_14)

(4.62) The institutional review board at each center approved the protocol, and written *informed consent* was obtained from all participants or their authorized representatives. (MRAC_01)

Like other verbal [engagement] resources, [acknowledge] is most congruently realized at the clausal level. However, as can be seen above, 'acknowledgments' can also be expressed further down the rank scale. Superscript numbers and reporting verbs extend over clauses or clause-complexes to express [acknowledge] at the level of the proposition or proposition-nexus, while nominal groups (often containing nominalizations of those same reporting verbs) express [acknowledge] as a semantic element within a proposition.

The relatively neutral stance implied by verbal [acknowledge] in the examples above is unlikely to threaten writer–reader relations, and is certainly less likely to 'disalign' than the instantiation of other externally sourced features such as [endorse] and [distance], both of which draw on the resources of projection. 'Acknowledge' is also less likely to 'disalign' than 'entertain', which, as noted above, can be enacted through some of the same verbal resources as 'acknowledge', but which explicitly grounds the proposition (or semantic element) in the subjectivity of the textual voice rather than some text-external source.

*4.1.1.2.2.2 Distance* The [expand: attribute: distance] feature is realized by a relatively limited number of resources. Most commonly, [distance] is signalled or expressed by quotation marks and position verbs like *argue*, *criticize*, *assume*, *purport*, and *think* (see Fløttum et al. 2006, 233–234). All of these resources serve to dissociate or disalign the textual voice from some externally construed voice. Selected examples are shown in (4.63)–(4.65).

(4.63) Despite the dramatic increases in use and expenditures associated with alternative medical care, the extent to which patients disclose their use of alternative therapies to their physicians remains low. Less than 40% of the alternative therapies used were disclosed to a physician in both 1990 and 1997. It would be overly simplistic to blame either the patient or their physician for this inadequacy in patient-physician communication. The current status quo, which can be described as "*don't ask and don't tell,*" needs to be abandoned.[29] Professional strategies for responsible dialogue in this area need to be further developed and refined. (MRAC_09)

(4.64) It is commonly *argued* that it is difficult to change the lifestyle of obese and sedentary people, but such pessimism may not be justified. The reasonably low dropout rate in our study also indicates that subjects with impaired glucose tolerance are willing and able to participate in a demanding intervention program if it is made available to them. (MRAC_43)

(4.65) Several cross-sectional investigations have found associations between mortality rates and particulate air pollution in U.S. metropolitan areas[1–3]. A recent study reported associations between infant mortality and particulate air pollution in the Czech Republic[4]. These studies have often been *criticized* because they did not control directly for cigarette smoking or other covariates. (MRAC_07)

Quotation marks indicate, or give the impression of, a direct quote or paraphrase, i.e. the explicit presence of a voice other than the textual voice. In (4.63), quotation marks are suggestive of a general response or implied meaning associated with patients' reporting of alternative medicine use, a position that the textual voice appears to dissociate and 'distance' itself from. Not all uses of quotation marks, however, are directed at some external voice; some may address the textual voice itself. In (4.66), for example, the textual voice appears to 'distance' itself from its own terminology. It 'acknowledges' the potentially problematic nature of the term and 'entertains' the possibility of more suitable terminology. This is a relatively common way of using or introducing terms that may be controversial or contested, or simply new and not well established or recognized in the discourse. Unlike [distance] more generally, these resources may help 'align' the writer and reader in a way that resembles that of [entertain].

(4.66) We have used the term "*onset of angiogenic activity*" to describe marked neovascularization present within or at the periphery of a neoplastic focus. This usage should not imply knowledge of a mechanism. Whether capillaries will grow or not grow toward a tumor may depend on one or more events that are not clearly understood at this time. (MRAC_47)

Although rare in medical research discourse, the attributive adjective *so-called* can function in a similar way to quotation marks, and indeed often accompanies them. Like certain uses of quotation marks, *so-called* can 'distance' the textual voice from some potentially controversial or unfamiliar term, as in (4.67).

(4.67) One specific histologic type of gastric adenocarcinoma, the *so-called* intestinal type, is particularly prone to the regional and temporal variations of an environmentally related malignant condition[5, 9]; the decrease in the incidence of stomach cancer in the United States has resulted primarily from a decline in the intestinal type of disease.[10] (MRAC_29)

Like other features of the ENGAGEMENT system, [distance] can be realized at clausal or sub-clausal levels. The 'distancing' construed by position-verbs extends over propositions or proposition-nexuses, while quotation marks and the attributive adjective *so-called* tend to be restricted to nominal groups or embedded clauses, and therefore express [distance] at a level below the proposition.

The act of 'distancing' carries a certain risk of 'disalignment'. 'Entertain' resources may mitigate this risk, as some of the examples above show. In other cases, 'distancing' may be expressed implicitly through the use of other APPRAISAL resources. In (4.68), for example, the textual voice ostensibly 'distances' itself from certain inferences made by other studies (referred to by superscript numbers), but it does so primarily through a combination of different [engagement] and [attitude: appreciation] resources; [distance] does not seem to be expressed by any one single verbal resource (note the use of quotation marks at the end, though). Here, the textual voice first rejects or 'denies' a particular proposition (*cannot*, *un*likely) and expresses negative appreciation of studies that draw conclusions based on potentially incorrect assumptions ([36, 37 and 38], *misleading*). It then 'counters' those misleading inferences (*by contrast*) and offers an alternative method.

(4.68) In randomised trials of statin therapy versus placebo, groups of patients defined by the size of their postrandomisation cholesterol reductions *cannot* be guaranteed—and, indeed, are *un*likely—to differ only randomly from each other (since factors related to the apparent lipid response may well also be related to outcome). Hence, inferences drawn from comparisons of outcome between such groups[36, 37 and 38] might be *misleading*.[32] *By contrast* in the present trial, the use by all participants of a few weeks of simvastatin during the prerandomisation run-in period (see Methods) allows unbiased randomised comparisons of the effects of treatment on clinical outcomes within subgroups defined by each individual's apparent LDL cholesterol "responsiveness". (MRAC_03)

### *4.1.2 Monogloss*

'Monoglossic' or single-voiced utterances make no overt reference to other voices or viewpoints in the discourse. They are bare assertions that, for a given textual moment, represent "the textual voice's single, autonomous and isolated subjecthood" (Martin and White 2005, 99).

As bare assertions, 'monoglossic' utterances are not characterized or encoded by specific sets of lexical items. Rather, they are identified as main or matrix clauses that lack the kinds of verbal resources described in Section 4.1.1. For example, (4.69) contains a series of bare assertions about what was done as part of a particular study protocol. Each main or matrix clause—each sentence, in this case—represents a single instance of [monogloss].

(4.69) The first treatment group received peginterferon alfa-2b (PEG-Intron, Schering Corp, Kenilworth, NJ, USA) at a dose of 1·5 (μg/kg each week subcutaneously plus oral ribavirin (Rebetol, Schering Corp) at a dose of 800 mg/day for 48 weeks (n=511). The second group received peginterferon alfa-2b subcutaneously at a dose of 1·5 (μg/kg each week for the first 4 weeks followed by 0·5 (μg/kg per week for the next 44 weeks plus 1000–1200 mg/day of ribavirin orally for 48 weeks (n=514). The third group received interferon alfa-2b (Intron A, Schering Corp), 3 million units subcutaneously three times per week, plus ribavirin 1000–1200 mg/day orally, both for 48 weeks (n=505). In the two groups receiving 1000–1200 mg ribavirin, the dose was adjusted according to bodyweight (1000 mg for weight below 75 kg, and 1200 mg for weight 75 kg or more). For all groups, ribavirin was administered in two divided doses per day. Peginterferon alfa-2b was administered subcutaneously once per week according to weight. Both drugs were started and stopped at the same time. Patients were followed up for 24 weeks after treatment. (MRAC_23)

The clauses in (4.69) are all material, i.e. "clauses or doing or happening" (Halliday and Matthiessen 2004, 224), as are the majority of bare assertions in MRAC. Relational clauses, i.e. "clauses of being and having" (Halliday and Matthiessen 2004, 259), like those in (4.70) and (4.71), are also commonly used to express [monogloss], as are existential clauses, i.e. clauses that serve to introduce or bring into existence a particular entity or thing (Halliday and Matthiessen 2004, 307–310), like the example in (4.72).

(4.70) Dr Gotto is a consultant and speaker for Merck & Co Inc. (MRAC_08)

(4.71) The participation rate was 43 percent. (MRAC_48)

(4.72) There were 53 fatal myocardial infarctions in the placebo group as compared with 40 in the enalapril group. (MRAC_49)

The examples of [monogloss] in (4.69)–(4.72) are unlikely to 'disalign' the textual voice and the reader; rather, they are likely to be 'taken for granted', as generally accepted representations of domain-specific experience, knowledge, or fact (cf. White 2003, 263, Martin and White 2005, 100). Some instances of [monogloss], however, may carry greater interpersonal risk, potentially threatening writer–reader solidarity. In such cases, like the examples in (4.73) and (4.74), pairings of [monogloss] with [justify] or [acknowledge] may serve to anticipate and prevent or mitigate this risk.

(4.73) Peginterferon alfa-2b therapy in this study was optimised by dosing according to the patient's weight. The decision to dose the drug by weight was based on findings that response rates to interferon alfa-2b monotherapy are strongly associated with weight. (MRAC_23)

(4.74) The ob gene is an adipocyte-specific gene that encodes leptin, a protein that regulates body weight.[1] In mice, mutations in the ob gene that result in a lack of circulating leptin cause obesity. The administration of recombinant leptin causes weight loss in these mice.[2–4] (MRAC_05)

### *4.1.3 Scope and Interaction of Verbal Dialogic Resources*

Verbal [engagement] can be realized and enacted at different levels of the lexicogrammar and semantics. In its most congruent form, [engagement] is expressed at the level of the main or matrix clause, but group-, word-, and morpheme-level realizations are also possible. In some cases, multiple realizations, at varying levels of the rank scale, are deployed within a single clause or clause-complex, creating clusters or syndromes of [engagement] that overlap and interact in different ways. The overall effect is not usually one of simple addition (or subtraction), but depends on the scope or rank of the realizations and their dialogic meanings.

In (4.75), for example, there are several instances of [engagement]: three instances of [acknowledge], realized by *postulated* and the numerical references [31] and [35]; three instances of [entertain], realized by *may*, *potential*, and *when*; one instance of [counter], realized by *despite*; one instance of [deny], realized by *un-*; and one instance of [endorse], realized by *-known*. The overall effect here is not [attribute] + [attribute] + [entertain] + [attribute] + [counter] + [entertain] + [entertain] + [deny] + [endorse], even if the dialogic meanings themselves unfold in that particular order. Rather, it might be better described as ([attribute *postulated*])←[attribute [31]] + ([entertain *may*])←[attribute [35]] + [counter *despite*]→([entertain *potential*]) + [entertain *when*] + [deny *un-*]→([endorse *-known*]), where left- or right-pointing arrows indicate, respectively, that a particular feature extends retroactively or proactively over the feature(s) in parentheses.

(4.75) Ribavirin has been *postulated* to inhibit viral-dependent RNA polymerase, the capping structure of viral messenger RNA, and inosine monophosphate dehydrogenase.[31] Other immunomodulatory

> actions *may* also contribute to the drug's beneficial effects.[35] *Despite* these *potential* actions, the exact mechanism responsible for the improved response that occurs *when* ribavirin is combined with interferon is *unknown*. (MRAC_25)

In (4.76), the interaction of [engagement] features is potentially more complex. It might be summarized as (([endorse *shown*])←[attribute [8-11]])←[counter *however*]→([deny *not*]→([concur *clear*]))→([entertain *whether*]→([entertain *can*]→([deny *not*]))), where the central node in this [engagement] syndrome is the instance of [counter] realized by *however*.

(4.76) Clinical trials have *shown* that lowering elevated LDL cholesterol levels prevents both first and recurrent coronary events.[8-11] *However*, it has *not* been *clear whether* coronary events *can* be prevented by cholesterol-lowering therapy in patients who do *not* have hypercholesterolemia. (MRAC_35)

A further complication or challenge with regard to the scope and interaction of verbal [engagement] features concerns the relative strengths of those features as they extend across (parts of) propositions. Taking [counter *however*] in (4.76) as an example, the dialogic function of this feature extends retroactively and proactively over preceding and subsequent propositions. However, the semantic weight or strength of the feature is likely to be greatest at the moment of instantiation (the moment of utterance or reading) than at any other point in its scope. Instantiations in closest proximity to [counter *however*], e.g. the first [deny *not*], are likely to be affected more than those peripheral to the semantic reach of [counter *however*], e.g. [entertain *can*] or the second instance of [deny *not*]. Representation of these potential hierarchies, scopes, and strengths of instantiated meaning can become rather unwieldy, but the proactive scope and relative weight of [counter *however*] in (4.76) might be expressed diagrammatically as shown in Figure 4.2. It should be noted, though, that the diagram represents the initial semantic weights of each instance as being equal. There is, however, no reason to assume parity of semantic weight for each instance of [engagement]. The fact that the second [deny *not*] is rankshifted to part of a semantic element

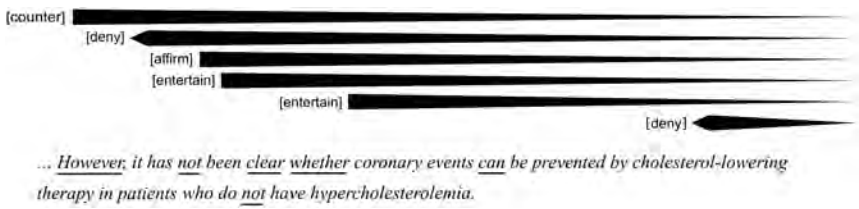


*Figure 4.2* An example of the scope, interaction, and semantic weight of [engagement].

(structurally part of an embedded clause in a nominal group in a prepositional phrase in a nominal group, etc.) suggests that it may not carry the same semantic weight as the first [deny *not*] or indeed any of the other instances of [engagement] in the example. For lack of a systematic way to determine variation in semantic weight, I have chosen to keep initial semantic weight the same for each feature.

What Figure 4.2 shows, then, is a proposition that is, overall, dialogically 'contractive', one that 'counters' and 'denies' a possible and expected proposition or position in which "coronary events are prevented by cholesterol-lowering therapy for certain patients". Despite the narrow dialogic space construed by the [counter] + [deny] pairing, other instances of [engagement], subordinate to this pairing, can perturb the dialogic space in various ways and to varying degrees. The instances of [entertain], for example, serve to 'expand' the space in which the 'countered' and 'denied' proposition can be seen as one among several possibilities, e.g. that for some patients (but not this particular group) coronary events are preventable by cholesterol-lowering medication.

### *4.1.4 Summary of Realization and Instantiation of Verbal Engagement*

Medical research articles seem to be more 'heteroglossic' than 'monoglossic'; they construe for the text a background of other voices or viewpoints, avoiding for the most part the single-voiced autonomy or authority of the textual voice. Moreover, the [heterogloss] enacted in or through these texts tends to be more 'expansive' than 'contractive', opening up the dialogic space for those alternative voices or viewpoints. 'Entertain' is the most commonly construed feature, followed by 'deny' and 'acknowledge'. Instances of 'concur', 'pronounce', and 'distance' are relatively uncommon. Most instances of [engagement], it seems, serve to 'align' the textual voice and the reader, and moments of 'disalignment' are rare. In cases where there is potential for 'disalignment', various [engagement] and [attitude] resources are mobilized to help mitigate the risk. The choice of verbal [engagement] resources in contemporary medical research articles suggests a discourse that is less polemic and potentially more consensus-seeking compared with other domains such as politics or journalism (cf. Martin and White 2005, White 2012).

## 4.2 Verbal Engagement across Generic Stages and Phases of the Medical Research Article

In the following sections, we take a closer look at the distribution of verbal [engagement] resources across the different stages and phases of the medical research article, with a view to examining the relations between the instantiation of verbal [engagement] and genre as a staged, goal-oriented social

practice (Martin 1992, 505, Martin and Rose 2008, 6). We begin with the four main sections or stages of the contemporary medical research article, the Introduction, Methods, Results, and Discussion, commonly referred to as IMRaD (see Chapter 3, Section 3.2.1).

### *4.2.1 Introductions*

The Introduction stage of contemporary medical research articles typically consists of three generic phases: describing the field of study; identifying a problem, gap, or niche in the field; and stating the main research aims or purposes in regard to the perceived problem or niche.

The first phase, describing the field of study, is characterized by a generalizable opening statement like those in (4.77) and (4.78). Both of these statements are ostensibly 'monoglossic'. In (4.77), the [monogloss] is presumably 'taken for granted', encoded as a statement of fact that needs no further support or substantiation. The apparent [monogloss] of the opening proposition in (4.78), however, is mitigated by a reference to some external source (superscript *1*). This 'attribution' may be a matter of convention—many opening statements are of this [monogloss] + [attribute] type—or it may represent a position that is 'open for discussion' and not necessarily widely held by others in the scientific-medical community. The example in (4.78) also contains an instance of [attitude: appreciation], realized by *important* (see Section 4.1.1.1.2.2 on [proclaim: pronounce]). While this may be a widely held view, especially among researchers in the field of oncology, the explicit expression of [attitude] here may require a certain amount of community support so as to present the evaluation as one that is shared and not merely grounded in the subjecthood of the textual voice.

(4.77) *The incidence of type 2 diabetes mellitus is increasing worldwide.* Type 2 diabetes results from the interaction between a genetic predisposition and behavioral and environmental risk factors.[1] Although the genetic basis of type 2 diabetes has yet to be identified, there is strong evidence that such modifiable risk factors as obesity and physical inactivity are the main nongenetic determinants of the disease.[2–9] (MRAC_43)

(4.78) Vascular endothelial growth factor (VEGF), a diffusible glycoprotein produced by normal and neoplastic cells, is an important regulator of physiologic and pathologic angiogenesis.[1] Preclinical studies have shown that a murine antihuman monoclonal antibody against VEGF can inhibit the growth of human tumor xenografts,[2] and a humanized variant of this antibody (bevacizumab [Avastin])[3] is being evaluated in clinical trials as a treatment for various cancers. (MRAC_18)

In further describing the field of study, 'monoglossic' statements like those above give way to 'heteroglossic' propositions that bring other voices into the discourse. Previous studies are explicitly 'acknowledged', and the findings and implications of those studies are variously 'endorsed' and 'entertained' as the textual voice establishes the overall field of study. Examples of some of these 'heteroglossic' resources are highlighted in (4.79) and (4.80) below.

(4.79) Patients with diabetic nephropathy have a progressive decline in glomerular function, and the treatment of hypertension in these patients slows the rate of loss of renal function[1–5]. Angiotensin-converting-enzyme inhibitors have been used in several trials[6–8]. *Findings* in studies of animals with diabetes mellitus *suggested* that angiotensin-converting-enzyme inhibitors *could* reduce glomerular damage by one or more mechanisms independent of their antihypertensive effects[9–11]. (MRAC_20)

(4.80) The treatment of human immunodeficiency virus (HIV) infection has undergone considerable change.[1–3] Protease inhibitors and non–nucleoside-analogue reverse-transcriptase inhibitors, *when* used as part of combination drug regimens, *can* profoundly suppress viral replication, with consequent repletion of CD4+ cell counts.[4–7] Multiple clinical trials have *shown* the virologic and immunologic efficacy of the newer, highly active antiretroviral-drug combinations[7,8] by measuring the plasma load of HIV RNA and CD4+ cell counts.[9–16] (MRAC_28)

The second phase of the Introduction, identifying a problem or gap in the research, is typified by 'contractive' features such as [counter] and [deny], often as [counter] + [deny] pairings (Martin and White 2005, 120)—see (4.81) and (4.82). Conjuncts such as *however* and *although* and the conjunction *but* commonly signal adversativity or counterexpectancy, invoking a contrary position that is construed not to hold. Such counterexpectancy plays an important rhetorical role in convincing the reader that not only are there gaps in the research, but that these gaps need to be addressed (see (4.81)).[1] Similarly, [deny] resources such as the negative operator *not* (see (4.81)) and the negative determiner *no*, as well as certain negative prefixes such as *un-* (see (4.82)) and *non-*, invoke and reject alternative (polar-positive and modal) positions.

(4.81) Clinical trials have shown that lowering elevated LDL [low-density lipoprotein] cholesterol levels prevents both first and recurrent coronary events.[8–11] *However*, it has *not* been clear whether coronary events can be prevented by cholesterol-lowering therapy in patients who do not have hypercholesterolemia. This issue is of importance because the large majority of patients with coronary disease have

cholesterol levels that are, like those of the general population,[12] in the average, not the elevated, range.[13–16] (MRAC_35)

(4.82) Large end point studies have demonstrated conclusively that effective cholesterol-lowering treatment can substantially reduce myocardial infarction and other coronary events. In the Scandinavian Simvastatin Survival Study the 3-hydroxy-3-methylglutaryl coenzyme A reductase inhibitor simvastatin reduced total mortality in patients with CHD by 30% because of a 42% reduction in deaths from CHD.[6] Subsequently, pravastatin was shown to reduce fatal and nonfatal coronary events in patients with[7] and without[8] CHD. *However*, it is *un*known whether benefit from reduction of low-density lipoprotein cholesterol (LDL-C) in patients without CHD (primary prevention) extends to individuals with average serum cholesterol levels, women, and older persons. (MRAC_08)

The third phase of the Introduction states the main research aim(s) or purpose(s), shifting focus from "other studies" to the "present study". This text-external to text-internal shift is marked dialogically by a specific set of [entertain] resources and a relative lack of 'acknowledgments' (cf. first two stages described above), with propositions grounded primarily in the subjecthood of the textual voice rather than external sources. Some articles formulate research purposes as closed questions (see example in (4.83)), 'entertaining' a potentially diverse dialogic background of alternative responses: yes, no, and everything in between (Martin and White 2005, 110).[2] Most articles, however, formulate research purposes as statements, with instances of [entertain] realized by nominal groups such as *the aim* or *the hypothesis*, or their verbal-group equivalents (*aimed*, *hypothesized*). Examples of these are provided in (4.84) and (4.85). In (4.84), the research purpose is stated as an indirect question and then as a hypothesis, both of which construe [entertain].[3] In (4.85), the research purpose is cast as a mental clause in which *this study*, "a product of human consciousness" directly related to the textual voice, is given the role of senser (Halliday and Matthiessen 2014, 250). The verb *aimed*, as an expression of intention or desire, construes [entertain].

(4.83) The Diabetes Prevention Program Research Group conducted a large, randomized clinical trial involving adults in the United States who were at high risk for the development of type 2 diabetes. The study was designed to answer the following primary questions: Does a lifestyle intervention or treatment with metformin, a biguanide antihyperglycemic agent, prevent or delay the onset of diabetes? Do these two interventions differ in effectiveness? Does their effectiveness differ according to age, sex, or race or ethnic group? (MRAC_19)

(4.84) We therefore asked *whether the extent of angiogenesis in human breast carcinoma correlated with the occurrence of metastasis*. The

*hypothesis* we wished to test was that lesions that have little angiogenesis have a relatively low rate of metastasis, whereas lesions that have entered a higher angiogenic state have an increased probability of metastasis. (MRAC_47)

(4.85) This study *aimed* to assess the safety and efficacy of two different regimens of peginterferon alfa-2b in combination with ribavirin compared with interferon alfa-2b plus ribavirin, and to identify predictors of response for peginterferon alfa-2b plus ribavirin. (MRAC_23)

Not all articles mark the shift from other studies to the present study 'heteroglossically'. Some present the main research purpose 'monoglossically', deploying lexicogrammatical resources that otherwise construe [heterogloss: expand: attribute]. In (4.86), for example, *report* does not 'acknowledge' some external source; rather, it grounds the proposition in the textual voice's "single, autonomous and isolated subjecthood" (Martin and White 2005, 99), retaining the text-external to text-internal shift characteristic of the generic stage.

(4.86) In this article we *report* the results from the latest NHANES [National Health and Nutrition Examination Survey] data from 1999-2000 regarding population trends in obesity and in the frequency distribution of BMI [body-mass index]. (MRAC_11)

There is little evidence of 'disalignment' in the Introduction sections of MRAC. The purpose of the Introduction stage is to present a convincing background and rationale for the study, and it is crucial that readers are 'aligned' with the textual voice by the time they read the statement of study aims, usually at the end of the Introduction. Potential 'disalignment'—for example that implied by an ostensibly 'monoglossic' opening statement or by 'counters' and 'denials'—may need to be mitigated or negotiated by 'acknowledging' the work of others and by claims of importance or relevance, as we saw in (4.78).

In summary, Introduction sections are characterized by a changing set of verbal [engagement] resources as the generic stage unfolds. The phase that describes the field of study is characterized by an opening statement that is ostensibly 'monoglossic' followed by a series of dialogically expansive 'acknowledgments' to and 'endorsements' of other researchers' work; the phase that identifies a gap in the field is characterized by dialogically contractive 'counters' and 'denials'; and the phase that states the main research purpose is characterized by 'entertain' and 'monogloss'. Overall, in terms of verbal [engagement], medical research article introductions represent a dialogic narrowing that resembles the general-to-particular funnelling effect described by Hill et al. (1982, 335–336), Swales (1990, 133–134), and Atkinson (1992, 341) for research article introductions and that mirrors a text-external to text-internal shift in the text.

### *4.2.2 Methods*

The Methods section of contemporary medical research articles typically comprises two generic phases: describing the study material, and recounting the experimental and data-analysis procedures.

The first of these two phases, describing the study material, variously includes a description of the study-type, the nature and size of the study sample, the selection of study groups (including an account of inclusion and exclusion criteria), study location, and/or length of study period. These descriptions are often 'monoglossic', presented as bare assertions—material and relational clauses of doing, happening, and being—that do not recognize or invoke other voices in the dialogic space. The "autonomous subjecthood" of the textual voice and its presumed role in collecting study material can be taken as given (see (4.87)).

(4.87) The double-blind, two-by-two factorial, randomized Heart Outcomes Prevention Evaluation study evaluated ramipril and vitamin E in 9541 patients. A substudy compared a low dose of ramipril (2.5 mg per day) with a full dose (10 mg per day) or placebo; there were 244 patients in each group. The results of the placebo-controlled study of full-dose ramipril are given here. (MRAC_50)

Some studies are direct follow-up or continuation studies of previous or ongoing research and thus elaborate upon previously published work. In such instances (see (4.88) below), the Methods section opens with a reference or references to previously published research, offering the reader a more comprehensive description of some or all of the methods used and providing 'acknowledgments' and possible 'endorsements' of those methods.

(4.88) A full description of the methods of the study has been published elsewhere.[19] The key features of the conduct of the trial were as follows. (MRAC_41)

In describing and explaining the selection of study groups, certain propositions are rejected or 'denied', especially with regard to the exclusion of different patients or patient groups.[4] That 'denial' can be expressed at the level of the clause or clause-complex, or further down the rank scale, within phrases, groups, or words, as shown in examples (4.89) and (4.90), respectively. In both cases, 'justifications' (*since* and *because*) are given for those 'denials'.

(4.89) Silent myocardial infarctions were *not* included, since they could *not* be dated accurately. (MRAC_32)

(4.90) We declared 481 households *in*eligible because respondents did *not* speak English or because of cognitive or physical *in*capacity. (MRAC_09)

In some Methods sections, conditions for inclusion or exclusion are signalled by [entertain] resources like *if* and *when* (see Section 4.1.1.2.1). An example of this is provided in (4.91).

(4.91) Patients were excluded *if* they had bilateral breast cancer, untreated brain metastases, osteoblastic bone metastases, pleural effusion or ascites as the only evidence of disease, a second type of primary cancer, or a Karnofsky score of less than 60. Patients were also excluded *if* they were pregnant or had received any type of investigational agent within 30 days before the study began. (MRAC_39)

Statements regarding study approval and informed consent are sometimes considered a separate phase in the Methods (Davis 2015) or a sub-phase of describing the study material (Fryer 2012). In terms of [engagement], study approval represents an 'acknowledgment' of an 'endorsement', i.e. "we, the authors, acknowledge that this study was approved [endorsed] by a local ethics committee". Similarly, informed consent suggests a double 'acknowledgment' (see Section 4.1.1.2.2.1) in which the textual voice 'acknowledges' the study participants as the source of consent and the study or researchers as the source of information. Together, study approval and informed consent constitute a research article's "ethics statement" (Davis 2015, 90–92), which, interpersonally, is an important part of asserting credibility for the research. See example (4.62), reproduced below as (4.92).

(4.92) The institutional review board at each center approved the protocol, and written informed consent was obtained from all participants or their authorized representatives. (MRAC_01)

A second phase in the Methods section is recounting the experimental procedure. This phase, like the previous phase, is characterized by 'monoglossic' statements. In (4.69)—reproduced here as (4.93)—those statements describe a step-by-step experimental study protocol. As discussed in Section 4.1.2, all seven matrix clauses construe [monogloss] and recount what was done. All clauses are material, i.e. clauses of doing or happening, and there are no instances of [heterogloss].[5]

(4.93) The first treatment group received peginterferon alfa-2b (PEG-Intron, Schering Corp, Kenilworth, NJ, USA) at a dose of 1·5 μg/kg each week subcutaneously plus oral ribavirin (Rebetol, Schering Corp) at a dose of 800 mg/day for 48 weeks (n=511). The second group received peginterferon alfa-2b subcutaneously at a dose of 1·5 μg/kg each week for the first 4 weeks followed by 0·5 μg/kg per week for the next 44 weeks plus 1000–1200 mg/day of ribavirin orally for 48 weeks (n=514). The third group received interferon alfa-2b (Intron A, Schering Corp), 3 million units subcutaneously

three times per week, plus ribavirin 1000–1200 mg/day orally, both for 48 weeks (n=505). In the two groups receiving 1000–1200 mg ribavirin, the dose was adjusted according to bodyweight (1000 mg for weight below 75 kg, and 1200 mg for weight 75 kg or more). For all groups, ribavirin was administered in two divided doses per day. Peginterferon alfa-2b was administered subcutaneously once per week according to weight. Both drugs were started and stopped at the same time. Patients were followed up for 24 weeks after treatment. (MRAC_23)

A similar series of 'monoglossic' statements can be seen in (4.94). Like (4.93), the text recounts what was done. However, (4.94) also includes instances of [heterogloss] that [acknowledge] previous work and [justify] certain methodological choices (highlighted below).

(4.94) Base-line plasma samples from each woman with an event and each control subject were thawed and assayed for hs-CRP, serum amyloid A, and Lp(a) lipoprotein with use of latex-enhanced immunonephelometric assays on a BN II analyzer (Dade Behring, Newark, Del.). Apolipoprotein A-I and apolipoprotein B-100 were simultaneously measured with this device by immunoassay. Total cholesterol, HDL cholesterol, and directly obtained LDL cholesterol levels were measured on a Hitachi 911 analyzer (Roche Diagnostics, Indianapolis) with reagents from Roche Diagnostics and Genzyme (Cambridge, Mass.). Plasma levels of sICAM-1 and interleukin-6 were measured by enzyme-linked immunosorbent assay (R & D Systems, Minneapolis), and the total plasma homocysteine level was measured with an IMx homocysteine assay (Abbott Laboratories, Abbott Park, Ill.) *as previously reported*.[16] Samples were handled in identical and in blinded fashion throughout the study. Samples were analyzed in triplicate and in random order *so as to reduce systematic bias and interassay variation*. (MRAC_33)

A related phase, recounting the data-analysis procedure, has a similar function to recounting the experimental procedure.[6] However, in accounting for the statistical tests and software used in the study, this phase contains fewer instances of [monogloss] and more instances of [heterogloss], particularly in the form of references and mathematical expressions of probability ([acknowledge] and [entertain], respectively).[7] Instances of [justify] are also characteristic of the phase. See highlighted examples in (4.95)–(4.97) below.

(4.95) After the serum analysis, epidemiologic, pathological, and serologic data were entered and analyzed with the EpiInfo (Centers for Disease Control, Atlanta) and Egret (Statistics and Epidemiology Research Corporation, Seattle) computer programs. Pairs of

patients and control subjects were excluded from analysis *if* serum was not available from both members of the pair. Matched analysis was done with McNemar's chi-square test with 95 percent confidence intervals as *described* previously,[34] the paired t-test, and conditional logistic regression. Unmatched analyses among case patients were done with the chi-square test, the t-test, and logistic regression. (MRAC_29)

(4.96) At the outset of the study, the size of the required sample (428 patients) was based on an *assumed* rate of clinical events of 30 percent in the angioplasty group and a reduction of that rate by 40 percent in the stent group (by a two-sided test with an *alpha error* of 0.05 and a *power* of 0.80). *To* compensate for unsuccessful interventions and losses to follow-up, the sample was enlarged by 10 percent (to 470 patients). In addition, *to* adjust for a loss of power due to a planned interim analysis, the sample was increased by another 10 percent, reaching a final size of 520 patients[11]. (MRAC_36)

(4.97) The study was designed to have 220 patients per group *in order to* have a *power* of 89 percent *to* detect a difference of 15 percentage points between the rates of sustained virologic response (30 percent vs. 45 percent), at a 5 percent level of significance (with two-sided tests). The treatment responses were compared with the use of Fisher's exact test.[21] Changes in the liver-biopsy score within each group were compared with the use of Student's t-tests.[21] The relation between pretreatment variables and treatment response was examined by stepwise logistic-regression analysis.[22] All P values are two-tailed. (MRAC_25)

None of the examples discussed in this section seem to imply 'disalignment' between the textual voice and the reader, or some third party. Any potential 'disalignment', for example with regard to choice of methods, is likely avoided through the use of 'justification', 'acknowledgment', and/or 'entertain'. A possible example of this can be seen in (4.98), where two calculations of costs are described. Note how the reasons for recalculating costs are presented as [entertain] + [justify] pairings—*partly to* and *primarily to*—connected by an instance of [counter *but*]. A final [entertain] resource, *should*, helps recognize and legitimize a position that may differ from that of the textual voice, maintaining the possibility of solidarity even with someone who might hold contrary views (cf. Martin and White 2005, 109).

(4.98) We calculated costs based on per-visit prices chosen from typical prices paid for such services by private insurers using a Resource-Based Relative Value Scale (RBRVS)[16] system in selected states. We then recalculated costs using a second set of prices chosen *partly to* reflect empirical data on the out-of-pocket costs paid by the

> respondents, *but primarily to* represent conservative estimates of the per-visit cost of alternative therapies. Total costs based on this second set of prices *should* represent a lower bound on true expenditures. (MRAC_09)

In summary, Methods sections are characterized by relatively high frequencies of [monogloss], [deny], and [justify], and low frequencies of [counter] and [entertain]. Parts of the Methods section construe a relatively narrow dialogic space, but not one that necessarily resembles Hill et al.'s (1982, 335–336) narrow funnel stem. From a dialogic perspective, the experimental procedure phase is arguably narrower than the study material and data-analysis phases that precede and succeed it, suggesting a generic stage that more closely resembles that of an hourglass, as phases open, close, then open the dialogic space for alternatives.

### *4.2.3 Results*

The Results stage of contemporary medical research articles typically comprises three or four interrelated generic phases: reporting findings, presenting data in the form of tables and graphs, describing and reporting the results of any adjustments made to the data or data analysis, and explaining or evaluating selected findings.

Some Results sections begin by reporting patient enrolment or baseline characteristics, which variably includes how many patients entered the study, how many were considered (in)eligible, how many were randomized, how many were lost to follow-up, and possible reasons for dropping out of or discontinuing the study. Other research articles present this information as part of the Methods section (see Section 4.2.2). An example of this phase in the Results section is given in (4.99). A variety of [engagement] features are instantiated. These include [monogloss] and [deny], in asserting polar-positive or polar-negative facts about patients; [entertain], in speculating on eligibility and compliance, and in making approximations; [acknowledge], in referring to previous studies or to patients' own reports of their conditions; and [counter] and [deny], at the end of the paragraph, to make clear that, despite indications to the contrary, two patients were not excluded from the study.

(4.99) > *63 603 people attended the initial screening clinic visit*, and 32 145 were *potentially* eligible and agreed to enter the prerandomisation run-in phase of the study (figure 1).[23] Of those who entered run-in, 36% were *not* subsequently randomised: 26% chose *not* to enter the trial or did *not seem likely* to be compliant for 5 years, 5% were *considered* by their own doctors to have a *clear indication* for (or, *rarely*, *contraindication* to) statin therapy, 3% had elevated concentrations of liver enzymes, creatinine, or creatine kinase in their pretreatment screening blood sample, 2% attributed various

> problems to the run-in treatment (with *about* half doing so before starting any simvastatin), 1% had *non*-fasting screening total cholesterol below 3·5 mmol/L, 0·3% *reported* having myocardial infarction, stroke, or hospitalisation for angina during run-in, and two (0·01%) developed myopathy. *Nobody* was *excluded because of* elevations in liver enzymes during run-in: central laboratory assay of blood collected at the randomisation visit *did* subsequently identify alanine aminotransferase >4XULN in two people who had been randomised, *but* both continued in the study and those elevations were *not* persistent. (MRAC_03)

Not all opening phases of Results sections are as dialogically diverse as (4.99). In (4.100), for example, the opening paragraph on baseline characteristics starts with a series of 'monoglossic' statements (italicized) before recognizing or invoking other voices in the discourse.

(4.100) *Between December 4, 1989, and December 31, 1991, 4159 patients were randomly assigned to study groups, 2078 to the placebo group and 2081 to the pravastatin group. The characteristics of the patients before randomization were similar in the two groups (Table 1). In the last year of follow-up, 86 percent of the placebo group and 94 percent of the treatment group were taking their study medication.* This included the 6 percent of patients in each treatment group who were taking cholestyramine according to the protocol. Of the patients, 8 percent in the placebo group and 2 percent in the treatment group discontinued the study medication and started treatment to lower lipid levels with open-label drug therapy, as prescribed by their personal physicians. The final study visit was between January 1 and February 14, 1996, at which time the median duration of follow-up was 5.0 years (range, 4.0 to 6.2). Data were obtained to classify myocardial infarctions as confirmed or unconfirmed for all patients in whom a myocardial infarction was reported. Vital status was ascertained for the first four years for all patients and, at the end, for all but one patient. (MRAC_35)

'Monoglossic' statements are commonly used for reporting study findings.[8] In MRAC_39, for example, several instances of [monogloss] are evident. In reporting on the number of adverse events (including death) in the study, the textual voice has little or no need to recognize or invoke other voices in the discourse (see examples (4.101) and (4.102)).

(4.101) *As of October 1999, 314 patients had died (149 in the group given chemotherapy plus trastuzumab and 165 in the group given chemotherapy alone); 95 percent of these deaths were attributed*

*to progressive disease*. Two deaths, both in patients who had received an anthracycline, cyclophosphamide, and trastuzumab, were possibly related to trastuzumab therapy: one patient died of sepsis after 2 doses of trastuzumab, *and the second died of hepatitis B-related hepatorenal syndrome after 11 doses of trastuzumab*. (MRAC_39)

(4.102) *Infection occurred in 47 percent of patients who were given chemotherapy plus trastuzumab and in 29 percent of those treated with chemotherapy alone (Table 4). These infections consisted of mild-to-moderate infections of the upper respiratory tract in 72 percent of cases, catheter-related infections in 9 percent, a viral syndrome in 3 percent, and other types of infections in 16 percent. Of the 14 catheter-related infections among patients who received trastuzumab, 3 were severe, 13 required treatment, and 4 required surgical removal of the catheter. The incidence of sepsis was low and evenly distributed among the four subgroups. The addition of trastuzumab to the chemotherapy regimen increased the frequency of leukopenia and anemia (Table 4). These cases of cytopenia were mild to moderate in severity* and did not necessitate the discontinuation of trastuzumab or withdrawal from the study. (MRAC_39)

When the textual voice does recognize or invoke a dialogic background, it typically does so through negation or modality (see instances in (4.101) and (4.102) above). The Results section of MRAC_39, to continue with the same example, concludes with two instances of [deny] (see (4.103)). However, what is 'denied' or rejected in (4.103) is not some commonly held "misunderstanding or misconception"; the rejection is not "corrective" (Martin and White 2005, 120). Rather, the rejected propositions are based on prior, text-internal utterances, set up in the Abstract, Introduction, and Methods, as part of the study aims. Those aims are reproduced in (4.104), taken from the Introduction of MRAC_39. This use of [deny], as rejecting some prior, text-internal proposition, is a common feature of Results sections and differs from the text-external 'denials' frequently instantiated in Introductions.

(4.103) Adding trastuzumab to the chemotherapy regimen did *not* increase the risk of other adverse events related to chemotherapy, and in *no* patient were antibodies against trastuzumab detected. (MRAC_39)

(4.104) We report the results of a phase 3 trial in which women with cancers that overexpressed HER2 who had not previously received chemotherapy for metastatic disease were randomly assigned to receive either chemotherapy alone or chemotherapy plus trastuzumab. The primary end points of the study were the time to disease progression and the incidence of adverse effects. Secondary

> end points were the rates and the duration of responses, the time to treatment failure, and overall survival. (MRAC_39)

References to nonverbal or multimodal material in tables and graphs usually take one of three forms. Most commonly, they are given as parenthetical additions, as in (4.105), but occasionally they take the form of 'monoglossic' directives (see (4.106)).[9] Less frequently, references to tables and graphs are an integral part of the clause (cf. Swales 1990, 148, Fløttum 2003a, 102–105, Fløttum et al. 2006, 227), appearing in Subject position or as part of a circumstantial Adjunct, e.g. *Table 3 shows* (MRAC_06) or *are shown in Figure 2* (MRAC_16, MRAC_23).[10] In both examples, *show* is used in the sense of "be, allow, or cause to be visible" rather than "demonstrate or prove" (Oxford English Dictionary; cf. [endorse *show*], Section 4.1.1.1.2.3).

(4.105) Enrolment began in March, 1998, and the trial was completed in October, 2000. A total of 2316 patients were screened, and 1530 were enrolled and treated (*figure 1*). (MRAC_23)

(4.106) The proportional reduction in LDL cholesterol produced by actual use of 40 mg simvastatin daily is approximately independent of the presenting cholesterol concentration (*see table 4 footnote*). (MRAC_03)

None of the Results sections in the material I examined include a specific generic phase that explains or evaluates selected findings. However, interpretations of selected findings are offered at various points in the section. In (4.107) and (4.108), explanations or evaluations are given and clusters or syndromes of verbal and mathematical [entertain] (see Chapter 5, Section 5.1.1.2) are deployed as authors speculate on the significance of their findings.

(4.107) No mutations were detected, *suggesting* that only a subgroup of cancers, in which EGFR signaling *may* play a critical role in tumorigenesis, harbor EGFR mutations. (MRAC_22)

(4.108) Few women with a history of VTE were enrolled, but these data *suggest* a *possibility* that these women *may* be at greater risk of future VTE events *when* taking estrogen plus progestin (7 vs 1; *HR*, 4.90; *95% CI*, 0.58-41.06) than those without a history of VTE (144 vs 66; *HR*, 2.06; *95% CI*, 1.54-2.76). (MRAC_34)

It seems that Results sections, perhaps more than any other section in medical research articles, are grounded in the (often autonomous) subjecthood of the textual voice rather than some external source. While this may imply a generic stage in which the relation between writer and reader is at greater risk of 'disalignment', there seem to be few if any examples of this in the corpus. Instances of [monogloss] are likely to be 'taken for granted', and dialogic features that may imply a certain interpersonal risk—those construing

[concur], [pronounce], and [endorse], for example—are scarce. In instances where there may be a threat to writer–reader solidarity, for example in interpreting or evaluating selected findings, combinations of [entertain] and [justify] ensure that, even in the case of disagreement, 'disalignment' between the writer and reader (or some other third party) is unlikely.

In summary, Results sections are relatively 'monoglossic', with few instances of [heterogloss] compared with other sections. From a more fine-grained, feature-by-feature perspective, the section is characterized by high relative frequencies of [monogloss] and [deny], and low relative frequencies of [acknowledge] and [endorse]. The section as a whole maintains a relatively narrow dialogic space for alternatives, particularly the phase that presents study findings. The statistical analyses and interpretation of selected findings in some Results sections, however, contain instances of mathematical and verbal [entertain] that suggest a broadening of the dialogic space as the section unfolds.

### *4.2.4 Discussions*

The Discussion stage of the medical research article consists of several generic phases. Those phases include reporting main findings (a reiteration of part of the Results section), exploring connections with the literature, explaining or discussing possible mechanisms or causes, discussing limitations, recommending possible applications and future research, and summarizing or concluding.

For Discussion sections that begin with a phase that reports or reiterates the study's main findings, there are usually two ways, dialogically speaking, of doing this. The first, and least common of these, is by using [monogloss] to restate, in categorical and undialogized terms, specific relationships uncovered by the study (see (4.109) and (4.110)).[11] More commonly, though, the phase appears to start as an 'endorsement'—see (4.111)–(4.113)—in which typical [endorse] resources like *find*, *show*, and *demonstrate* frame the projected proposition as being "correct, valid, undeniable or otherwise maximally warrantable" (Martin and White 2005, 126). However, unlike the 'endorsements' typical of Introductions (see Section 4.2.1), the 'endorsements' in Discussions, and especially in this phase of the Discussion, are directed primarily towards propositions within the text rather than those external to it, with the researchers or the study itself positioned as framer (see Section 4.1.1.1.2.3). In the corpus as a whole, text-internal 'endorsements' account for approximately one-third of all 'endorsements'; in Discussions, text-internal 'endorsements' like those in (4.111)–(4.113) account for approximately half of all 'endorsements'.

(4.109) The angiotensin-II–receptor antagonist irbesartan was associated with better renal outcomes than the other agents (amlodipine, placebo, and antihypertensive agents) we used. (MRAC_21)

(4.110) Peginterferon alfa-2a plus ribavirin was significantly more effective than interferon alfa-2b plus ribavirin or peginterferon alfa-2a alone for the treatment of chronic hepatitis C. (MRAC_12)

(4.111) We *found* that captopril significantly retarded the rate of loss of renal function in this group of patients with diabetic nephropathy. (MRAC_20)

(4.112) Our *findings show* that ramipril, an angiotensin-converting–enzyme inhibitor, is beneficial in a broad range of patients without evidence of left ventricular systolic dysfunction or heart failure who are at high risk for cardiovascular events. (MRAC_50)

(4.113) This study *demonstrated* a significant reduction in mortality and hospitalizations for congestive heart failure in patients treated with an angiotensin-converting-enzyme inhibitor, enalapril, in addition to conventional therapy for heart failure. (MRAC_49)

'Endorsements' become text-external again in the generic phase that explores connections with the literature, as the textual voice makes comparisons with studies it considers highly warrantable. This phase is also characterized by integral and non-integral 'acknowledgments' of other researchers' work, to provide support and substantiation for study findings. Examples are given in (4.114)–(4.116).

(4.114) Previous epidemiological studies have *shown* an association between hypertension and albuminuria in patients with type 2 diabetes who do not have renal failure.[11 12] (MRAC_40)

(4.115) Clinical trials have *demonstrated* that a structured lifestyle intervention including dietary change, weight loss, and increased physical activity can reduce the risk of progressing to diabetes mellitus from impaired glucose tolerance.[21–22] (MRAC_11)

(4.116) Excess bleeding was not higher in the patients in our study than *reported* with the same dose of acetylsalicylic acid in secondary prevention,[16] where the use of acetylsalicylic acid is now *considered* standard therapy. The advantages of using acetylsalicylic acid in hypertension have been *shown* in extremely well treated patients with hypertension, such as those in our study, and do not necessarily extend to less well treated patients with hypertension. (MRAC_16)

In exploring connections with the literature, the textual voice sometimes 'counters' and 'denies' and/or 'distances' itself from certain aspects of previous work, setting itself apart from, though not necessarily at odds with, other studies. 'Concur' and 'pronounce' also make appearances in this phase, as the textual voice seeks to substantiate and validate its own position. Examples of these are shown and highlighted in (4.117) and (4.118).

(4.117) *This finding* [endorse, text-internal] in patients without clinical heart failure at base line accords well with *findings* [endorse, text-external] from the Studies of Left Ventricular Dysfunction Prevention study.[31] That study, *however* [counter], did *not* [deny] include patients with impaired renal function. The Heart Outcomes Prevention Evaluation (HOPE) Study[32] and its substudy of patients with diabetes, MICRO-HOPE,[20] *showed* [endorse, text-external] benefits of angiotensin-I–converting enzyme inhibition in terms of the signs and symptoms of heart failure *but* [counter] *failed* [deny] to *show* [endorse, text-external] significant differences in hospitalizations for heart failure. Furthermore, the evaluation of a subgroup of the HOPE population with renal insufficiency[5] did *not* [deny] *show* [endorse, text-external] a significant effect on this outcome. *Our findings* [endorse, text-internal] *suggest* [entertain] that angiotensin II blockade in patients with renal disease decreases the risk of overt heart failure resulting in hospitalization. (MRAC_02)

(4.118) The beneficial actions of captopril *may* [entertain] also result *in part* [entertain] from the direct inhibition of the proposed deleterious effects of neurohumoral activation.[33] The renin-angiotensin system *can* [entertain] be activated after an acute myocardial infarction.[34] In patients with severe chronic heart failure, the degree of activation is a powerful determinant of survival.[33] A recent experimental study *demonstrated* [endorse] that the myocytolysis produced by endogenous angiotensin II *could* [entertain] be prevented by captopril therapy.[35] These *purported* [distance/acknowledge] mechanisms by which captopril exerts its beneficial effects (i.e., the attenuation of ventricular remodeling and the inhibition of neurohumoral activation) are *not* [deny] mutually exclusive. *Indeed* [pronounce], in this study the combination of ventricular enlargement and elevated plasma levels of neurohormones at base line was associated with a higher risk of death than that *found* [endorse, text-external] for either of these adverse prognostic indicators alone.[36] (MRAC_30)

The generic phase that discusses possible mechanisms or causes is characterized, dialogically, by instances of [entertain], [acknowledge], and [justify]. In (4.119), for example, [entertain] combines with [acknowledge] to ground speculation on causality in both the subjectivity of the textual voice and the subjectivity of several external sources. 'Justification' for this particular line of reasoning is then signalled by the conjunction *since*, and further support for the 'justification' is indicated by an additional set of 'acknowledgments'.

(4.119) Spironolactone *may* prevent myocardial fibrosis by blocking the effects of aldosterone on the formation of collagen,[5,35,36] which in

turn *could* play a part in reducing the risk of sudden death from cardiac causes, *since* myocardial fibrosis *could* predispose patients to variations in ventricular-conduction times and, hence, to reentry ventricular arrhythmias.[32,35–37] (MRAC_31)

Discussions of study limitations—or strengths and weaknesses—often refer to the extent to which study material and study findings can be generalized and how the study might be improved. In (4.120)–(4.122), a variety of [entertain], [counter], and [justify] resources are deployed in order to present possible limitations and to argue for the study's relevance despite those limitations.

(4.120) *Although* the frequency with which follow-up angiography was performed was relatively high in both groups, there was a higher rate of angiographic follow-up in the stent group (92 percent vs. 83 percent, $P = 0.008$). This difference, which *may* bias the rate of restenosis in favor of stent placement, is a limitation of the study. (MRAC_10)

(4.121) One *potential* limitation of the current study is that the rates of mortality from coronary heart disease in Finland are among the highest in the world.[23] *However*, *for a number of reasons*, we *believe* our data are *likely* to be generalizable to countries with lower rates of coronary heart disease. Within Finland, rates of coronary heart disease vary widely,[23] ranging from very high in eastern Finland (Kuopio) to lower in western Finland (Turku). In Turku, the rate of coronary heart disease in men is somewhat higher than that in men in the United States, *whereas* the rate of coronary heart disease in women in Turku is *actually* lower than that in women in the United States.[23] Furthermore, in this population, the relation between type 2 diabetes and both the prevalence[18] and incidence[24] of coronary heart disease is similar in both high-risk areas (eastern Finland) and moderate-risk areas (western Finland). (MRAC_14)

(4.122) The relatively high rates of discontinuation in the active treatment arm (42%) and crossover to active treatment in the placebo arm (10.7%) are a limitation of the study; *however*, the lack of adherence *would tend* to decrease the observed treatment effects. *Thus*, the results presented here *may* underestimate the magnitude of both adverse effects on cardiovascular disease and breast cancer and the beneficial effects on fractures and colorectal cancer among women who adhere to treatment. (MRAC_34)

Discussion sections typically conclude with a brief restatement of the main findings and remarks on the possible implications or applications of those findings. One of the characteristics of this phase is its instantiation of

[entertain]. As examples (4.123)–(4.126) show, modalizing resources such as *suggest*, *could*, *may*, *probably*, *possibility*, and *likely* are deployed to make claims about the study's relevance and application, and modulating resources such as *should* and *must* are used to make proposals for future work. The phase also includes instances of text-internal and text-external 'endorsements', as well as 'acknowledgments', 'denials', and 'counters' (see examples below).

(4.123) In summary, the addition of bevacizumab to bolus IFL conferred a clinically meaningful and statistically significant improvement in overall survival, progression-free survival, and response rate. These results *suggest* that bevacizumab plus fluorouracil-based chemotherapy *should* be considered a new option for the treatment of metastatic colorectal cancer. (MRAC_18)

(4.124) Our data *suggest* that an intensive combination drug-therapy regimen that includes a protease inhibitor *should* be considered the standard of care for patients with advanced HIV infection.[27] (MRAC_28)

(4.125) In conclusion, we have shown that patients with type 2 diabetes who have not had a myocardial infarction have a risk of infarction similar to that among nondiabetic patients who have had a prior myocardial infarction. This observation, combined with the results of previous studies showing the efficacy of lipid-lowering therapy in diabetic patients with coronary heart disease[12,13] and the high mortality (including prehospital mortality) after myocardial infarction,[14–16] *suggests* that all persons with diabetes *could* be treated as if they had prior coronary heart disease. The best way to answer this question more definitively would be to conduct a clinical trial comparing the effect of different levels of lipid-lowering therapy on coronary heart disease in diabetic subjects. Clinical trials, however, are very expensive and take many years to complete. In the short term, further confirmation of our findings *may* come from other observational studies. (MRAC_14)

(4.126) We draw four main conclusions from these data. First, among apparently healthy men, the base-line level of inflammation as assessed by the plasma concentration of C-reactive protein predicts the risk of a first myocardial infarction and ischemic stroke, independently of other risk factors. Second, the base-line concentration of C-reactive protein is not associated with the risk of venous thrombosis, a vascular event generally not associated with atherosclerosis. Third, C-reactive protein is not simply a short-term marker of risk, as has previously been demonstrated in patients with unstable angina,[9] but is also a long-term marker of risk, even for events occurring six or more years later. This observation *suggests* that the effects of inflammation are probably

> mediated through a chronic process and excludes the possibility that undetected acute illness at base line is responsible for the observed effects. Finally, the benefits of aspirin appear to be modified by underlying inflammation — an observation that raises the *possibility* of antiinflammatory as well as antiplatelet effects of this agent. The latter observation also *suggests* the *possibility* that other antiinflammatory agents *may* have a role in preventing cardiovascular disease. Moreover, these data *suggest* that inflammatory markers such as C-reactive protein *may* provide a method of identifying people for whom aspirin is *likely* to be more or less effective — a hypothesis requiring direct testing in randomized trials. (MRAC_32)

In terms of intersubjective positioning, Discussions generally work to maintain 'alignment' between the textual voice and reader. Features like [entertain] and [justify]—and, to a lesser extent, [acknowledge]—are deployed throughout the section, as the textual voice attempts to keep the reader "on side". However, the high relative frequencies of [pronounce], [concur], and text-internal [endorse] can convey "heightened personal investment" (White 2003, 269) and may imply a certain amount of interpersonal risk. Examples of this can be seen in (4.117) and (4.118), in which the textual voice appears to reject the methodologies or findings of certain studies, while vouching for its own position. The risk to writer–reader solidarity, while arguably low, seems to be greater in Discussions than in other sections.

In summary, Discussion sections are characterized by high relative frequencies of [heterogloss] and low relative frequencies of [monogloss]. The deployment of these [engagement] features and their more fine-grained subfeatures changes as the section unfolds. The phase that restates main findings is characterized by text-internal 'endorsements'; the phase that explores connections with the literature is characterized by text-external 'endorsements' and 'acknowledgments'; the phase that discusses possible mechanisms or causes is characterized by 'entertain', 'acknowledge', and 'justify'; the phase that discusses study limitations is characterized by 'entertain', 'counter', and 'justify'; and the concluding phase of the section is characterized by 'entertain'. The dialogic space in Discussions variously expands and contracts as the text unfolds, beginning relatively narrow before opening up the space to a variety of alternative voices and positions in the discourse.

### *4.2.5 Other Sections or Segments of the Medical Research Article*

In this section, we take a closer look at how verbal [engagement] is instantiated in other (sometimes overlooked) parts of the medical research article. We begin with the Abstract, the research article's peritext, before considering titles, acknowledgments, appendices, references, and the sections headed "Conflict of Interest" or "Role of the Funding Source".

*4.2.5.1 Abstracts*

The generic phases of the Abstract closely resemble the four main stages of the medical research article (see Sections 4.2.1–4.2.4). The first phase describes the background and aims for the study; the second phase describes the material and methods; the third phase presents findings; and the fourth phase provides a brief conclusion. These phases are often labelled *Background* or *Context*, *Methods*, *Results* or *Findings*, and *Conclusions* or *Interpretations*, respectively.

The first generic phase of the Abstract—the *Background* or *Context*—is characterized by [monogloss] and [endorse] (see (4.127) and (4.128), respectively). Some instances of [endorse] in (4.128) and (4.129) are 'denied' (e.g. *not been determined* and *not been confirmed*) or 'countered' (e.g. *but*) and highlight a potential gap in the field (cf. Introductions, Section 4.2.1). The aim or objective of the study is to fill this perceived gap. Unlike Introduction sections, this background or context phase, and Abstracts in general, contain few if any 'acknowledgments', and none in the form of numerical references.

(4.127) *Treatment with peginterferon alfa-2a alone produces significantly higher sustained virologic responses than treatment with interferon alfa-2a alone in patients with chronic hepatitis C virus (HCV) infection. We compared the efficacy and safety of peginterferon alfa-2a plus ribavirin, interferon alfa-2b plus ribavirin, and peginterferon alfa-2a alone in the initial treatment of chronic hepatitis C.* (MRAC_12)

(4.128) Controlled clinical trials have *shown* that beta-blockers can produce hemodynamic and symptomatic improvement in chronic heart failure, *but* the effect of these drugs on survival has *not* been *determined*. (MRAC_27)

(4.129) Context.— Observational studies have *found* lower rates of coronary heart disease (CHD) in postmenopausal women who take estrogen than in women who do not, *but* this potential benefit has *not* been *confirmed* in clinical trials.
Objective.— To *determine* if estrogen plus progestin therapy alters the risk for CHD events in postmenopausal women with established coronary disease. (MRAC_17)

In the second phase—*Methods*—[monogloss] predominates (see (4.130)) as the textual voice describes the study material and recounts the main experimental and data-analysis procedures (cf. Methods, Section 4.2.2). In (4.131), the latter part of the phase, the last sentence, includes a cluster of [engagement] resources that construe [acknowledge], [justify], and [endorse].

(4.130) *We randomly assigned 410 patients with symptomatic coronary disease to elective placement of a Palmaz-Schatz stent or*

*to standard balloon angioplasty. Coronary angiography was performed at base line, immediately after the procedure, and six months later.* (MRAC_10)

(4.131) From a cohort of 128,992 persons followed since the mid-1960s at a health maintenance organization, 186 patients with gastric carcinoma were selected as case patients and were matched according to age, sex, and race with 186 control subjects without gastric carcinoma. Stored serum samples collected during the 1960s were tested for IgG antibodies to H. pylori by enzyme-linked immunosorbent assay. Data on cigarette use, blood group, ulcer disease, and gastric surgery were obtained from questionnaires administered at enrollment. Tissue sections and pathology *reports* were *reviewed to confirm* the histologic results. (MRAC_29)

The third phase—*Results* or *Findings*—is characterized by verbal [monogloss] accompanied by mathematical-symbolic and mathematical-verbal resources construing [entertain] or [endorse] (see Chapter 5). Examples of some of these are shown in (4.132) and (4.133). 'Deny' is also frequently instantiated (cf. Results, Section 4.2.3). At the end of (4.133), for example, any assumption or anticipation of *differences* is rejected or 'denied' by the textual voice.

(4.132) The men in the quartile with the highest C-reactive protein values had three times the risk of myocardial infarction (relative risk, 2.9; P<0.001) and two times the risk of ischemic stroke (relative risk, 1.9; P = 0.02) of the men in the lowest quartile. (MRAC_32)

(4.133) Results.— After an average follow-up of 5.2 years, lovastatin reduced the incidence of first acute major coronary events (183 vs 116 first events; relative risk [RR], 0.63; 95% confidence interval [CI], 0.50-0.79; P<.001), myocardial infarction (95 vs 57 myocardial infarctions; RR, 0.60; 95% CI, 0.43-0.83; P=.002), unstable angina (87 vs 60 first unstable angina events; RR, 0.68; 95% CI, 0.49-0.95; P=.02), coronary revascularization procedures (157 vs 106 procedures; RR, 0.67; 95% CI, 0.52-0.85; P=.001), coronary events (215 vs 163 coronary events; RR, 0.75; 95% CI, 0.61-0.92; P=.006), and cardiovascular events (255 vs 194 cardiovascular events; RR, 0.75; 95% CI, 0.62-0.91; P=.003). Lovastatin (20-40 mg daily) reduced LDL-C by 25% to 2.96 mmol/L (115 mg/dL) and increased HDL-C by 6% to 1.02 mmol/L (39 mg/dL). There were *no* clinically relevant differences in safety parameters between treatment groups. (MRAC_08)

The fourth phase of the Abstract—*Conclusions* or *Interpretations*—is typically brief, usually comprising a single sentence. (The examples in (4.134)–(4.137) each show the phase in its entirety.) Like the concluding remarks

in Discussions (see Section 4.2.4), the conclusions phase of the Abstract is characterized by verbal [entertain] resources, e.g. *may*, *suggest*, *seem*, and *should*. The phase also features [monogloss], [deny], and text-internal [endorse].

(4.134) The number of microvessels per 200× field in the areas of most intensive neovascularization in an invasive breast carcinoma *may* be an independent predictor of metastatic disease either in axillary lymph nodes or at distant sites (or both). Assessment of tumor angiogenesis *may* therefore prove valuable in selecting patients with early breast carcinoma for aggressive therapy. (MRAC_47)

(4.135) Although the effects of other, unmeasured risk factors *cannot* be excluded with *certainty*, these results *suggest* that fine-particulate air pollution, or a more complex pollution mixture associated with fine particulate matter, contributes to excess mortality in certain U.S. cities. (MRAC_07)

(4.136) *Losartan prevents more cardiovascular morbidity and death than atenolol for a similar reduction in blood pressure and is better tolerated*. Losartan *seems* to confer benefits beyond reduction in blood pressure. (MRAC_06)

(4.137) *In patients with chronic hepatitis C, initial therapy with interferon and ribavirin was more effective than treatment with interferon alone*. (MRAC_25)

Abstracts are an integral part of medical research articles, but they often appear as standalone texts in databases and on journal websites. Their basic function is to summarize and promote research (see Section 3.1.2). Generically, abstracts closely resemble the four main stages of the research article. With regard to verbal [engagement] and dialogic positioning, there are some important similarities and differences between Abstracts and the Introduction, Methods, Results, and Discussion sections. For example, the background phase of the Abstract construes a text that, like the Introduction section, is dialogically 'expansive', but that, unlike Introductions, only rarely 'acknowledges' external sources. The methods phase, like the Methods section, construes a relatively narrow dialogic space, but one in which, compared with the Methods section, other voices are rarely invoked. The results phase, like the Results section, is often 'monoglossic' and may contain instances of [deny]; there is also a considerable amount of mathematical [entertain] in this phase, in the form of statistical analyses (see Section 5.2.5.1). Similarly, the conclusion phase of the Abstract resembles the first and final phases of the Discussion section, in terms of its use of [monogloss] and [entertain] to summarize main findings and to speculate on their relevance. However, compared with Discussions, there are relatively few instances of text-external [endorse]; and [counter], [deny], and [justify] are rarely used to comment on study limitations.

Abstracts instantiate few if any [engagement] features that are likely to construe 'disalignment' between the textual voice and reader. There are, for example, no instances of [pronounce] and comparatively few instances of [concur].

Space, it seems, is a crucial factor in how and when verbal [engagement] is construed in Abstracts, and how that construal compares with verbal [engagement] in the Introduction, Methods, Results, and Discussion sections. The relative brevity and semantic density of the Abstract (see León and Divasson 2006) means that, in comparison to the rest of the research article, something is inevitably lost in translation or summarization. What is lost is both ideational (Pitkin et al. 1999) and interpersonal (Adams Smith 1984, Hyland 1998, 78), and [engagement] is no exception.

In summary, Abstracts are characterized by a relative frequency of verbal [engagement] that is similar to the research article as a whole. The type and realization of [engagement] varies according to generic phase. The background phase is characterized by [monogloss] and [endorse]; the methods and results phases are characterized by [monogloss]; and the conclusion is characterized by [monogloss], text-internal [endorse], and [entertain]. The dialogic space created by each of those Abstract phases is similar to, but generally narrower than, that construed by each of the four main sections, with the first and the last phases of the Abstract potentially more dialogically 'expansive' than the second and third phases.

#### *4.2.5.2 Titles*

Titles are typically the first element a reader engages with, whether in a list of references, accompanying a standalone abstract, or in the full research article itself. Thematically, titles are likely to be understood as the point of departure for the rest of the text, what Martin and Rose (2007, 197–199) call the macro-Theme.

All of the titles in MRAC are of the nominal-group type; there are no clausal or full-sentence titles (despite their relative prevalence in medicine, biology, and biochemistry research articles; Soler 2007). The extent to which titles can be described as 'heteroglossic' or 'monoglossic' is therefore debatable. The main unit of analysis, the utterance, takes the form of a proposition realized by a clause; standalone nominal groups are not normally associated with "language as exchange" (see Halliday and Matthiessen 2014, Chapter 4). While identifying instances of [heterogloss] may be relatively straightforward—below-the-clause realizations are likely the same as those used elsewhere in medical research articles—'monoglossic' elements are more difficult to identify. The default method I have used for clauses (i.e. no heterogloss = monogloss) may be applicable to nominal-group titles, especially if one thinks of titles as representing the autonomous subjecthood of the textual voice, but their role in language as exchange is unclear. A title like *Efficacy and Safety of Recombinant*

*Human Activated Protein C for Severe Sepsis* (MRAC_01) could be represented clausally as "recombinant human activated protein C is efficacious and safe for severe sepsis". On the other hand, it could just as easily be reformulated as "How efficacious and safe is recombinant human activated protein C for severe sepsis?" or "Recombinant human activated protein C may be efficacious and safe". For these reasons, it may be more appropriate to refer to titles as either 'heteroglossic' or 'non-heteroglossic' (rather than 'monoglossic') in order to distinguish between titles that express [heterogloss] and those that do not.

The few instances of verbal [heterogloss] in titles are [deny] and [entertain]. There are also some instances of mathematical-verbal [heterogloss] (see Chapter 5). Otherwise, titles are generally 'non-heteroglossic'. Examples of 'heterogloss' (italicized) and 'non-heterogloss' can be seen in (4.138)–(4.141).

(4.138) Inflammation, Aspirin, and the *Risk* of Cardiovascular Disease in *Apparently* Healthy Men (MRAC_32)

(4.139) Mortality from Coronary Heart Disease in Subjects with Type 2 Diabetes and in *Non*diabetic Subjects with and *without* Prior Myocardial Infarction (MRAC_14)

(4.140) *Un*conventional Medicine in the United States – Prevalence, Costs, and Patterns of Use (MRAC_09)

(4.141) Peginterferon Alfa-2a plus Ribavirin for Chronic Hepatitis C Virus Infection (MRAC_12)

#### *4.2.5.3 Acknowledgments*

Acknowledgments typically express gratitude to those involved in the research, particularly those with technical, administrative, or financial roles. The section also includes a series of statements regarding potential conflicts of interest between the authors and funding bodies involved in the research (see also Section 4.2.5.6). In (4.142) and (4.143), acknowledgments are presented in 'monoglossic' terms, primarily realized by unmodulated, polar-positive relational clauses that identify and characterize participants.

(4.142) Funding was provided by Merck & Co Inc. Drs Shapiro and Beere and Ms Langendorfer are employees of Merck & Co Inc. Dr Stein is a consultant, speaker, and funded researcher for Merck & Co Inc. Dr Gotto is a consultant and speaker for Merck & Co Inc. (MRAC_08)

(4.143) We are indebted to Elizabeth Hawkins (protocol specialist), Bethann Cunningham (data manager), Lynn Morrow (data manager), Michael Wulfson, M.D. (statistician), and John Modlin, M.D. (protocol team member), for their critical contributions; to the women who participated in the trial; and to the many AIDS

> Clinical Trials Group investigators and personnel who contributed to the successful conduct of the study. (MRAC_04)

That Acknowledgments are primarily 'monoglossic' may seem counterintuitive, considering the title of the section (*acknowledgments*) and its function as an "academic thank-you note" (Salager-Meyer et al. 2009, 2011). As Salager-Meyer et al. (2006, 425) note, acknowledgements are "the only place where science is portrayed as a dialogic process that reveals the complex web of interpersonal debts implicit in the construction of knowledge". Yet this dialogic process is not made explicit through choices in the verbal ENGAGEMENT system. The *presence* of different participants is manifested through personal pronouns and determiners (*we*, *our*) and the names of colleagues and pharmaceutical companies (see (4.142) and (4.143)), but the *voices* of those participants are rarely recognized or invoked.

The few explicit instances of [heterogloss] in Acknowledgments are typically realized by the resources of projection and modality (e.g. *report*, *may*, *in part*). In (4.144), the textual voice creates a dialogic space in which a potential conflict of interest is construed as one among a number of possible alternatives. In terms of dialogic positioning, this can lead to 'disalignment' between the textual voice and reader if the reader considers the multi- or other-voicedness of the proposition to be deliberately obfuscating some relation that ought to be made clearer. For instances of [heterogloss] that likely confer less or no interpersonal risk, see (4.145) and (4.146).

(4.144) Drs. Snapinn, Zhang, and Shahinfar are employees of Merck and *may* own stock or hold stock options in Merck. (MRAC_02)

(4.145) Dr. Hurwitz was supported *in part* by a Career Development Grant (K23 CA085582–04). (MRAC_18)

(4.146) The opinions stated in the article are those of the authors and do *not* represent those of the Department of Defense or the US Air Force. (MRAC_08)

#### *4.2.5.4 Appendices*

Appendices generally provide lists of research participants and sometimes comment on the roles and responsibilities of the main authors. Examples of these are given in (4.147) and (4.148), respectively.

(4.147) The following institutions and investigators participated in the STRESS trial: Arizona Heart Institute, Phoenix (E. Davis, W. Catran, and K. Waters); Beth Israel Hospital, Boston (D.J. Diver, J. Carrozza, and C. Senerchia); [list continues] (MRAC_10)

(4.148) The members of the writing committee were Salim Yusuf, Bertram Pitt, Clarence E. Davis, William B. Hood, and Jay N. Cohn. (MRAC_49)

In one article, MRAC_22, the Appendix is an extension of the Methods section (see Section 4.2.2), describing and recounting parts of the experimental procedure in more detail. Reference to the Appendix appears in the Methods section of the paper, PDF, and HTML versions of the article, but the Appendix itself is only available in HTML (see (4.149)). An abridged extract of the Appendix is given in (4.150).

(4.149) Primer sequences and amplification conditions are explained in the Supplementary Appendix, available with the full text of this article at www.nejm.org. *EGFR* mutations in exons 19 and 21 were also sought in primary tumors of the breast (15 specimens), colon (20 specimens), kidney (16 specimens), pancreas (40 specimens), and brain (4 specimens), along with a panel of 108 cancer-derived cell lines representing diverse histologic types (listed in the Supplementary Appendix). (MRAC_22)

(4.150) This appendix has been provided by the authors *to* give readers additional information about their work. Mutational Analysis. The polymerase chain reaction was used to amplify the 28 exons comprising the EGFR gene using DNA isolated from primary tumor tissue or tumor-derived cell-lines. Primer pairs used were: Exon 1, CAGATTTGGCTCGACCTGGACATAG (sense) and CAGCTGATCTCAAGGAAACAGG (antisense); [list continues]. Nested PCR amplification of DNA extracted from archival tumor tissue was performed as follows. An initial PCR for exons 2, 5, 6, 7, 11, 12, 14, 16, 18, 19, 20, 21, 22, 23, 24, 25, 26, and 27 was generated using primers and conditions described above. Subsequently, 2 µl of this reaction was amplified in a secondary PCR using the following internal primer pairs (MRAC_22)

In terms of [engagement], Appendices are characterized by [monogloss] (see examples above). Occasional instances of [acknowledge] and [justify] are also present—see, for example, the opening sentence of (4.150) for an instance of 'justification'.

There is nothing to suggest that the [monogloss] characteristic of Appendices should be interpreted as anything other than 'taken for granted', as factual statements about who was involved and what they did; the propositions express no overt value-positions in terms of [affect], [judgment], or [appreciation] (see Section 2.4.1). 'Heteroglossic' resources are few and far between in Appendices, implying a generic stage that is primarily grounded in "the textual voice's single, autonomous and isolated subjecthood" and that is "not in tension with, or contradistinction to, any alternative position or positions" in the discourse (White 2003, 263).

Before concluding this section, the instance of [justify] in (4.150) may be worth further explication, particularly with regard to generic staging. Unlike other 'justifications' in the corpus (see Section 4.1.1.1.2.4), the 'justification'

in the opening sentence of (4.150)—*This appendix has been provided by the authors to give readers additional information about their work*—refers to the text itself, the Appendix, rather than to reasons why particular activities were carried out as part of experimental or data-analysis procedures (see examples in Section 4.2.2). The 'justification' in (4.150) is discoursal or textual rather than real-world or research-process oriented, to paraphrase the terminologies of Thomas and Hawes (1994) and Fløttum (2003a, b). It overtly signals a reason for including in the Appendix something that may otherwise be reserved for the Methods section, and which, in this case, is not included in any other articles in the corpus. Although appendices, by their very name ("a section or table of subsidiary matter at the end of a book or document", Oxford English Dictionary), can include anything considered supplementary or extrinsic to the main article, the fact that the Appendix in MRAC_22 is justified in these text-discoursal terms suggests a generic stage that is somehow unusual or marked. MRAC_22 investigates a specific genetic mutation among patients with non-small-cell lung cancer. The methods of relatively small-scale gene-based studies like this may be less familiar to readers of a general medical journal like *New England Journal of Medicine* than other types of studies such as largescale randomized controlled trials (37 of 50 articles in MRAC are RCTs). The general lack of space given to Methods sections in some research articles (see Chapter 6, Section 6.2.2 for more on this) may further account for the need for this supplementary information. The article thus retains what seems to be the generic expectation of a short Methods section while also maintaining a sense of methodological transparency. As ICMJE (2008, 13) puts it:

> Extra or supplementary materials and technical detail can be placed in an appendix where they will be accessible but will not interrupt the flow of the text, or they can be published solely in the electronic version of the journal.

#### *4.2.5.5 References*

The referencing system used throughout the corpus, and indeed in most scientific-medical research, is Vancouver, a numerical endnote citation system in which superscript numbers in the main body of the text refer to a list of numbered references at the end of the article (BMJ 2018). References are not organized chronologically but based upon first mention. The basic structure for standard journal references is author names (or study group name), article title, journal name, year of publication, volume number, and page numbers. An example of the first three entries in the References section of MRAC_24 is shown in (4.151); the reference list contains 31 entries in total. In its current guidelines for authors, NEJM recommends up to 40 references (NEJM 2018). LAN recommends no more than 30 references (LAN 2018b). JAMA and BMJ do not specify a maximum or minimum number of references.

(4.151) References

1. Division of Chronic Disease Control and Community Intervention. Cardiovascular disease surveillance: stroke, 1980-1989. Atlanta: Centers for Disease Control and Prevention, 1994.
2. Fieschi C, Argentino C, Lenzi GL, Sacchetti ML, Toni D, Bozzao L. Clinical and instrumental evaluation of patients with ischemic stroke within the first six hours. J Neuro Sci 1989;91:311-22.
3. del Zoppo GJ, Poeck K, Pessin MS, et al. Recombinant tissue plasminogen activator in acute thrombotic and embolic stroke. Ann Neurol 1992;32:78- 86. (MRAC_24)

The dialogic resources in References are similar to those found in titles and are similarly scarce (see Section 4.2.5.2). However, the dialogic functionality of references needs to be considered in light of the kinds of intra- and intertextual relations they construe. Superscript numbers in the main text direct the reader to the relevant numbered entries in the References section, which in turn direct the reader to various external sources.[12] These resources act ostensibly to 'acknowledge' other voices in the discourse, but they may also serve to 'endorse' and 'justify' certain text-internal or text-external positions.

References are not only one of the defining characteristics of scientific discourse of this kind; they are also a defining characteristic of [engagement]. References are the most frequently occurring dialogic resources in medical research articles, and, more generally, they are one of the most conspicuous resources of 'heterogloss' as intertextuality in written science (cf. Bakhtin 1981 [1935], Kristeva 1984).

#### *4.2.5.6 Conflict of Interest and Role of the Funding Source*

Although typically part of the Acknowledgments section (see Section 4.2.5.3), statements declaring potential conflicts of interest are sometimes presented as separate sections or stages of the medical research article. Two Conflict-of-Interest sections are reproduced in their entireties in (4.152) and (4.153). Both of these articles also include a section headed *Role of the Funding Source*, which appears as a subsection or phase of the Methods section, reproduced below as (4.154) and (4.155).

(4.152) Conflict of interest statement

The Clinical Trial Service Unit has a staff policy of not accepting honoraria or other payments from the pharmaceutical industry, except for the reimbursement of costs to participate in scientific meetings. Coordinating centre members of the writing committee (R Collins, J Armitage, S Parish, R Peto) have, therefore, only had such costs reimbursed. P Sleight has received honoraria and costs for participating in meetings. (MRAC_03)

(4.153) Conflict of interest statement
K Kristiansson is a Merck employee and was a non-voting member of the steering committee. (MRAC_06)

(4.154) Role of the funding source
The study was designed, conducted, analysed, and interpreted by the investigators entirely independently of all funding sources. (MRAC_03)

(4.155) Role of the funding source
Study data are in a Merck database. Merck provided the study steering committee with free access to all data. The steering committee was free to interpret data and write the paper and the outcome was validated independently by the steering committee statistician. (MRAC_06)

The examples above are primarily 'monoglossic', but also include 'heteroglossic' resources that [deny] and [counter] alternative propositions. Like Acknowledgments, these generic stages or phases are only likely to 'disalign' the textual voice and reader if the reader is unconvinced that the research presented is not affected or biased in some way by the role of funding bodies. The 'countering' statement in (4.152), for example—*except for*—may lead a potential reader to question the relationship between researchers and funding bodies, particularly if those funding bodies have commercial interests in the research (cf. example (4.144) in Section 4.2.5.3). This does not necessarily imply 'disalignment', but it could lead to a more sceptical reading of the article. The primary intention of such statements, of course, is to make medical research as transparent as possible and to avoid or make clear any potential conflicts of interest.

## 4.3 Verbal Engagement and the Discipline(s) of Medicine

Although the ability to read context through text may be limited (see Fairclough 1992, 88–89), "the interpersonal resources of language […] play an important role in the negotiation of scientific knowledge and in the creation and maintenance of scholarly communities" (Matthiessen et al. 2010, 12), and an analysis of the instantiation and realization of verbal [engagement] may provide valuable insights into the discipline and ideology of medical research. The above analyses show, for example, that medical research articles are primarily 'heteroglossic', even if that [heterogloss] is often realized or instantiated at levels below the clause or proposition; there is relatively little [monogloss]. Propositions are generally supported by evidence and argumentation (cf. [acknowledge], [endorse], [justify]) or grounded in the (un)certainty of the textual voice ([entertain]), regardless of whether those propositions challenge other voices or viewpoints in the communicative context. Choices of verbal [engagement] in medical research articles imply a discourse that primarily attempts to build alliances and

seek consensus and 'alignment'. There is very little opposition or 'disalignment' (cf. mass-communicative texts examined in White 1998, 2003, 2012, Martin and White 2005, inter alia). If propositions do risk challenging the values, beliefs, or positions of readers, they tend to be so carefully negotiated, usually with additional verbal [engagement] resources, as to make 'disalignment' unlikely.

Differences in the instantiation and realization of [engagement] across different generic stages and phases of the medical research article seem to imply an epistemology and writer–reader relation that evolves as the text unfolds. The verbal [monogloss] (and mathematical [entertain]) of the Methods and Results sections, for example, may be more indicative of an objectivist ideal and an empirical, positivist epistemology than the Introduction and Discussion sections (cf. Dahl 2004, Arsenault et al. 2006, Fløttum et al. 2006, Hiltunen 2010, Hu and Wang 2014, among others). The dialogically 'expansive' Introduction and Discussion sections construe a more intersubjective position than the Methods and Results sections, emphasizing the presence of other voices and connecting the study to a wider medico-scientific context (see Rowley-Jolivet 2002, 2004, Herrando-Rodrigo 2010, Lafuente Millán 2010, Yang et al. 2015, inter alia). Adams Smith (1984) and MacDonald (2002) note that the bracketing of the relatively objective Methods and Results sections by the more subjective Introduction and Discussion sections is part of what makes the medical research article "a particularly hybrid text" (MacDonald 2002, 458). This hybridity can be seen through patterns of verbal [engagement] choices and demonstrates how certain stages and phases of the medical research article might be considered relatively harder (Methods, Results) or softer (Introduction, Discussion), more singular (Methods, Results) or more regional (Introduction, Discussion).

ICMJE (2008, 11) describes the IMRaD structure of the medical research article as "a direct reflection of the process of scientific discovery". This point is not elaborated further by ICMJE (2008), but it might be formulated, in a somewhat simplified form, as follows.

> Based on the interests or health concerns of a particular group or groups and on current medico-scientific knowledge and on funding opportunities, a particular set of hypotheses, aims, and/or research questions are proposed. Those hypotheses, aims, and/or research questions are investigated by conducting a series of tests and analyses on a sample of said group or groups, sometimes in comparison with other (unaffected) groups. The findings based on those tests and analyses are compared with the original hypotheses and with the literature, and possible explanations for agreement with or deviation from those hypotheses and other work are offered. The possible generalizability of the findings may be discussed, and suggestions for future research are sometimes proposed.

This process is an idealized one, of course, and one that is concerned primarily with the reporting of empirical studies rather than, say, case studies or reviews. Clearly, not all empirical studies and scientific discoveries follow such a process (cf. Latour and Woolgar's 1986 anthropological study of laboratory science and the production of texts). The verbal [engagement] resources identified here give us relatively limited insight into the *actual* processes behind the research and the roles and relations of those involved. Rather, choices in verbal [engagement] reflect the idealized process suggested by ICMJE (2008), but an idealized process in which exchange, interaction, and negotiation are foremost.

## Notes

1 In the third sentence of (4.81), the textual voice gives an explicit reason ('justify') as to why "[t]his issue is of importance", signalled by the conjunction *because*.
2 Although research objectives may be "more sharply focused when stated as a question" (ICMJE 2008), this option is not the default choice in contemporary medical research articles (Webber 1994, Carter-Thomas and Rowley-Jolivet 2014).
3 *Hypothesis*: "a supposition or proposed explanation made on the basis of limited evidence as a starting point for further investigation" (OED).
4 *Exclude* and *exclusion* are instances of 'semantic negation' (Fairclough 1992, 122). See Section 4.1.1.1.1 for discussion of the role of semantic negation in construing [deny].
5 The high frequency of material clauses in 'monoglossic' statements and in propositions in general in Methods sections reflects the "doings and happenings" characteristic of the stage and characteristic of the activity of "doing" research. Processes typical of these material clauses include the verbs *measure*, *give*, *take*, *receive*, *use*, *record*, *administer*, and *perform*.
6 Davis (2015, 96) argues that recounting experimental procedures and recounting data-analysis procedures are similar in "rhetorical intent" and might therefore be considered a single, combined generic phase.
7 Although the statistical tests described in Methods sections usually involve some measure of probability (e.g. the extent to which a particular outcome may be due to chance), simply stating that a particular test was performed does not necessarily encode [entertain] (see Chapter 5, Section 5.2.2).
8 'Monoglossia' in Results sections differs from that in Introductions and Methods, in that a greater number of 'monoglossic' statements are realized by relational and existential clauses rather than material clauses. Results sections focus less on what was done and more on what was observed and how those observations are characterized. Examples include *there were 142 and 209 acute major coronary events in participants treated with lovastatin and placebo, respectively* (MRAC_08) and *the incidence of thrombotic events was similar in the two groups* (MRAC_01). Note how the embedded clause in the first example is material, referring to what was done as part of the study methods.
9 Although the parenthetical addition in (6.149) is encoded as a command or directive, it is unlikely that such an instruction, in this instance, would not allow for the possibility of alternative actions, as Martin and White (2005, 111) seem to suggest.
10 Swales (1990, 148) uses the terms "integral" and "non-integral" to refer to citations, where "[a]n integral citation is one in which the name of the researcher

occurs in the actual citing sentence as some sentence-element; in a non-integral citation, the researcher occurs either in parenthesis or is referred to elsewhere by a superscript number or via some other device" (see review and discussion in Section 4.2.2.2). Similar descriptors might be usefully applied to the way texts refer to tables and figures.

11 Unlike 'monoglossic' statements in Introduction, Methods, and Results sections, those in Discussion sections are more frequently realized by relational clauses, i.e. clauses of being and having. 'Monogloss' in Discussions relates more often to characterizing research findings and less often to describing what was done or what happened than other sections. The main clauses in (4.109) and (4.110) are both relational.

12 The structure of entries in Reference sections is arguably a form of projection (see, for example, Hood 2010, 180-182), in which references, using entry 3 in (4.151) as an example, might be understood as "del Zoppo et al. report on recombinant tissue plasminogen activator in acute thrombotic and embolic stroke in this particular issue of *Annals of Neurology*". Indeed, in some referencing systems, such as the one I use in this work, article titles are set in quotation marks suggestive of direct speech, e.g. del Zoppo et al. "Recombinant tissue plasminogen activator in acute thrombotic and embolic stroke".

## References

Adams Smith, Diana E. 1984. "Medical discourse: aspects of author's comment." *ESP Journal* 3:25–36.

Arsenault, Darin J., Laurence D. Smith, and Edith A. Beauchamp. 2006. "Visual inscriptions in the scientific hierarchy: mapping the 'treasures of science'." *Science Communication* 27 (3):376–428. doi: 10.1177/1075547005285030.

Atkinson, Dwight. 1992. "The evolution of medical research writing from 1735 to 1985: the case of the Edinburgh Medical Journal." *Applied Linguistics* 13 (4):337–374.

Bakhtin, Mikhail Mikhailovich. 1981 [1935]. *The dialogic imagination: four essays*. Translated by Caryl Emerson and Michael Holquist. Edited by Michael Holquist. Austin, Texas: University of Texas Press.

BMJ. 2018. "House style." accessed 6 August 2018. https://www.bmj.com/about-bmj/resources-authors/house-style.

Carter-Thomas, Shirley, and Elizabeth Rowley-Jolivet. 2014. "A syntactic perspective on rhetorical purpose: the example of *if*-conditionals in medical editorials." *Ibérica* 28:59–82.

Dahl, Trine. 2004. "Textual metadiscourse in research articles: a marker of national culture or of academic discipline?" *Journal of Pragmatics* 36:1807–1825.

Davis, Richard Hill. 2015. "A genre analysis of medical research articles." PhD thesis, English Language, School of Critical Studies, University of Glasgow.

Fairclough, Norman. 1992. *Discourse and Social Change*. Cambridge: Polity Press.

Fløttum, Kjersti, Trine Dahl, and Torodd Kinn. 2006. *Academic Voices: Across Languages and Disciplines*. Amsterdam: John Benjamins.

Fryer, Daniel Lees. 2012. "Analysis of the generic discourse features of the medical research article: a systemic-functional approach." *Functions of Language* 19 (1):5–37.

Givón, Talmy. 2001. *Syntax: An Introduction*. revised ed. Vol. I. Amsterdam: John Benjamins.

Halliday, M. A. K., and Christian M. I. M. Matthiessen. 2004. *Introduction to Functional Grammar*. 3rd ed. London: Arnold.

Halliday, M. A. K., and Christian M. I. M. Matthiessen. 2014. *Introduction to Functional Grammar*. 4th ed. Abingdon: Routledge.

Herrando-Rodrigo, Isabel. 2010. "'If you suffer from… check the Internet': the role of engagement and self-mention devices in medical research articles and electronic popularizations." In *Constructing Interpersonality: Multiple Perspectives on Written Academic Genres*, edited by Rosa Lorés-Sanz, Pilar Mur-Dueñas and Enrique Lafuente-Millán, 255–274. Newcastle upon Tyne: Cambridge Scholars Publishing.

Hill, Susan S., Betty F. Soppelsa, and Gregory K. West. 1982. "Teaching ESL students to read and write experimental-research papers." *TESOL Quarterly* 16 (3):333–347.

Hiltunen, Turo. 2010. "'There are good reasons for this': disciplinary variation in the use of existential *there* constructions in academic research articles." In *Constructing Interpersonality: Multiple Perspectives on Written Academic Genres*, edited by Rosa Lorés-Sanz, Pilar Mur-Dueñas and Enrique Lafuente-Millán, 181–204. Newcastle upon Tyne: Cambridge Scholars Publishing.

Hood, Susan. 2010. *Appraising Research: Evaluation in Academic Writing*. Basingstoke: Palgrave Macmillan.

Hu, Guangwei, and Guihua Wang. 2014. "Disciplinary and ethnolinguistic influences on citation in research articles." *Journal of English for Academic Purposes* 14:14–28.

Hyland, Ken. 1998. *Hedging in Scientific Research Articles*. Amsterdam: John Benjamins.

International Committee of Medical Journal Editors (ICMJE). 2008. *Uniform Requirements for Manuscripts Submitted to Biomedical Journals: Writing and Editing for Biomedical Publication*. Vancouver: International Committee of Medical Journal Editors.

Kress, Gunther, and Robert Hodge. 1979. *Language as Ideology*. London: Routledge & Kegan Paul.

Kristeva, Julia. 1984. *Desire in Language: A Semiotic Approach to Literature and Art*. London: Blackwell.

Lafuente Millán, Enrique. 2010. "'Extending this claim, we propose…' The writer's presence in research articles from different disciplines." *Ibérica* 20:35–56.

LAN. 2018. "Information for authors." accessed September 5, 2018. https://www.thelancet.com/lancet/information-for-authors.

Latour, Bruno, and Steve Woolgar. 1986. *Laboratory Life: The Construction of Scientific Facts*. Princeton, NJ: Princeton University Press.

León, Isabel K., and Lourdes Divasson. 2006. "Nominal domain in the biomedical research paper: a grammatico-rhetorical study of postmodification." In *Advances in Medical Discourse Analysis: Oral and Written Contexts*, edited by Maurizio Gotti and Françoise Salager-Meyer, 289–309. Bern: Peter Lang.

MacDonald, Malcolm N. 2002. "Pedagogy, pathology and ideology: the production, transmission and reproduction of medical discourse." *Discourse & Society* 13 (4):447–467.

Martin, J. R. 1992. *English Text: System and Structure*. Amsterdam: John Benjamins.

Martin, J. R. 2008. "Innocence: realization, instantiation and individuation in a Botswanan town." In *Questioning Linguistics*, edited by A. Mahboob and N. K. Knight, 32–76. Newcastle: Cambridge Scholars.

Martin, J. R., and David Rose. 2007. *Working with Discourse: Meaning Beyond the Clause*. 2nd ed. London: Continuum.

Martin, J. R., and David Rose. 2008. *Genre Relations: Mapping Culture*. London: Equinox.

Martin, J. R., and P. R. R. White. 2005. *The Language of Evaluation: Appraisal in English*. Basingstoke: Palgrave Macmillan.

Matthiessen, Christian M. I. M., Kazuhiro Teruya, and Marvin Lam. 2010. *Key Terms in Systemic Functional Linguistics*. London: Continuum.

Pitkin, Roy M., Mary Ann Branagan, and Leon F. Burmeister. 1999. "Accuracy of data in abstracts of published research articles." *Jama-Journal of the American Medical Association* 281 (12):1110–1111.

Quirk, Randolf, Sidney Greenbaum, Geoffrey Leech, and Jan Svartvik. 1985. *A Comprehensive Grammar of the English Language*. London: Longman.

Rowley-Jolivet, Elizabeth. 2002. "Visual discourse in scientific conference papers: a genre-based study." *English for Specific Purposes* 21:19–40.

Rowley-Jolivet, Elizabeth. 2004. "Different visions, different visuals: a social semiotic analysis of field-specific visual composition in scientific conference presentations." *Visual Communication* 3 (2):145–175. doi: 10.1177/147035704043038.

Salager-Meyer, Françoise. 1994. "Hedges and textual communicative function in medical English written discourse." *English for Specific Purposes* 13 (2):149–170.

Salager-Meyer, Françoise, María Ángeles Alcaraz Ariza, Maryelis Pabón, and Nahirana Zambrano. 2006. "Paying one's intellectual debt: acknowledgments in scientific/conventional and complementary/alternative medical research." In *Advances in Medical Discourse Analysis: Oral and Written Contexts*, edited by Maurizio Gotti and Françoise Salager-Meyer, 407–430. Bern: Peter Lang.

Salager-Meyer, Françoise, María Ángeles Alcaraz Ariza, and Maryelis Pabón Berbesí. 2009. "'Backstage solidarity' in Spanish- and English-written medical research papers: publication context and the acknowledgment paratext." *JASIST (Journal of the American Association of Information Science and Technology)* 60 (2):307–317.

Salager-Meyer, Françoise, María Ángeles Alcaraz Ariza, Marianela Luzardo Briceño, and Georges Jabbour. 2011. "Scholarly gratitude in five geographical contexts: a diachronic and cross-generic approach of the acknowledgment paratext in medical discourse (1950–2010)." *Scientometrics* 86:763–784.

Soler, Viviana. 2007. "Writing titles in science: an exploratory study." *English for Specific Purposes* 26:90–102.

Swales, John M. 1990. *Genre Analysis: English in Academic and Research Settings*. Edited by Michael H. Long and Jack C. Richards, *The Cambridge applied linguistics series*. Cambridge: Cambridge University Press.

Thomas, Sarah, and Thomas P. Hawes. 1994. "Reporting verbs in medical journal articles." *English for Specific Purposes* 13 (2):129–148.

Tottie, Gunnel. 1987. "Rejections, denials, and explanatory statements: a reply to Fretheim." *Studia Linguistica* 41 (2):154–163.

Webber, Pauline. 1994. "The function of questions in different medical journal genres." *English for Specific Purposes* 13 (3):257–268.

White, Peter R. R. 1998. "Telling media tales: the news story as rhetoric." PhD thesis, Department of Linguistics, University of Sydney.

White, Peter R. R. 2003. "Beyond modality and hedging: a dialogic view of the language of intersubjective stance." *Text* 23 (2):259–284.

White, Peter R. R. 2012. "Exploring the axiological workings of 'reporter voice' news stories—attribution and attitudinal positioning." *Discourse, Context & Media* 1:57–67.

White, Peter R. R., and Alexanne Don. 2012. "The appraisal website." accessed February 9, 2015, last modified June 15, 2012. http://www.grammatics.com/appraisal/index.html.

Yang, An, Shu-yuan Zheng, and Guang-chun Ge. 2015. "Epistemic modality in English-medium medical research articles: a systemic functional perspective." *English for Specific Purposes* 38:1–10.

# 5 Mathematical Engagement in Medical Research Articles

This chapter presents and discusses mathematical [engagement]. It begins by examining the mathematical resources that are used to instantiate each feature or option in the ENGAGEMENT system. It then looks at the scope and interaction of those features before examining their distribution across different generic stages and phases of the medical research article. The chapter concludes with a discussion of the potential relations between mathematical [engagement] and the discipline of medical research.

## 5.1 Realizing and Instantiating Mathematical Engagement

For a summary of how mathematical [engagement] is typically instantiated and realized in text, see Section 2.4.4. For convenience, I include here the system network for mathematical-symbolic ENGAGEMENT (see Figure 5.1, reproduced earlier as Figure 2.5).

### *5.1.1 Heterogloss*

'Heteroglossic' utterances invoke other voices or viewpoints in the discourse. They 'contract' or 'expand' the space for dialogic alternatives.

#### *5.1.1.1 Contract*

Mathematical 'contraction' has two subtypes: [disclaim] and [proclaim]. These are typically realized by the resources of negation and the expression of certain logical relations.

'Disclaim'—the denying or countering of alternative propositions in the discourse—can be realized verbally or symbolically. Mathematical-verbal [disclaim] is typically expressed by the negative operator *not* or the negative prefix *non-*. Mathematical-symbolic [disclaim] is typically represented by strike-throughs, e.g. $\neq$ ("is not equal to") or $\notin$ ("is not a member of").

'Proclaim'—emphasizing the textual voice's own position or some other maximally warrantable position or proposition—can also be realized verbally and symbolically. Potential realizations of mathematical [proclaim]

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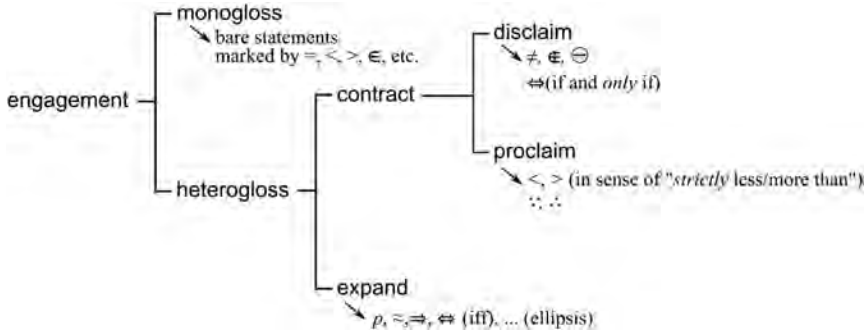



*Figure 5.1* System network for mathematical-symbolic ENGAGEMENT.

include ∴, ∵, ⊢, and ⊤ and their approximate verbal equivalents *therefore*, *because*, *proves*, and *truth*, respectively (cf. verbal [justify], [endorse], and [pronounce] in Chapter 4).[1]

In MRAC, all instances of mathematical [contract] are enacted verbally, and all are of the [disclaim] subtype. Mathematical-verbal [disclaim] is construed through the resources of negation, e.g. *not*, *no*, and *non-* (cf. verbal [disclaim: deny]). The use of these resources, as can be seen in examples (5.1)–(5.4), relate to statistical significance (i.e. "the extent to which a result deviates from that expected to arise simply from random variation or errors in sampling", Oxford English Dictionary), or rather the lack thereof. Note how the lack of significance is commonly numericized in the form of a *p*-value (see examples (5.1)–(5.3)), although there are exceptions (see example (5.4)). For more on the dialogic function of *p*-values, see Section 5.1.1.2.

(5.1) The decrease in base-line mean arterial pressure in the 155 patients in the captopril group who had preexisting hypertension averaged 7 ±11 mm Hg, and it averaged 5 ±11 mm Hg in the 153 patients with preexisting hypertension in the placebo group. This difference in blood-pressure control was *not* significant (P = 0.16). (MRAC_20)

(5.2) There was *no* significant difference in the proportion of patients with impaired vision preventing driving (visual acuity < 6/12 Snellen or ETDRS chart>0.3), although the trend was for a 28% reduction in risk in the group assigned to tight control (32/371, 8.6%) compared with the group assigned to less tight control (24/201,11.9%) (P=0.20). (MRAC_40)

(5.3) A Cox proportional-hazards model, with adjustment for age, sex, ethnic group, and FPG after 3 months' diet, with current therapies as a time-dependent variable, showed a *non*-significant risk reduction in diabetes related death for sulphonylurea plus metformin compared

with all other treatments of 5% (95%CI -33 to 32, p=0·78). (MRAC_45)

(5.4) Base-line levels of Lp(a) lipoprotein were somewhat higher and levels of apolipoprotein A-I somewhat lower among the women with events than among control subjects, but these differences were *not* significant. (MRAC_33)

Mathematical-verbal [disclaim] is realized at different levels of the rank scale. In (5.1) and (5.4), we have clausal negation, enacting propositional [disclaim: deny]. In (5.2) and (5.3), the negation is local and affixal, respectively, enacting [disclaim: deny] as part of a semantic element.

Mathematical [disclaim] serves primarily to reject alternative propositions, e.g. that some observed effect *was* statistically significant. Those potential alternatives (or expectations) are typically set up within the text itself, usually as part of the Introduction or Methods (see Sections 5.2.1 and 5.2.2). Mathematical [disclaim] in MRAC is unlikely to challenge the reader's knowledge, beliefs, or values—unless the measurements taken or the statistical tests applied are considered incorrect or inappropriate—and is unlikely to threaten writer–reader 'alignment'.

#### *5.1.1.2 Expand*

Mathematical 'expansion' is construed by the mathematical-verbal and mathematical-symbolic resources of probability and approximation. Most common among these resources are mathematical-verbal *risk* and mathematical-symbolic *p* (or *p*-value). Indeed, in MRAC, *risk* and *p*, as well as *hazard*, *mean*, and *confidence interval*, are more frequently deployed than verbally 'expansive' resources such as *may*, *suggest*, and *if* (see Chapter 4, Section 4.1.1.2.1). Examples (5.5)–(5.8) show selected mathematical-verbal and mathematical-symbolic realizations of [expand].

(5.5) The *risk* of albuminuria was reduced by 56 percent ($P = 0.01$) in the secondary-intervention cohort. (MRAC_37)

(5.6) The *relative risk* was 0.78 in the second year, 0.73 in the third year, and 0.74 in the fourth year, when the data on patients who were still alive at the end of the preceding year were analyzed. (MRAC_50)

(5.7) A small subset of women (n = 400; *average* follow-up, 57.4 months) in WHI (Women's Health Initiative) reported conditions at baseline that would have made them eligible for HERS [Heart and Estrogen/progestin Replacement Study], ie, prior MI [myocardial infarction] or revascularization procedures. Among these women with established coronary disease, the *HR* for subsequent CHD [coronary heart disease] for estrogen plus progestin relative to placebo was 1.28 (*95% CI*, 0.64-2.56) with 19 vs 16 events. The remaining women, those without prior CHD, had an identical *HR* for CHD (145 vs 106; *HR*,

1.28; *95% CI*, 1.00-1.65). Few women with a history of VTE were enrolled, but these data suggest a possibility that these women may be at greater risk of future VTE events when taking estrogen plus progestin (7 vs 1; *HR*, 4.90; *95% CI*, 0.58-41.06) than those without a history of VTE (144 vs 66; *HR*, 2.06; *95% CI*, 1.54-2.76). (MRAC_34)

(5.8) Of the 109 patients with confirmed gastric adenocarcinoma (excluding tumors of the gastroesophageal junction), 84 percent had been infected previously with H. pylori, as compared with 61 percent of the matched control subjects (*odds ratio*, 3.6; *95 percent confidence interval*, 1.8 to 7.3). Tumors of the gastroesophageal junction were not linked to H. pylori infection, nor were tumors in the gastric cardia. H. pylori was a particularly strong *risk factor* for stomach cancer in women (*odds ratio*, 18) and blacks (*odds ratio*, 9). A history of gastric surgery was independently associated with the development of cancer (*odds ratio*, 17; $P = 0.03$), but a history of peptic ulcer disease was negatively associated with subsequent gastric carcinoma (*odds ratio*, 0.2; $P = 0.02$). (MRAC_29)

*Risk* (or *relative risk*), in the sense of "a possibility of harm or damage" or "the possibility that something unpleasant or unwelcome will happen" (Oxford English Dictionary), usually represents a statistically quantifiable entity in scientific-medical research (see examples (5.5) and (5.6)). In other words, it not only encodes the meaning of possibility; it also numerically scales that meaning. Considered dialogically, *risk* 'entertains' the extent to which some outcome or endpoint is likely, and therefore also unlikely. While this may not ground "the proposition in the contingent, individual subjectivity of the speaker/writer" (Martin and White 2005, 105)—but in some form of mathematical objectivity—it still 'entertains' the possibility of alternatives in the discourse, albeit in a potentially narrower sense than, say, "albuminuria was less likely to occur in the secondary-intervention group" (cf. example (5.5)). Similarly, the dialogic 'expansion' construed by *p* (or *p*-value), a statistical measure of the probability of some effect being due to chance, is narrower than that of, say, "the probability of this effect being one of chance is very low" (see examples (5.5) and (5.8)). The same can be said for other mathematical-verbal and mathematical-symbolic expressions such as *95% CI* (*95% confidence interval*), *odds ratio*, and *hazard ratio* (*HR*) (see examples (5.7) and (5.8)).[2]

All the examples above express mathematical-verbal or mathematical-symbolic [expand] at the group or component/expression levels. However, mathematical-symbolic processes like $\approx$, $\leq$, and $\geq$, and their mathematical-verbal equivalents ("approximately equal to", "less than or equal to", and "greater than or equal to", respectively), express mathematical [expand] at the level of the clause or above. All these instances of mathematical [expand] serve to open a space for alternatives, albeit in a relatively narrow and ideationalized sense compared with instances of verbal [expand: entertain] (see Chapter 4, Section 4.1.1.2.1).

Instances of mathematical [expand] like those discussed above are unlikely to 'disalign' the textual voice and the reader. The use of such resources, from a dialogic perspective, generally implies little or no interpersonal risk, unlike certain aspects of verbal [expand], e.g. [expand: attribute: distance] (see Chapter 4, Section 4.1.1.2.2.2). Only in cases where the choice of measurement or statistical test is deemed inappropriate or incorrect are such 'expansive' resources likely to present any challenge to writer–reader solidarity.

### *5.1.2 Monogloss*

'Monoglossic' utterances are those utterances that make no overt reference to other voices or propositions in the discourse. They generally take the form of polar-positive bare assertions.

Mathematically, [monogloss] can be signalled by process symbols such as =, ∈, <, and >, and is characterized by a lack of [heterogloss] (cf. verbal [monogloss]). In MRAC, mathematical [monogloss] is expressed symbolically and verbally, e.g. *N=890* and *The body-mass index was calculated as the weight in kilograms divided by the square of the height in meters* (both from MRAC_14).[3] These examples construe [monogloss] at the level of the clause or mathematical statement, but mathematical [monogloss] can also be expressed further down the rank scale. In (5.9), for example, the [monogloss] of < is realized at a level below the clause, restricting its dialogic meaning to a semantic element in the proposition. (Note how the entire utterance in (5.9) is 'monoglossic'.)

(5.9) At nine years the proportion of patients with both a systolic blood pressure of <150 mm Hg and a diastolic blood pressure of <85 mm Hg was 56% in the group assigned to tight control and 37% in the group assigned to less tight control. (MRAC_40)

The use of mathematical symbolism to construe nonmathematical meaning is common. The symbol =, for example, is frequently used in a nonmathematical or non-numerical sense, as an explanation for abbreviations or initialisms, e.g. *ALT=alanine aminotransferase* (MRAC_03) and *HRT=hormone replacement therapy* (MRAC_44). Propositions like these are also 'monoglossic'.

Mathematical [monogloss] is likely to be 'taken for granted', without need for clarification or justification (cf. verbal [monogloss]). The examples in MRAC seem to represent little or no threat to writer–reader solidarity.

### *5.1.3 Scope and Interaction of Mathematical Dialogic Resources*

Mathematical [engagement] can be realized and enacted at different levels of the grammar and semantics. Most congruently, it is expressed at the level of the clause or statement, but expression- and component-level

realizations are also possible. This means that, within mathematical clauses or statements, multiple realizations of [engagement] can overlap and interact. While these clusters or syndromes of [engagement] are more commonly construed verbally and visually (see Sections 4.1.3 and 6.1.3 in Chapters 4 and 6, respectively), they can also be enacted mathematically.

A frequent example of this is found in the expression of probability. P-values are usually presented in the form of simple clauses or statements, e.g. $p<0.05$ or $p=0.007$. In each of these examples, the processes < and = suggest mathematical [monogloss]—"is less than" or "is equal to" (see Chapter 5, Section 5.1.2)—but the component $p$, the probability of some event or observation being one of chance, is 'heteroglossic'. At the clausal level, we have [monogloss], but within the clause, at the component or expression level, we have [heterogloss]. The ostensibly 'monoglossic' utterance is perturbed or disrupted, allowing for a potential set of alternatives within, creating a dialogic space that, while narrow, is qualitatively different from that construed by pure or unperturbed [monogloss].

Another example is the way in which mathematical-verbal [contract: disclaim] is potentially explained or 'justified' by mathematical-symbolic [expand: entertain]. In (5.1), reproduced in part as (5.10) below, the statement of probability, $P = 0.16$, provides numerical evidence or 'justification' for the mathematical-verbal construal of lack of significance.

(5.10) This difference in blood-pressure control was *not* significant ($P = 0.16$). (MRAC_20)

Similarly, in (5.11), mathematical [heterogloss] opens up the dialogic space otherwise construed as 'monoglossic' by the verbal text and provides a mathematical 'justification' for the otherwise verbally 'monoglossic' statement.

(5.11) *The effect of pravastatin was greater among women than among men* ($P = 0.05$ for the interaction between the patient's sex and treatment). (MRAC_35)

### *5.1.4 Summary of Realization and Instantiation of Mathematical Engagement*

Medical research articles seem to be mathematically more 'heteroglossic' than 'monoglossic', and more 'expansive' than 'contractive'. This is primarily due to the mathematical encoding of probability and the levels of certainty (or uncertainty) implied and often numericized by those mathematical statements. The dialogic space construed by mathematical resources is a narrow one compared with verbal and visual [engagement] (see Chapters 4 and 6, respectively).

None of the instances of mathematical [engagement] discussed herein appear to threaten writer–reader solidarity. This does not exclude potential 'disalignment', but mathematical [engagement] generally construes for the

text an ostensibly neutral intersubjective position compared with verbal and visual [engagement].

## 5.2 Mathematical Engagement across Generic Stages and Phases of the Medical Research Article

In the following sections, we take a closer look at the distribution of mathematical resources across the different stages and phases of the medical research article, with a view to examining the relations between the instantiation of mathematical [engagement] and genre as a staged, goal-oriented social practice (Martin 1992, 505, Martin and Rose 2008, 6). We begin with the four main sections or stages of the contemporary medical research article—the Introduction, Methods, Results, and Discussion—before discussing other sections or segments including the title, abstract, and appendices.

### *5.2.1 Introductions*

The Introduction stage of the medical research article usually comprises three phases: describing the field of study, identifying a gap or niche in the field, and stating the main research purpose(s) (see Chapter 3, Section 3.2.1). The Introduction contains relatively few instances of mathematical [engagement] compared with the other main stages of the text.

Among the mathematical resources that do appear in this section, mathematical-verbal *risk* is the most common (see examples (5.12)–(5.14)). It is not generally numericized (see Section 5.1.1.2). The majority of these instances of mathematical-verbal [expand] are found in the opening phase of the Introduction, but they can appear across all three phases: (5.12) is part of the phase that describes the field of study, (5.13) is from the phase that identifies a gap in the field, and (5.14) is from the phase that states the main research purpose.

(5.12) Survivors of acute myocardial infarction are at a greatly increased *risk* for subsequent fatal and nonfatal cardiovascular events.[1] This heightened *risk* is influenced by many factors, the most important of which is the severity of left ventricular dysfunction. The degree of ventricular dysfunction correlates highly with mortality and is useful in stratifying survivors of acute myocardial infarction according to *risk*.[2 3 4 5] (MRAC_30)

(5.13) Most patients with CHD have cholesterol levels that are not markedly elevated.[4] However, most randomized, controlled trials of cholesterol-lowering therapy have involved patients with at least moderate hypercholesterolemia, and the treatments used have had limited efficacy in lowering cholesterol. Taken together, those trials have demonstrated a clear reduction in the incidence of coronary

events, both among persons with a history of CHD5 and among those without such a history.[6] However, the reduction in coronary mortality associated with cholesterol-lowering therapy has been small (about 10 percent) and may be partially counterbalanced by a nonsignificant excess of deaths from noncoronary causes.[7] There has therefore been considerable uncertainty about the effects of cholesterol-lowering therapy on overall mortality among patients with high cholesterol levels[8] and about its effects on the *risk* of coronary events among patients with lower cholesterol levels. (MRAC_42)

(5.14) We report here on whether addition of metformin reduces the *risk* of clinical complications of diabetes. (MRAC_45)

Other instances of mathematical [engagement] in the Introduction include mathematical [contract: disclaim] realized by *not* and *non-*, and mathematical [expand: entertain] realized by measures of central tendency such as *average* and *median*, approximators such as *approximately*, *about*, and *around*, and expressions of probability such as *p* and *trend*. Examples of some of these mathematical-verbal and mathematical-symbolic resources are presented in (5.15)–(5.17).

(5.15) In three studies in which aspirin was compared with ticlopidine, the odds reduction, while *not* statistically significant, favoured ticlopidine by 10%.[3] (MRAC_13)

(5.16) Recently, large randomised trials have shown that lowering LDL cholesterol with 3-hydroxy-3-methylglutaryl-coenzyme A (HMG-CoA) reductase inhibitors ("statins") reduces coronary mortality and morbidity in some types of high-risk patient.[6, 7, 8, 9, 10 and 11] Typically in those trials, an *average* reduction in LDL cholesterol of *about* 1 mmol/L maintained for *about* 5 years produced a reduction in non-fatal myocardial infarction and coronary death of *about* one-quarter (which is *about* half the effect associated epidemiologically with a long-term difference of 1 mmol/L in people without diagnosed vascular disease[2 and 4]). (MRAC_03)

(5.17) The Veterans Administration Cooperative Vasodilator Heart Failure Trial[4] reported a lower mortality in patients with congestive heart failure treated with hydralazine and isosorbide dinitrate than in patients receiving placebo ($P = 0.093$). (MRAC_49)

Although relatively few in number, instances of mathematical [engagement] are deployed across all three phases of the Introduction, but are most commonly observed in the first two, as the text negotiates the research space for the study. The use of nonnumerical *risk* to construe [expand: entertain] parallels and complements to some extent the dialogic 'expansion' expressed verbally in the first two phases of the Introduction (see Section 4.2.1).

### *5.2.2 Methods*

The Methods stage of the medical research article describes the study material and explains how (and why) it was selected; it also recounts the experimental and data-analysis procedures. Mathematical [engagement] is deployed throughout the stage, but features mainly in the phase or phases that present the experimental and data-analysis procedures. It is here that the numerical basis for the study is set.

In an example from the previous chapter, reproduced here as (5.18), we can see the centrality of measurements in establishing precision and allowing replication, a keystone of empiricism and the scientific method. The entire excerpt here is 'monoglossic'. There are no approximators or other potentially 'expansive' resources, only precise numerical measurements and 'monoglossic' mathematical clauses or statements.

(5.18) The first treatment group received peginterferon alfa-2b (PEG-Intron, Schering Corp, Kenilworth, NJ, USA) at a dose of 1·5 μg/kg each week subcutaneously plus oral ribavirin (Rebetol, Schering Corp) at a dose of 800 mg/day for 48 weeks (n=511). The second group received peginterferon alfa-2b subcutaneously at a dose of 1·5 μg/kg each week for the first 4 weeks followed by 0·5 μg/kg per week for the next 44 weeks plus 1000–1200 mg/day of ribavirin orally for 48 weeks (n=514). The third group received interferon alfa-2b (Intron A, Schering Corp), 3 million units subcutaneously three times per week, plus ribavirin 1000–1200 mg/day orally, both for 48 weeks (n=505). In the two groups receiving 1000–1200 mg ribavirin, the dose was adjusted according to bodyweight (1000 mg for weight below 75 kg, and 1200 mg for weight 75 kg or more). For all groups, ribavirin was administered in two divided doses per day. Peginterferon alfa-2b was administered subcutaneously once per week according to weight. Both drugs were started and stopped at the same time. Patients were followed up for 24 weeks after treatment. (MRAC_23)

In the data-analysis phase, we find explicit mention and description of statistical tests that typically involve some measure of probability. These tests are sometimes listed without further comment or explanation, as in (5.19). In other cases, the tests are numericized. In (5.20), a low *alpha error* and a high *power* suggest lower chances of false-positive or false-negative errors, respectively. These mathematical-numerical expressions of probability encode dialogic 'expansion', since they create a (quantifiable) space in which alternative observations or results might be imagined or expected.

(5.19) After the serum analysis, epidemiologic, pathological, and serologic data were entered and analyzed with the EpiInfo (Centers for Disease

Control, Atlanta) and Egret (Statistics and Epidemiology Research Corporation, Seattle) computer programs. Pairs of patients and control subjects were excluded from analysis if serum was not available from both members of the pair. Matched analysis was done with McNemar's chi-square test with 95 percent confidence intervals as described previously,[34] the paired t-test, and conditional logistic regression. Unmatched analyses among case patients were done with the chi-square test, the t-test, and logistic regression. (MRAC_29)

(5.20) At the outset of the study, the size of the required sample (428 patients) was based on an assumed rate of clinical events of 30 percent in the angioplasty group and a reduction of that rate by 40 percent in the stent group (by a two-sided test with an alpha error of 0.05 and a power of 0.80). To compensate for unsuccessful interventions and losses to follow-up, the sample was enlarged by 10 percent (to 470 patients). In addition, to adjust for a loss of power due to a planned interim analysis, the sample was increased by another 10 percent, reaching a final size of 520 patients[11]. (MRAC_36)

In two articles in MRAC—MRAC_47 and MRAC_49—mathematical equations are a prominent part of the data-analysis phase of the Methods (see (5.21) and (5.22)). This prominence is discussed in the chapter on visual [engagement] (see Chapter 6, Section 6.2.2). Mathematically, these equations include expressions of probability or show how probability is calculated. Probability, in the form of *p*-values or *relative risk*, enacts mathematical [expand: entertain]. All the instances here are realized at the component or expression levels of the grammar.

The probability of metastasis was calculated from our logistic-regression model, which basically fit the following equation[18]:

$$\log (P/1 - P) = a + B_1x_1 + B_2x_2 \ldots,$$

where P denotes the probability of the outcome (metastasis). However, our model could be simplified:

$$\log (P/1 - P) = a + Bx,$$

where x denotes the vessel count at 200×. With the microvessel count determined at 200×, this model yielded an intercept (constant), a, of −2.614 and a slope, B, of 0.0464. Using these numbers and rearranging the above equation, we calculated the predicted probability of metastasis with a given vessel count according to the following equation:

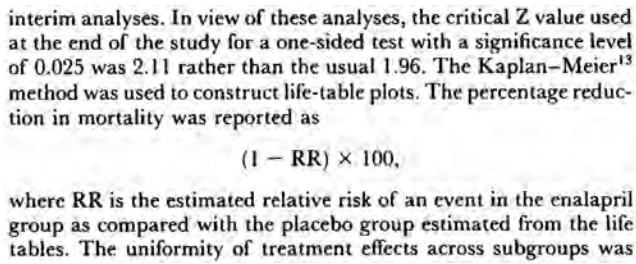
$$P = e^{a+Bx}/(1 + e^{a+Bx}).$$

For example, if the highest microvessel count per 200× field was 80, the probability of metastasis would be

(5.21) $$P = e^{-2.614+0.0464(80)}/(1 + e^{-2.614+0.0464(80)}) = 0.735.$$

(screenshot from MRAC_47)

(5.22)



interim analyses. In view of these analyses, the critical Z value used at the end of the study for a one-sided test with a significance level of 0.025 was 2.11 rather than the usual 1.96. The Kaplan–Meier[13] method was used to construct life-table plots. The percentage reduction in mortality was reported as

$$(1 - \mathrm{RR}) \times 100,$$

where RR is the estimated relative risk of an event in the enalapril group as compared with the placebo group estimated from the life tables. The uniformity of treatment effects across subgroups was

(screenshot from MRAC_49)

In summary, the main phases of the Methods stage—describing the study material and recounting the experimental and data-analysis procedures—are characterized by a combination of mathematical [monogloss] and mathematical [heterogloss: expand]. Like verbal [engagement], mathematical [engagement] in Methods sections suggests a narrow dialogic space in which there is variably little or no room for alternatives.

### *5.2.3 Results*

The Results stage of the medical research article typically reports findings, presents data, describes and reports the results of any adjustments made to the data or data analysis, and explains or evaluates selected findings. Mathematical [engagement] features heavily in this section of the article, especially with regard to statistical analyses (cf. Methods section).

The two most common realizations of mathematical [engagement] in the Results section are *p* and *risk*, both of which encode [expand: entertain] (see Section 5.1.1.2). Other expressions of probability or central tendency such as *confidence interval*, *standard deviation*, *standard error*, and *odds ratio*, as well as *mean*, *median*, and *average* function in a similar way to construe dialogic 'expansion'. Mathematical-verbal resources such as *not*, *non-*, and *no* commonly collocate with the statistical terms *significant*, *significance*, and *significantly* to express mathematical [disclaim]. Selected examples of these resources are shown below in (5.23)–(5.26).

(5.23) All-cause mortality was significantly reduced (1328 [12·9%] deaths among 10 269 allocated simvastatin versus 1507 [14·7%] among 10 267 allocated placebo; *p*=0·0003), due to a highly significant 18% (*SE* 5) proportional reduction in the coronary death rate (587 [5·7%] vs 707 [6·9%]; *p*=0·0005), a marginally significant reduction in other vascular deaths (194 [1·9%] vs 230 [2·2%]; *p*=0·07), and a *non*-significant reduction in non-vascular deaths (547 [5·3%] vs 570 [5·6%]; *p*=0·4). (MRAC_03)

(5.24) Among men, the increase in obesity was *not* significant (*P* = .0503). (MRAC_26)

(5.25) The age- and sex-adjusted *hazard ratio* was *not* significantly different from 1.0 (*hazard ratio*, 1.4; 95 percent *confidence interval*, 0.7

to 2.6), suggesting that these groups have similar mortality rates. Further adjustment for LDL cholesterol, HDL cholesterol, triglyceride, smoking, and hypertension did *not* significantly change the results. (MRAC_14)

(5.26) Data from 40 pairs of polysomnographic studies separated by 7 to 14 days showed that the subjects slept 32 minutes longer, *on average*, during the second study ($P<0.05$). However, there was *no* significant difference between study nights in the percentage of time spent in each sleep stage or in the apnea-hypopnea score. The *mean* (±*SE*) apnea-hypopnea scores for the first and second studies were 3.0 ±1.1 and 3.9 ±1.1, respectively. (MRAC_48)

Tables and graphs are frequently used in Results sections, and most contain some form of mathematical [engagement], especially of the [expand: entertain] subtype. The mathematical realization of [expand: entertain] in tables and graphs is primarily symbolic, e.g. $p$, ±, ≤, and ≥. Tables and graphs also contain instances of mathematical [monogloss], most typically marked by =, <, and >. Visual inscriptions are discussed in more detail in Chapter 6.

In summary, the Results section is dominated by mathematical-verbal and mathematical-symbolic [entertain]. The Results section contains more instances of mathematical [engagement]—both [monogloss] and [heterogloss]—than the other main sections of the medical research article.

### *5.2.4 Discussions*

The Discussion stage of the medical research article consists of several phases. Those phases include reporting or reiterating main findings, comparing with the literature, explaining or discussing possible mechanisms or causes, discussing study limitations, recommending possible applications and future research, and summarizing or concluding. Discussion sections generally contain more mathematical resources than the Introduction, but fewer than the Methods and Results sections.

Discussions sometimes include statements of mathematical probability as [expand: entertain], e.g. numerical and nonnumerical *risk*, *p*-values, *confidence intervals*, approximators, and the like. These are usually repeated from the previous section and occur in the phases that reiterate the study's main findings and summarize or conclude (see (5.27) and (5.28)). The rejection of statistically significant difference as mathematical-verbal construal of [disclaim] is also repeated in the Discussion (see (5.29)). There is generally no mathematical [monogloss] in the Discussion section.

(5.27) In AFCAPS/TexCAPS, treatment with lovastatin resulted in a 37% reduction ($P<.001$) in the *risk* for first acute major coronary events, defined as fatal or nonfatal myocardial infarction, unstable angina, or sudden cardiac death. (MRAC_08)

(5.28) We found that administering zidovudine to the mother during pregnancy and during labor and delivery and giving it to the infant for the first six weeks of life reduced the *risk* of maternal-infant transmission of HIV by *approximately* two thirds. (MRAC_04)

(5.29) Multivariable model results indicate that the only statistically significant trends were those noted overall for men and for children and adolescents. Trends did *not* differ significantly by age or racial/ethnic group. Although differences in point estimates may appear large in some subgroups, the differences are *not* statistically significant. (MRAC_26)

In summary, there are relatively few instances of mathematical [engagement] in the Discussion compared with the Methods and Results. Most instances of mathematical [engagement] in the Discussion—[entertain] and [disclaim]—are reiterations of those in the Results section.

### *5.2.5 Other Sections or Segments of the Medical Research Article*

Here, we take a closer look at how mathematical [engagement] is instantiated in other (sometimes overlooked) parts of the medical research article. We begin with the abstract—the research article's peritext—before considering titles, references, and additional material such as appendices and acknowledgments.

#### *5.2.5.1 Abstracts*

Abstracts consist of phases that resemble the four main stages of the medical research article. The first phase describes the background and aims for the study; the second describes the material and methods; the third presents the main findings; and the fourth provides a brief conclusion. The relative frequency of mathematical-verbal and mathematical-symbolic resources in the abstract is greater than that in each of the four main stages of the medical research article, including the Results section.

P-values are the most common expression of mathematical [heterogloss] in abstracts. They appear exclusively in the phase that presents the main findings. Other mathematically 'expansive' resources such as *confidence interval* (*CI*), *(relative) risk*, and *mean* are also deployed almost exclusively in the main-findings phase of the abstract. A similar pattern can be seen for mathematical 'contraction', where *not*, *no*, and *non-* are used to indicate a lack of statistically significant difference in the main findings. Mathematical [monogloss], on the other hand, is generally found in the phase that describes the material and methods. Examples of these [engagement] resources can be seen in (5.30)–(5.32).

(5.30) Results.— After an average follow-up of 5.2 years, lovastatin reduced the incidence of first acute major coronary events (183 vs 116 first

events; *relative risk [RR]*, 0.63; 95% *confidence interval [CI]*, 0.50-0.79; P<.001), myocardial infarction (95 vs 57 myocardial infarctions; *RR*, 0.60; 95% *CI*, 0.43-0.83; *P*=.002), unstable angina (87 vs 60 first unstable angina events; *RR*, 0.68; 95% *CI*, 0.49-0.95; *P*=.02), coronary revascularization procedures (157 vs 106 procedures; *RR*, 0.67; 95% *CI*, 0.52-0.85; *P*=.001), coronary events (215 vs 163 coronary events; *RR*, 0.75; 95% *CI*, 0.61-0.92; *P*=.006), and cardiovascular events (255 vs 194 cardiovascular events; *RR*, 0.75; 95% *CI*, 0.62-0.91; *P*=.003). Lovastatin (20-40 mg daily) reduced LDL-C by 25% to 2.96 mmol/L (115 mg/dL) and increased HDL-C by 6% to 1.02 mmol/L (39 mg/dL). There were *no* clinically relevant differences in safety parameters between treatment groups. (MRAC_08)

(5.31) Overall, there were *no* significant differences between groups in the primary outcome or in any of the secondary cardiovascular outcomes: 172 women in the hormone group and 176 women in the placebo group had MI or CHD death (*relative hazard [RH]*, 0.99; 95% *confidence interval [CI]*, 0.80-1.22). The lack of an overall effect occurred despite a net 11% lower low-density lipoprotein cholesterol level and 10% higher high-density lipoprotein cholesterol level in the hormone group compared with the placebo group (each *P*<.001). Within the overall null effect, there was a statistically significant time trend, with more CHD events in the hormone group than in the placebo group in year 1 and fewer in years 4 and 5. More women in the hormone group than in the placebo group experienced venous thromboembolic events (34 vs 12; *RH*, 2.89; 95% *CI*, 1.50-5.58) and gallbladder disease (84 vs 62; *RH*, 1.38; 95% *CI*, 1.00-1.92). There were *no* significant differences in several other end points for which power was limited, including fracture, cancer, and total mortality (131 vs 123 deaths; *RH*, 1.08; 95% *CI*, 0.84-1.38).

(5.32) Of 4075 patients recruited to UKPDS in 15 centres, 1704 overweight (>120% ideal bodyweight) patients with newly diagnosed type 2 diabetes, *mean* age 53 years, had raised fasting plasma glucose (FPG; 6·1–15·0 mmol/L) without hyperglycaemic symptoms after 3 months' initial diet. 753 were included in a randomised controlled trial, *median* duration 10·7 years, of conventional policy, primarily with diet alone (*n=411*) versus intensive blood-glucose control policy with metformin, aiming for FPG below 6 mmol/L (*n=342*). A secondary analysis compared the 342 patients allocated metformin with 951 overweight patients allocated intensive blood-glucose control with chlorpropamide (*n=265*), glibenclamide (*n=277*), or insulin (*n=409*). The primary outcome measures were aggregates of any diabetes-related clinical endpoint, diabetes-related death, and all-cause mortality. In a supplementary randomised controlled trial, 537 non-overweight and overweight patients, *mean* age 59 years, who were

> already on maximum sulphonylurea therapy but had raised FPG (6·1–15·0 mmol/L) were allocated continuing sulphonylurea therapy alone (*n=269*) or addition of metformin (*n=268*). (MRAC_45)

Abstracts serve to summarize and promote research (see Chapter 3, Section 3.2.1). They often contain "semantically dense nominal units" (León and Divasson 2006, 302) and relatively few instances of modality and author comment (Adams Smith 1984) compared with other stages of the research article. What we often find in the abstract is research reduced to its essence. For verbal [engagement] (see Chapter 4, Section 4.2.5.1), this means a backgrounding of certain types of dialogic meaning, e.g. [acknowledge] and [endorse], but for mathematical [engagement] there is a foregrounding of certain resources, e.g. *p* and *risk*, relative to their use in the rest of the article (consider the density of those expressions in (5.30) for example). This highlights the centrality of mathematics and mathematical meaning in medical research articles, especially as it pertains to largescale randomized controlled trials.

### *5.2.5.2 Titles*

Titles are typically the first element a reader engages with. They may be part of a list of references, in a research database, accompanying a standalone abstract, or in the full research article itself. Titles represent the article's overall macro-Theme, the point of departure for the rest of the text (Martin and Rose 2007, 197–199).

As noted in Chapter 4, Section 4.2.5.2, titles tend to be verbally 'non-heteroglossic'. The few instances of mathematical [engagement] in medical research titles, at least those in MRAC (eight of 50), are realized by non-numerical *risk*, as in examples (5.33) and (5.34).

(5.33) Helicobacter pylori infection and the *risk* of gastric carcinoma (MRAC_29)

(5.34) Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and *risk* of complications in patients with type 2 diabetes (UKPDS 33) (MRAC_44)

### *5.2.5.3 Acknowledgments and Appendices*

Acknowledgments typically express gratitude to those involved in the research, particularly those with technical, administrative, or financial roles. Appendices provide subsidiary or supplementary material. In MRAC, acknowledgments and appendices function in similar ways—both typically acknowledge and/or thank study participants and collaborators for their roles in the research—and neither usually contain mathematical resources.

In one article, however, MRAC_22, the appendix is an extension of the Methods section (see Section 5.2.2), describing and recounting parts of the experimental procedure in more detail. Parts of this appendix contain mathematical-symbolic [monogloss], realized as a series of mathematical clauses or statements, as can be seen in (5.35).

(5.35) A panel of 14 lung cancer-derived cell lines was analyzed for EGFR mutations. These were derived from tumors of NSCLC (*N=5*), small cell lung cancer (*N=6*), adenosquamous (*N=1*), bronchial carcinoid (*N=1*), and unknown histology (*N=1*). (MRAC_22)

In another article, MRAC_01, the appendix is also an extension of the Methods section, describing inclusion and exclusion criteria used in the study. Mathematical resources in this appendix include < and >, and ≤ and ≥, expressing mathematical-symbolic [monogloss] and mathematical-symbolic [expand], respectively.

#### *5.2.5.4 References*

References follow the same or similar patterns of mathematical [engagement] as titles. Most contain no mathematical [engagement] resources; the few that do usually refer to nonnumerical *risk* or *odds ratio*, potentially enacting a narrow form of mathematical [expand]. Examples (5.36) and (5.37) are taken from MRAC. In (5.37), *estimator* refers to a rule or statistic for making estimates, and *variance* is a statistical measure of the spread of a set of values. The whole title here might be said to instantiate mathematical-verbal [expand].

(5.36) Stamler J, Wentworth D, Neaton JD for the MRFIT Research Group. Is relationship between serum cholesterol and risk of premature death from coronary heart disease continuous and graded?: findings in 356,222 primary screenees of the Multiple Risk Factor Intervention Study (MRFIT). JAMA. 1986;256:2823-2828. (MRAC_08)

(5.37) Robins J, Greenland S, Breslow NE. A general estimator for the variance of the Mantel-Haenszel odds ratio. Am J Epidemiol 1986;124:719–23. (MRAC_29)

#### *5.2.5.5 Conflict of Interest and Role of the Funding Source*

The conflict-of-interest and role-of-the-funding source segments contain no mathematical resources.

## 5.3 Mathematical Engagement and the Discipline(s) of Medicine

Mathematical [engagement] in MRAC is primarily 'heteroglossic', but the kind of dialogic space suggested by mathematically 'expansive' and

'contractive' resources is always a narrow one. This is especially true of the numericized 'expansion' most commonly realized by mathematical clauses or statements of probability. P-values, confidence intervals, relative risks, hazard ratios, and odds ratios all serve to express probability—and thus construe for the text a backdrop of possible alternatives—but it is a probability that is quantified and ideationalized (cf. Doran 2016, 168). The interpersonal, and thus the dialogic, is greatly reduced or restricted in mathematics compared with language (O'Halloran 2005, 114). By quantifying probability, mathematics simultaneously construes the uncertainty and provisionality of scientific medical knowledge (Vihla 1999) and emphasizes "epistemological authority" (Jones 2013, 40) and a sense of rational truth (O'Halloran 2005, 74).

As the medical research article unfolds, the instantiation of mathematical [engagement] changes. There are relatively few instances of mathematical [engagement] in the Introduction and Discussion stages, for example, and considerably more in the Methods and Results. Mathematics plays an important role in construing for the Methods and Results stages a text or study that is objective and empirical.

## Notes

1 The meanings of these mathematical symbols vary. I include here only those verbal equivalents whose meaning potentials suggest some dialogic functionality.
2 Hazard ratio is a comparison of rates of event occurrence (e.g. death or onset of disease) between two groups. Confidence interval is a mathematical expression of the likelihood of some future result or value falling within a particular range. Odds ratio is a measure of the strength of association between two parameters.
3 Note that this mathematical-verbal expression of body mass index, BMI, can also be expressed symbolically and verbally in a variety of ways, e.g. "BMI = weight (kg) / height$^2$ (m$^2$)".

## References

Adams Smith, Diana E. 1984. "Medical discourse: aspects of author's comment." *ESP Journal* 3:25–36.

Doran, Yaegan John. 2016. "Knowledge in physics through mathematics, image and language." PhD thesis, Department of Linguistics, University of Sydney.

Jones, Rodney H. 2013. *Health and Risk Communication: An Applied Linguistic Perspective*. Abingdon: Routledge.

León, Isabel K., and Lourdes Divasson. 2006. "Nominal domain in the biomedical research paper: a grammatico-rhetorical study of postmodification." In *Advances in Medical Discourse Analysis: Oral and Written Contexts*, edited by Maurizio Gotti and Françoise Salager-Meyer, 289–309. Bern: Peter Lang.

Martin, J. R. 1992. *English Text: System and Structure*. Amsterdam: John Benjamins.

Martin, J. R., and P. R. R. White. 2005. *The Language of Evaluation: Appraisal in English*. Basingstoke: Palgrave Macmillan.

Martin, J. R., and David Rose. 2007. *Working with Discourse: Meaning Beyond the Clause*. 2nd ed. London: Continuum.

Martin, J. R., and David Rose. 2008. *Genre Relations: Mapping Culture*. London: Equinox.

O'Halloran, Kay L. 2005. *Mathematical Discourse: Language, Symbolism and Visual Images*. London: Continuum.

Vihla, Minna. 1999. *Medical Writing: Modality in Focus*. Amsterdam: Rodopi.

# 6 Visual Engagement in Medical Research Articles

This chapter presents and discusses visual [engagement]. It begins by examining the visual resources that are used to instantiate each feature or option in the ENGAGEMENT system. It then looks at the scope and interaction of those features before examining their distribution across different generic stages and phases of the medical research article. The chapter concludes with a discussion of the potential relations between visual [engagement] and the discipline of medical research.

## 6.1 Realizing and Instantiating Visual Engagement

For a summary of how visual [engagement] is typically instantiated and realized in text, see Chapter 2, Section 2.4.3. For convenience, I include here the system network for visual ENGAGEMENT (see Figure 6.1, reproduced earlier as Figure 2.4).

### *6.1.1 Heterogloss*

'Heterogloss' invokes other voices or propositions in the discourse. It 'contracts' or 'expands' the space for dialogic alternatives.

#### *6.1.1.1 Contract*

Dialogically 'contractive' visual resources are those resources that in some way act to challenge, block, or restrict the scope of alternative voices, positions, or propositions in the discourse. There are two basic types of dialogic contraction: [disclaim] and [proclaim]. The first rejects or counters other voices in the discourse; the second emphasizes the textual voice's own position or some other position or proposition it finds maximally warrantable.

##### *6.1.1.1.1 Disclaim*

There are several ways in which visual elements might reject or counter different voices, positions, or propositions in the text. In the figurative-graphical image in (6.1), for example, curved red lines connect a series of ovoid purple figures to several other figures and episodes in the image. The actions

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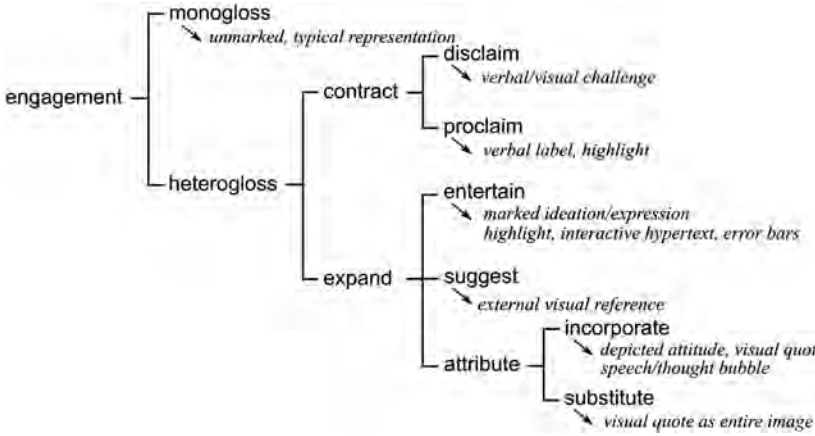
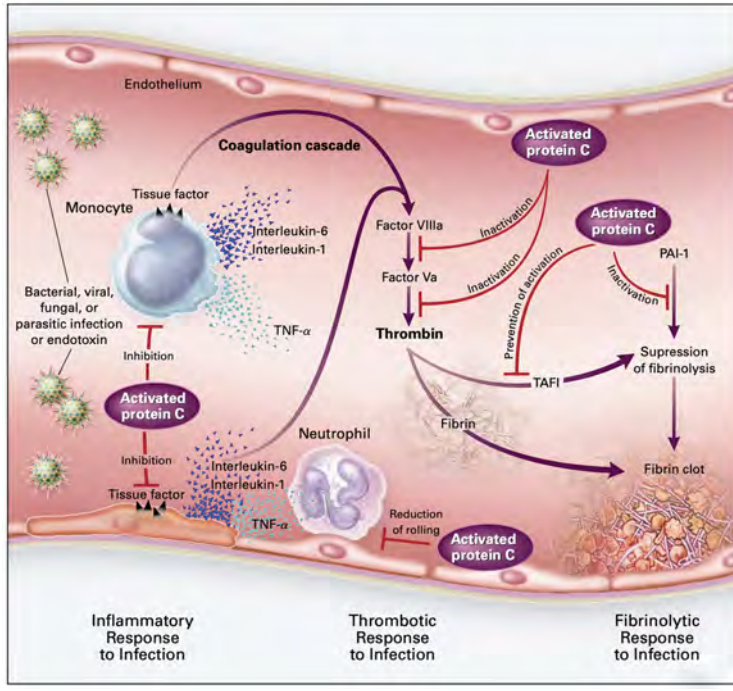



*Figure 6.1* System network for visual ENGAGEMENT (adapted from Economou (2009), Lemke (1998), O'Halloran (2005), Chen (2008, 2009, 2010), Tan (2010), and Feng and Wignell (2011)).

or processes suggested by those red lines, and by the verbal labels assigned to them (*inactivation*, *inhibition*, *reduction*, *prevention*), appear to disrupt or restrict the narrative and dialogic potential of the episodes they are directed towards and the overall left-to-right flow or 'rhythm' of the work.

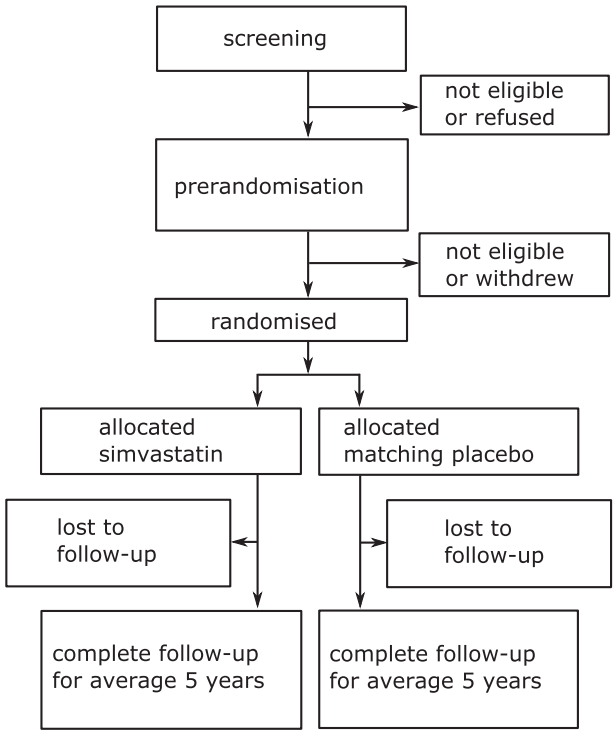



(6.1)

(MRAC_01)

Similar resources are found in scriptural-graphical images like flow-charts. In (6.2)—a redrawn diagram from MRAC_03, accounting for patient enrolment in a study—horizontal arrows, and the boxes they connect, run perpendicular to the main vertical top-down temporal flow or placement of patients into study groups.[1] The horizontal arrows and their boxes represent patients who were excluded or *lost* during the study period. Those episodes 'counter' the primarily vertical episode-nexus, and their dialogically 'contractive' potential is complemented in some instances by verbal negation, e.g. *not eligible or refused* (see Chapter 4, Section 4.1.1.1.1).

(6.2)

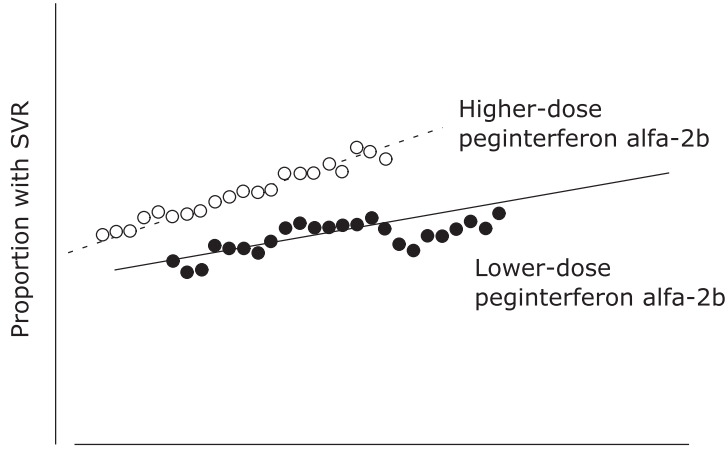



(adapted from MRAC_03)

Other instances of [disclaim] include episodes in linear regression charts like that in (6.3). Lines of best fit, or simple linear regressions, can 'deny' or at least discourage a particular (usually less linear) reading. In so doing, they make one reading, a specific linear interpretation, appear more valid or warrantable than another, nonlinear interpretation (cf. [proclaim], Section 6.1.1.1.2). Moreover, those same linear regressions represent a prediction of dependent variable values as a function

of some independent variable, in this case a prediction of the proportion of patients with SVR (sustained virologic response) as a function of increased or decreased ribavirin dosage.[2] Lines of best fit like those in (6.3) might also therefore construe mathematical-visual [entertain] (see Chapter 5, Section 5.1.1.2).

(6.3)




(adapted from MRAC_23)

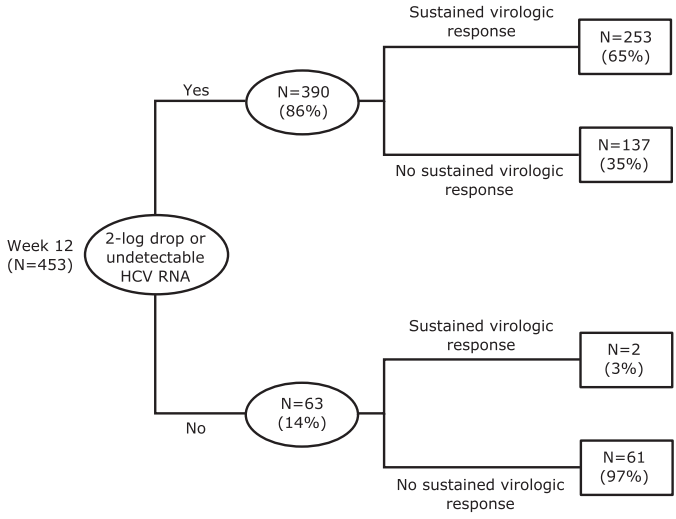
Among numerical images in MRAC, [disclaim] can be construed visually, mathematically, and verbally. The visual construal of [disclaim] in numerical images is primarily one of omission or non-inclusion, i.e. what is not represented rather than what is represented. Two common instantiations of this 'disclaim by omission' are non-use of symbols and lack of data. In Table 2 of MRAC_09, for example, several numerical values are marked with the symbols ¶, #, and **, indicating *p*-values of ≤0.05, ≤0.01, and ≤0.001, respectively. Some values, however, are not marked with those symbols, indicating that, while there may be differences in data values, those differences are *not* deemed statistically significant. There are also several instances of ellipsis ('…'), which indicate that, according to the table footnote, *data [are] not applicable*. Elsewhere in the corpus, missing data are marked by em- or en-dashes or empty spaces. It is these kinds of omission or non-inclusion that essentially function to [disclaim], rejecting or overturning generic expectations of what a numerical table typically includes.

Many of the tables and figures in the corpus include *p*-values. As discussed in Chapter 5, Section 5.1.1.2, *p* is a potential mathematical encoding of [expand: entertain], since it construes and quantifies the notion of probability. In some tables, *p*-values are given for all data comparisons; they are not only specified for those identified as statistically significant. *P*-values less than or equal to 5% (0.05) are typically considered statistically significant, while those above that threshold usually indicate relations that are

not statistically significant. In other words, the inclusion of high *p*-values in tables and graphs is a mathematical-numerical 'denial' of statistical significance, one that acknowledges and rejects the possibility or expectation of statistical significance. (Note that, in such cases, the difference between two variables or values is not what is being 'denied'; rather, it is that there is no statistically significant difference between them.)

Several of the graphical, numerical, and figurative elements in MRAC contain instances of verbal [disclaim], most typically in the form of negation. In (6.4), for example, the verbal resources *no* and *un-* construe [disclaim: deny] and are complemented by a visual representation that highlights the dialogic functionality of negation, i.e. that the use of such resources implies a background of one or more alternative (usually polar-positive) positions.[3] Other common examples of verbal [disclaim] in diagrams, graphs, and tables (and their accompanying legends and footnotes) include *none*, *non-*, and *however* (cf. findings in Chapter 4, Section 4.1.1.1.1).

(6.4)



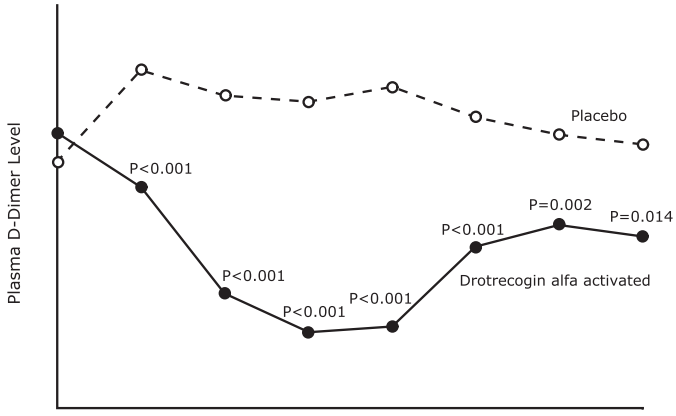

(adapted from MRAC_12)

*6.1.1.1.2 Proclaim*

By making prominent certain figures and episodes in an image, the textual voice marks those figures and episodes as somehow important, highly valued, or attention-worthy. Visual prominence allows the textual voice to distinguish between major and minor episodes in an image (O'Halloran 2005, 140) and 'proclaim' certain episodes, figures, or figure-parts to be more highly warrantable than others.

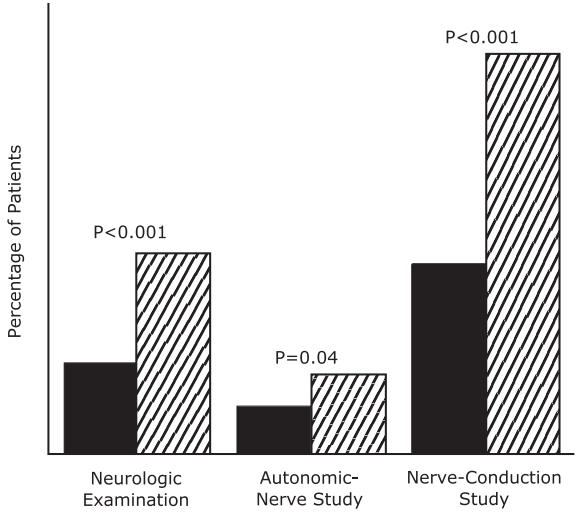
Visual prominence and the potential for 'proclaiming' importance can be expressed in a number of ways. For black-and-white or grey-tone images, solid or dark lines/areas and bold or italicized typeface tend to give greater

prominence to figures and episodes than dashed or grey lines/areas or a regular typeface. In (6.5), the filled circles and solid line of one dataset contrast with and are more prominent than the open circles and dashed line of another dataset (active treatment and placebo, respectively). Both datasets are important in this contrastive graphical image, but it is the former that, visually, represents the major episode in (6.5). Similarly, in (6.6), the solid bars representing patients receiving intensive therapy have more visual prominence than the hatched bars of patients receiving conventional therapy. The data shows the percentages of patients in these groups whose results in different neurologic studies were considered "abnormal".




(6.5)

(adapted from MRAC_01)

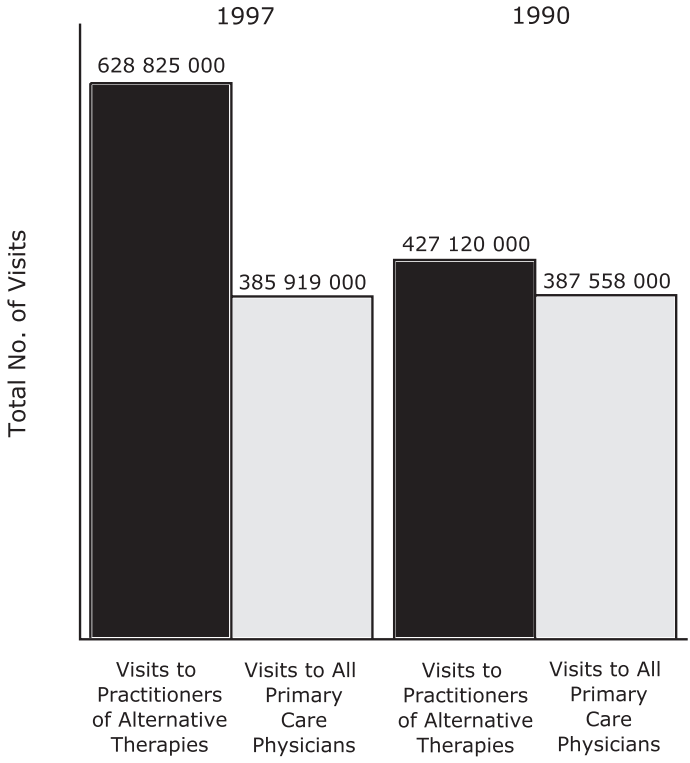



(6.6)

(adapted from MRAC_37)

One of the reasons for distinguishing datasets in this way may be the need to 'counter' readings that might otherwise privilege size or position. In (6.5), filled circles and solid lines might aid a reading that focuses, thematically, on active treatment rather than on placebo and its generally higher *y*-axis values. Similarly, the solid bars in (6.6) might encourage a reading that thematises intensive therapy rather than conventional therapy and its higher percentage of patients with adverse events. In (6.7), quantity, size, and shading combine to give prominence to the dataset marked *Visits to Practitioners of Alternative Therapies*. In all these instances, the major figures and episodes in (6.5)–(6.7) are also the main topics of the research articles from which they are taken.

(6.7)




(adapted from MRAC_09)

In numerical images such as tables, a number of strategies are used in order to foreground or emphasize different elements. As the example in (6.8) shows, horizontal lines and bold typeface can be used to distinguish between and categorize and taxonomize different variables. Capitalization and indentation can be used in similar ways. In (6.9) below, a series of key points or messages are highlighted in a separate panel—the frame of which delineates those messages from the rest of

the written text—and bullet points and reversed bold type are used for additional emphasis.

| Event type | Clopidogrel | Aspirin | Total |
|---|---|---|---|
| **Non-fatal events** | | | |
| Non-fatal ischaemic stroke | 472 | 504 | 976 |
| Non-fatal MI | 255 | 301 | 556 |
| Non-fatal primary ICH | 14 | 24 | 38 |
| Amputation | 52 | 47 | 99 |
| **Fatal events** | | | |
| Fatal ischaemic stroke | 37 | 42 | 79 |
| Fatal MI | 53 | 75 | 128 |
| Haemorrhagic death | 23 | 27 | 50 |
| Other vascular death | 260 | 261 | 521 |
| Non-vascular death | 187 | 166 | 353 |
| **Total** | 1353 | 1447 | 2800 |

(6.8)

(adapted from MRAC_13)

published. Intensive
etic subgroup of the
Follw-up Program
tality.[32]
duction in the rate of
or more steps using
he 47% reduction in
by three lines using
change from 6/6 to
1 chart) suggests that
lso prevented the
pathy, which is the
1 type 2 diabetes.[33] In
diabetic maculopa-
quiring retinal pho-
pathy responds less
on than proliferative
of maculopathy by
ht provide a major
of blindness. To our
1 patients with type 2
od pressure control
cations from diabetic

1 of patients in the

**Key messages**

- This study showed that tight control of blood pressure based on captopril or atenolol as first agents and aiming for both a systolic blood pressure <150 mm Hg and diastolic pressure <85 mm Hg achieved a mean 144/82 mm Hg compared with 154/87 mm Hg in a control group
- 29% of patients in the tight control group required three or more hypotensive treatments
- Tight control of blood pressure reduced the risk of any non-fatal or fatal diabetic complications and of death related to diabetes; deterioration in visual acuity was also reduced
- Reducing blood pressure needs to have high priority in caring for patients with type 2 diabetes

and in patients with type 1 diabetes with microalbuminuria or established nephropathy.[18 19] Guidelines were formulated on the assumption that data relating to hypertensive non-diabetic subjects and

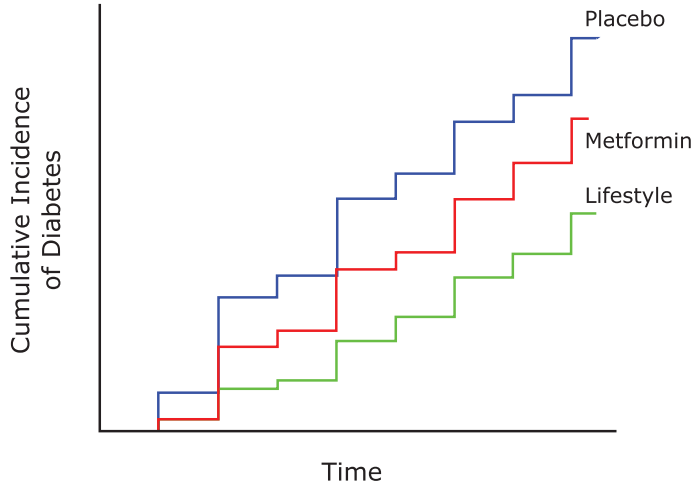
(6.9)

(screenshot from MRAC_40)

Although used relatively sparingly, colour (other than black, white, and grey-tone) plays an important role in highlighting major figures and episodes in the corpus. By using different hues and shades, the textual voice or image-producer can emphasize or 'proclaim' the relative importance of certain visual elements. Graphical and numerical images in MRAC_40, for example, have light-blue backgrounds that correspond with the colour-profile used by the source journal, the *British Medical Journal*. In several

graphical images, pairs of datasets are presented in dark blue and orange. The orange lines represent data for a group of patients assigned to a *tight control* group, while the dark-blue lines represent data for patients assigned to a *less tight control* group.[4] The contrast between orange and light blue is arguably greater than the contrast between dark blue and light blue—especially considering the journal's colour-profile—highlighting in these instances the relative importance of lower blood pressure and fewer adverse events in the *tight control* group compared with the *less tight control* group.

The role played by colour in the original version of (6.10), however, differs from that in MRAC_40. Blue, red, and green lines distinguish datasets for *placebo*, *metformin* (a medicine for treating type-2 diabetes), and *lifestyle*, respectively, and the image can be read in a number of ways, e.g. that the cumulative incidence of diabetes is greatest among those treated with placebo only, or that the cumulative incidence of diabetes is lowest among those who participated in a "lifestyle-modification program" (quote from MRAC_19). However, it is not clear whether or to what extent colour emphasizes any one particular episode or reading over another. The datasets are distinct, but together they construe a major episode-nexus that, due to the use of colour, distinguishes them from other minor figures and episodes in the image such as graph-axes and axis verbiage. These latter episodes are unmarked, ostensibly 'monoglossic' elements in the image, ones that the writer and reader might be expected to take for granted (see Section 6.1.2). A similar interpretation of axes and verbiage might also apply to other graphical images in the corpus.



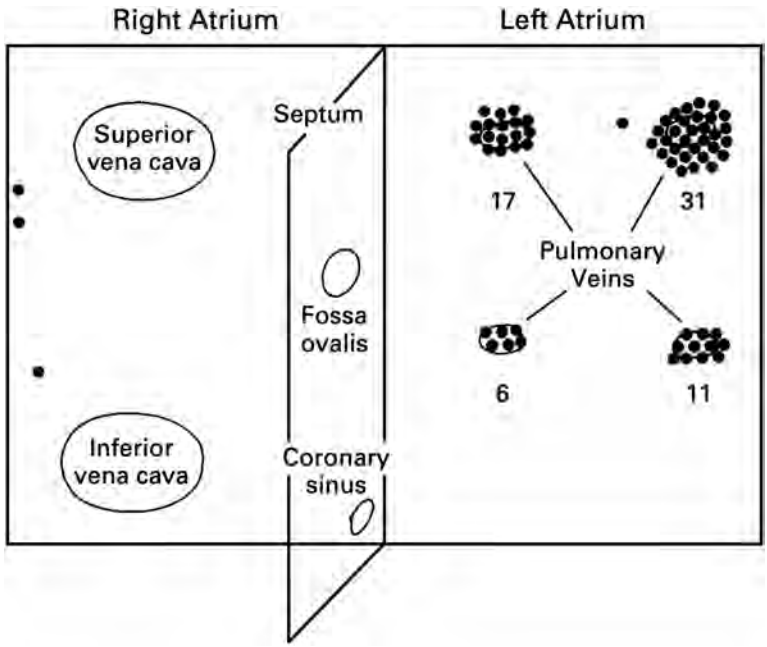

(6.10)

(adapted from MRAC_19)

In addition to its use in visual inscriptions, colour is sometimes used to highlight article-type and copyright ownership. In MRAC_11, for example, red is used to highlight the article as an *original contribution*. This colour

is used for all *Journal of the American Medical Association* papers, including case reports and editorials. Like the *British Medical Journal* mentioned above, red is part of JAMA's colour profile, and this same shade of red is used in the copyright catchline, *©2002 American Medical Association. All rights reserved*. The prominence assigned to these elements through the deployment of colour emphasizes or 'proclaims' their relative importance, in this case the overarching significance or position of the journal itself in relation to the research article and its authors.

Verbal labels allow the textual voice or image-producer to intervene in the reading of images, so as to assert a particular interpretation. In (6.11), most figures in the diagram are given labels, e.g. *superior vena cava* and *pulmonary veins*. Dialogically, those labels acknowledge, on the one hand, the possibility of alternative ways of seeing and interpreting the line-diagram, while, on the other, they 'contract' the dialogic space by anchoring the reader's gaze and the reader's understanding to a narrower set of possible interpretations (Barthes 1977, 39, Chen 2010, 491–493).




(6.11)

(MRAC_15)

Like verbal labels, arrows and arrowheads can also be used to guide the reader's attention to and engagement with certain figures or episodes in a visual work. Such arrows are typically accompanied by verbal prompts. In example (6.12), the arrows in the panel labelled *A* function firstly to highlight particular areas of interest and secondly to compare and contrast those areas of interest. The legend accompanying the image (not shown here) provides an

additional verbal cue and explanation for what the reader should otherwise be able to see. The images on the right, labelled *B* and *C*, use an additional technique for highlighting where and how a reader should engage with the text. A higher level of magnification allows the image-producer to "zoom in" on specific areas of *A*, giving the reader a closer look and, at the same time, guiding the reader's interpretation of the image.[5] This use of framing locates the reader in closer proximity to the areas of interest highlighted in *A* and may position the reader as being more directly connected to and engaged with the depicted objects (cf. Kress and van Leeuwen 2006, 127–128).

(6.12)


(adapted from MRAC_47)

Another highly conspicuous resource in the corpus is the mathematical equation. As a visual unit, equations like that in (6.13), reproduced earlier as (5.22), are set apart from the main verbiage, giving them a certain prominence in the text and 'proclaiming' their relative value or importance. Separating equations from the rest of the verbiage like this seems to be a matter of convention in scientific discourse. Regulative principles legitimize this choice (Bernstein 1981, 328 ff.), even for relatively short equations, and emphasize the high status such resources generally have.

(6.13)

interim analyses. In view of these analyses, the critical Z value used at the end of the study for a one-sided test with a significance level of 0.025 was 2.11 rather than the usual 1.96. The Kaplan–Meier[13] method was used to construct life-table plots. The percentage reduction in mortality was reported as

$$(1 - \mathrm{RR}) \times 100,$$

where RR is the estimated relative risk of an event in the enalapril group as compared with the placebo group estimated from the life tables. The uniformity of treatment effects across subgroups was

(screenshot from MRAC_49)

#### *6.1.1.2 Expand*

Dialogically 'expansive' visual resources open up or 'expand' in some way the scope for alternative voices, positions, or propositions in the discourse. According to Economou (2009), there are three types of visual dialogic 'expansion': [entertain], [attribute], and [suggest]. The first construes a subjectivized position that can be understood as one among several different positions (cf. verbal and mathematical [entertain]); the second indicates a position that might be considered external to that of the textual voice or image-producer (cf. verbal [attribute]); and the third alludes to semiotic choices that are characteristic of other domains or image-types.

##### *6.1.1.2.1 Entertain*

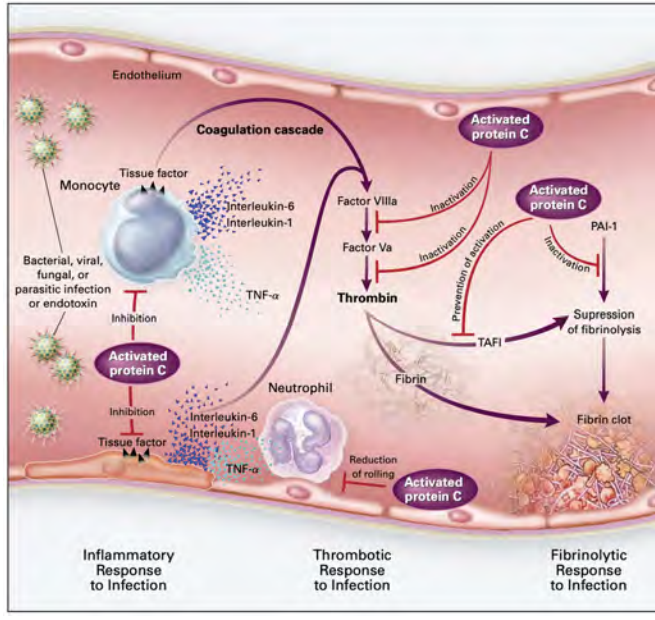
In construing for the text an overtly subjective position—one among a number of possible alternative positions or representations—visual [entertain] is typically realized by the resources of modality. Those resources include choices of colour, pictorial detail, background, and depth. They may also include interactive hypertext objects that set up alternative reading paths and error-bars that visualize the probability of error in graphical images (see Chapter 2, Section 2.4.3).

According to Economou (2009, 214), news photographs construe [entertain] through choices of "marked ideation" or "marked expression", i.e. where depictions of people, objects, or places are represented in "atypical or unrepresentative" ways, or where certain textural or spatial choices give a sense of the unreal or surreal. The yardstick for what might be considered "typical" or "representative" in science, and more specifically in contemporary medical research articles, is different from that of newspaper photography or fine art (cf. O'Toole 1994). Visual elements in medical research articles tend to be black and white and/or grey-tone, and depicted objects generally lack pictorial detail and depth. Marked ideation or expression in scientific-medical research might therefore entail the deployment of a broad palette of colours—not just the conventional colour-coding of diagrams (Kress and van Leeuwen 2006, 165)—as well as more "naturalistic" or verisimilar representations of objects.[6]

While there are no standard photographic images in the corpus, there are instances of photomicrographs and radiographs. Rowley-Jolivet (2002, 2004) treats both these image-types as figurative (see Chapter 3, Section 3.1), but distinguishes between the type-I figurative images of standard photography and the type-II figurative images of electron microscopy, x-ray imaging, ultrasound, and the like, techniques that "produce images down to the nano-scale and […] highlight a single feature (texture, structure, etc.) of the object" of interest (Rowley-Jolivet 2004, 150). Photomicrographs and radiographs probe beyond the naturalistic surface of objects to a different, potentially deeper, more hidden level of representation (Kress and van Leeuwen 2006, 145). That level may not be part of readers' everyday subjective experience, but photomicrographs and radiographs have a high

degree of iconicity that, like the images produced by standard photography, refers to specific sites of interest and specific patients rather than more abstract and generalizable representations such as the heart diagram in (6.11). Whether or not photomicrographs and radiographs are marked ideationally and/or interpersonally is difficult to say. They are certainly marked in relation to other images in MRAC, the majority of which are graphical and numerical images such as graphs and tables. However, photomicrographic stain images like those in MRAC_47, for example, are a mainstay of microscopy-based cytology and oncology and do not necessarily represent an overtly marked form of visual expression. For the experienced reader, such images are unlikely to be read as marked or atypical.

One image in MRAC that might be considered "marked" by the putative reader is the cross-section of a blood vessel in (6.14). This image, discussed above in Section 6.1.1.1.1 (example (6.1)), is a hybrid of verisimilar and schematic elements that depicts a generalized rather than individualized account of the body's response to sepsis. The relatively wide range of colours and the naturalistic representation of certain figures seem to be at odds with the kinds of choices typically associated with a technological-abstract coding orientation (cf. the heart image in (6.11)). To the extent that atypicality, i.e. marked ideational and interpersonal choices, construes for the text a more subjectivized position and one that implies and allows for alternative positions and representations, parts of the image in (6.14)—the figures labelled *monocyte*, *neutrophil*, *endothelium*, *bacteria*, and *fibrin clot*—might be said to instantiate [entertain].

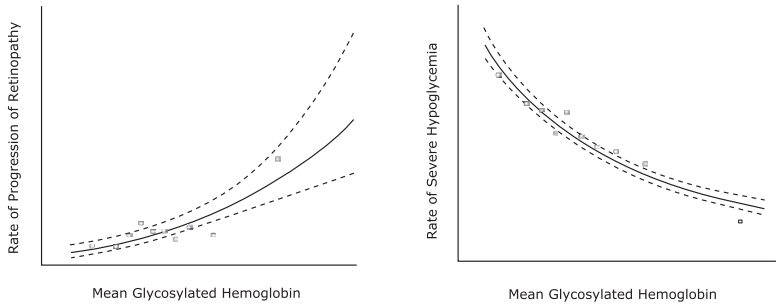



(6.14)

(MRAC_01)

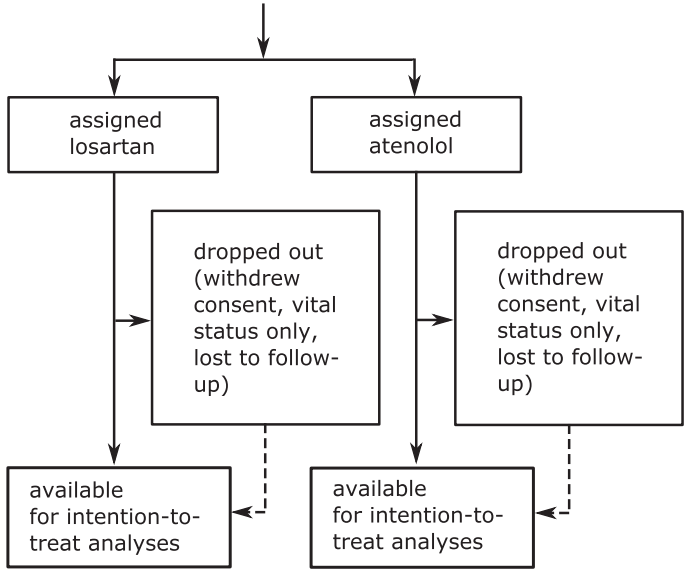
Dotted or dashed lines can be contrasted with solid lines to give varying degrees of salience or prominence (see Section 6.1.1.1.2). They can also be used to construe possibility or probability. In (6.15), the dashed curved lines represent confidence intervals, a mathematical expression of the likelihood of a particular future result or value falling within a certain range. In this case, 95% of all possible experimental results are estimated or expected to fall within the graphical area between the two sets of dashed curves. Dialogically, the curves 'entertain' the mathematical possibility of values falling within and outside of those estimation boundaries. Like the mathematical-symbolic realizations of [expand: entertain] discussed in Chapter 5, Section 5.1.1.2, this potential mathematical-visual construal of [entertain] is likely to carry a lower interpersonal or intersubjective risk than more subjectively oriented verbal and visual construals of [entertain].

(6.15)




(adapted from MRAC_37)

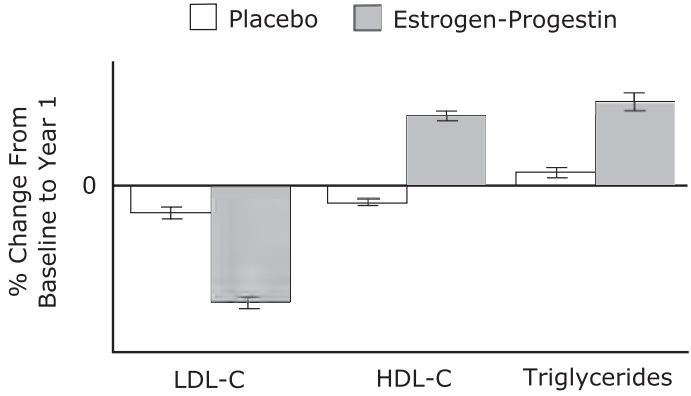
In the excerpted flowchart in (6.16), dashed lines suggest a possible or alternative pathway along which certain groups of patients can be included rather than excluded from analysis. Unlike the flowchart in (6.2) in Section 6.1.1.1.1, the flowchart in (6.16) presents baseline data for so-called intention-to-treat analyses. Intention-to-treat analyses attempt to reduce bias in large-scale randomized controlled trials (RCTs). Unlike analyses based on actual treatment received, intention-to-treat analyses include all randomized patients regardless of "noncompliance, protocol deviations, withdrawal, and anything that happens after randomization" (Gupta 2011, 109). The dashed lines in (6.16) indicate that, despite their exclusion from treatment, "dropout" patients can still be included in the final analysis, construing what appears to be a combination of [entertain] and [disclaim: counter].




(6.16)

(excerpt, adapted from MRAC_06)

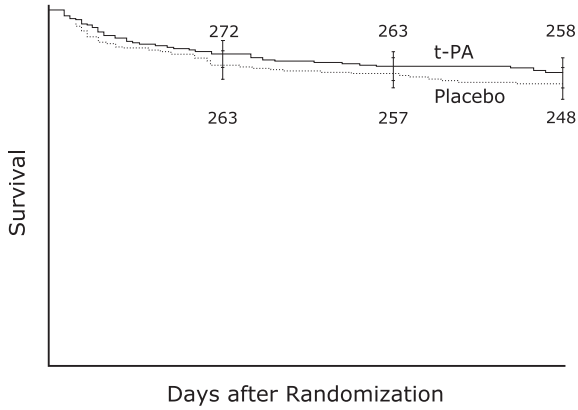
According to Lemke (1998, 101), error-bars indicate "the reliability or warrantability, and so probability of error, in the data"; they are "a visual presentation of a mathematical formulation of an orientational [= interpersonal] meaning". The graphs in (6.17) and (6.18) both contain error-bars. In the former, the error-bars are barely visible, indicating that, while one might 'entertain' the possibility of error and thus the possibility of alternative results, the dialogic space for those alternatives is relatively narrow. What is important in (6.17) is that, despite the margin for error indicated by the error-bars, the differences between the two study groups (note the use of shading and size) are sufficiently large for the standard error of the mean (SEM) to be of little or no consequence.




(6.17)

(adapted from MRAC_17)

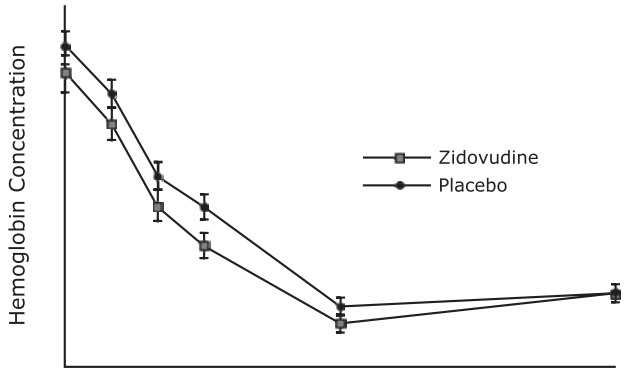
The same cannot be said of (6.18). Here, the error-bars for the two groups, *t-PA* (tissue plasminogen activator) and *placebo*, overlap to such an extent that, at the three time-points indicated, the distinction between the two series is within a margin of error (the standard error, SE) that 'entertains' the possibility that, overall, there is little or no difference between the two treatment groups. This point is also made clear in the verbiage referring to the graph: "There were no significant differences in mortality between the groups (Fig. 1)" (quoted from MRAC_24).




(6.18)

(adapted from MRAC_24)

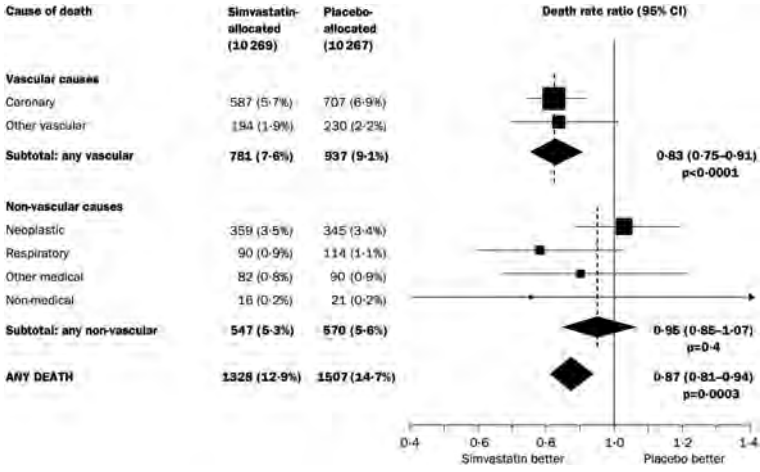
Standard deviations, like standard errors, are an integral part of the verbal-mathematical and visual construal of [engagement].[7] In (6.19), the vertical bars represent deviations from the mean and show the extent to which data from two treatment groups converge or diverge. The bars show variability within the study groups and thus construe, mathematically and visually, a dialogic space in which a range of possible values are permissible.




(6.19)

(adapted from MRAC_04)

The corpus contains several graphical-numerical images that combine different representations of probability and likelihood. Reading from left to right, the table-graph hybrid in (6.20) presents a series of variables (*cause of death*) and their values based on two treatment groups (*simvastatin* and *placebo*). Those values and their differences are visualized as a series of geometric shapes and horizontal and vertical lines. Of particular interest with regard to [entertain] are the horizontal lines and the horizontal axes of the filled diamonds, which represent 95% confidence intervals (cf. (6.15) above) and which may construe for the text a dialogic space in which a range of alternative values (both observed and predicted) are allowed for.




(6.20)

(MRAC_03)

Tan (2010) proposes that certain hypertext objects or links in online advertising campaigns can construe spaces that are "maximally *heteroglossic*" in terms of their dialogic potential for reader involvement (Tan 2010, 102, emphasis in original). Hypertext links in medical research articles provide possible or suggested pathways to both text-internal and text-external sites, e.g. to diagrams and tables, to a list of other studies (references), or to the cited studies themselves. Such links open up a dialogic space that allows for alternative positions and alternative readings.[8]

In the HTML versions of the corpus texts, links are activated by clicking on coloured and/or underlined elements. In the PDF and paper editions, those same links require scrolling or page-turning, or, in some cases, more comprehensive actions such as searching through catalogues and databases. While the links themselves may construe dialogically expansive [entertain] regardless of the site of engagement, the potential for interacting with those links is rather different.

Many of the images in the corpus contain some form of verbal and/or mathematical [engagement]. Particularly salient is the role played by

mathematical probability, e.g. *p*-values, risk, odds ratios, and confidence intervals (see Chapter 5, Section 5.1.1.2). The role of mathematics in such instances is to help ascertain possible relations and associations (or a lack thereof) between different observations.

From an interpersonal and dialogic perspective, mathematical or numerical expressions can, on the one hand, add to the warrantability or veracity of research findings, lending them "epistemological authority" (Jones 2013, 40) and "argumentative force" (Vihla 1999, 96) and functioning as a kind of mathematical-numerical 'proclamation'. On the other hand, those same mathematical and numerical expressions can construe uncertainty and varying degrees of "statistical support" (Vihla 1999, 96), which also allow the textual voice to invoke and 'entertain' alternatives in the discourse. This dialogic duality or ambiguity is perhaps unsurprising, given that visual instantiations of [proclaim], like those of [entertain], are generally grounded in the subjecthood of the textual voice—they tend to 'pronounce' rather than 'endorse' (cf. verbal instantiations of [proclaim] in Chapter 4, Section 4.1.1.1.2).

A similar polysemy can be seen in some of the mathematical equations in the corpus. As noted in Section 6.1.1.1.2, an equation like that in (6.21) is given greater conspicuity when separated from the main body of the written text. This highlights the potential importance of the equation and invites or encourages the reader to recognise that importance. At the same time, the equation as a mathematical statement or clause encodes probability, in this case *estimated relative risk* (*RR*), and therefore also instantiates [expand: entertain]. The relations between visual and mathematical instantiations of [engagement] are discussed further in Chapter 7.

(6.21)

interim analyses. In view of these analyses, the critical Z value used at the end of the study for a one-sided test with a significance level of 0.025 was 2.11 rather than the usual 1.96. The Kaplan–Meier[13] method was used to construct life-table plots. The percentage reduction in mortality was reported as

$$(1 - \mathrm{RR}) \times 100,$$

where RR is the estimated relative risk of an event in the enalapril group as compared with the placebo group estimated from the life tables. The uniformity of treatment effects across subgroups was

(screenshot from MRAC_49)

Approximators of quantity, degree, frequency, and time (see Salager-Meyer 1994 and Chapter 4, Section 4.1.1.2.1) are sometimes used in scriptural-numerical images to 'entertain' alternative variables or numerical values. In (6.22), the heading, *Most Frequent Adverse Reactions*, 'entertains' the possibility of other adverse reactions, and the putative reader is likely to

understand that the variables listed in the leftmost column are not exhaustive. The example also highlights how the textual voice in this instance makes certain adverse events more visible than others, privileging or valuing frequency over, say, type, severity, or duration. The heading and the included/excluded variables in (6.22) simultaneously encode [entertain] and [proclaim].

(6.22)

Table 4. Most Frequent Adverse Reactions.*

| REACTION | PLACEBO | CARVEDILOL |
|---|---|---|
| Dizziness | [...] | [...] |
| Fatigue | [...] | [...] |
| Dyspnea | [...] | [...] |
| URTI | [...] | [...] |
| Heart failure | [...] | [...] |
| [...] | | |

* Patients may have had more than one adverse reaction.

(adapted from MRAC_27)

*6.1.1.2.2 Attribute*

The only instances of [attribute] in MRAC are those realized verbally, numerically, and symbolically. There are no instances of the kinds of "embodied visual attitude" or direct incorporation of other visual texts that Economou (2009) identifies in newspaper photography (see Chapter 2, Section 2.4.3).

Verbal and numerical 'attributions' in the figurative, numerical, and graphical images in MRAC are much like those expressed verbally and numerically in the rest of the text (see Chapter 4, Section 4.1.1.2.2). They include direct quotes and projecting/projected clauses, associated nominalizations, and superscript numbered references.

In some tables, symbols such as †, ‡, §, and ¶ are used to introduce other voices into the communicative context in order to acknowledge the sources of definitions and classifications, e.g. *Type of lesion†* (MRAC_36). The sources themselves are then specified in the table-footnote and include superscript numbers referring to a reference list at the end of the article, e.g. *†According to the classification system of Ambrose et al.*[14] (MRAC_36) (cf. Chapter 4, Section 4.1.1.2.2). Dialogically, these resources—the symbols, the prepositional phrases and names of researchers (*according to X*), and the superscript numbers—together help ground propositions and semantic elements in the subjectivity of some external voice and dissociate the textual

voice from whatever position is being advanced. In terms of writer–reader alignment, these kinds of 'attributions' are likely to maintain a relation of alliance. They are unlikely to challenge the solidarity of the writer–reader relation, unless the reader considers the positions of those external voices or the external voices themselves to be somehow unconvincing, unreliable, controversial, etc.

Direct quotes are occasionally used in scriptural-numerical images. They play a similar dialogic role to those used elsewhere in MRAC, i.e. to ground a proposition explicitly in the subjectivity of an external voice and potentially to 'distance' the textual voice from it (cf. Chapter 4, Section 4.1.1.2.2). For example, in a table-footnote marked ‡ in MRAC_43, quotation marks and the reporting verb *reported* indicate the responses of patients: *Subjects reported* […] *"I read, watch television, and work in the household at tasks that don't strain me physically"*.[9] As the table-heading—*Self-reported change in dietary and exercise habits during the first year of the intervention, according to treatment group*—makes clear, these are the patients' own responses to questions concerning dietary and exercising habits. The role of the researcher(s), as interviewer and analyst, appears to be minimized, and the scriptural-numerical image can in its entirety be seen as an instance of [attribute]. The textual voice essentially reports what others have reported, potentially 'distancing' itself from the sources of that information.[10]

In a graphical image in MRAC_48, the heading *Proportion of Men and Women Who Reported Hypersomnolence, According to Category of Sleep-Disordered Breathing* indicates that the visualization of variables and their values in the graph is based at least in part on self-reporting (as is also specified elsewhere in MRAC_48). Like the example above, this graph as a whole can be understood, dialogically, as an instance of [attribute], in which the textual voice acknowledges and dissociates itself from the subjectivity of the external voices it references. Like the other examples in this section, the 'attribution' in this graphical image is unlikely to 'disalign' the textual voice and putative reader, assuming, that is, that the reader has no reason to question the rationale or method for collecting and presenting such material.

As with verbal and mathematical instantiations of [attribute], the dialogic function of these verbal-within-visual resources may be polysemic. While they clearly [attribute] some verbal or visual proposition to an external voice, such resources may also function to [endorse] or [justify] a particular position. In the case of the MRAC_36 table mentioned above, for example, references to *Ambrose et al.* and others 'attribute' the definitions and classifications in the table to specific sources. Depending on the perceived credibility of those sources, they might also be understood as 'endorsing' a particular choice of definition and, by implication, as providing a 'justification' for that choice, i.e. why one might choose one source or one

definition over another. Understanding this dialogic potential depends to a large extent on the reader's familiarity with those sources and a knowledge of more or less suitable alternatives.

Overall, verbal-within-visual 'attributions' of the kinds described above generally maintain writer–reader solidarity, although the distancing effect created by some 'attributing' resources may allow the textual voice to remain somewhat aloof from issues of 'alignment' or 'disalignment', construing the textual voice as "an informational fair trader" (Martin and White 2005, 115). Such positioning, as noted in previous chapters, is generally highly valued in scientific-medical discourse (cf. account of verbal and numerical 'attribution' in Chapter 4, Section 4.1.1.2.2).

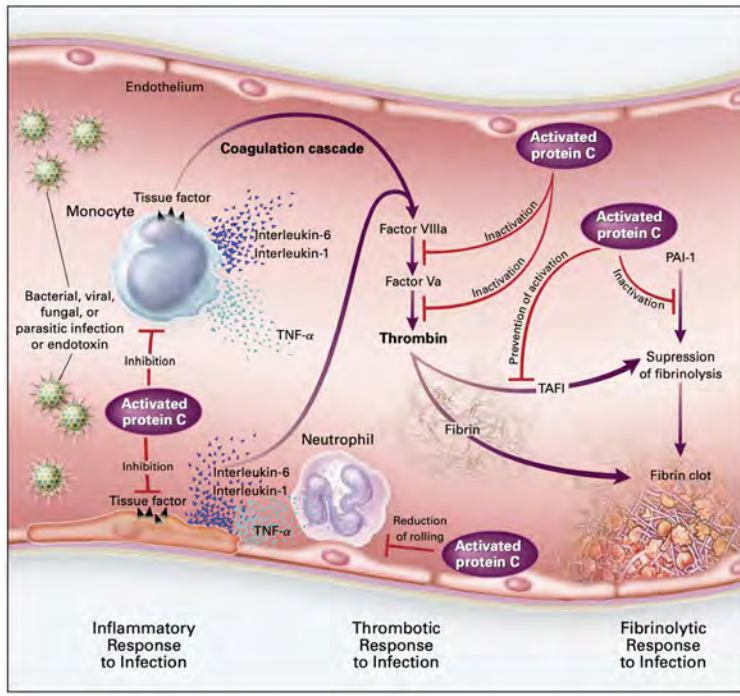
*6.1.1.2.3 Suggest*

Economou (2009) proposes a third dialogically 'expansive' option for the visual construal of [engagement]: [suggest]. The [suggest] option

> is called into play when a news photo alludes to, or suggests, by a certain combination of visual choices, an external visual genre or style; that is, a non-news image of some kind. This can evoke attitude associated with the non-news context and also affects viewer alignment with meanings in the photo and with the photo itself.
>
> (Economou 2009, 222)[11]

Economou's (2009, 228 ff.) examples include the rendering of news photographs as a police investigation board, as corporate promotional material, and as a silhouette memento cut-out. All of these images are 'suggestive' of "non-news" domains and can extend by association the kinds of meanings typical of newspaper photography, a phenomenon Economou (2009, 222 ff., after Fairclough 1992, 124–130, inter alia) refers to as "interdiscursivity".

In scientific-medical research, several visual choices seem to be 'suggestive' of other "non-medical" domains. One example we have seen already is (6.1), reproduced as (6.23) below. Here, certain ideational choices, e.g. the representations of endothelium, bacteria, monocyte, and neutrophil, are 'suggestive' of popular science, a field or domain in which verisimilitude may be given greater value compared with the scientific fields upon which it is often predicated (Myers 1990). The wide range of colours used in (6.23), and in other examples described or shown above, may also be 'suggestive' of the semiotic choices common to popular science (Herrando-Rodrigo 2010, 269), especially if one considers the use of colour to be largely unnecessary or "ornamental" in scientific visual representation (cf. Rowley-Jolivet 2004, 153). The image in (6.23) may also be 'suggestive' of the infographics sometimes used in news reporting (Dick 2014).




(6.23)

(MRAC_01)

As Rowley-Jolivet (2002, 2004) notes (see Chapter 3, Section 3.1), medicine tends to use more colour in images than physics and geology, which may be indicative of the relative "softness" of medicine compared with the hard sciences of physics and geology.[12] If this is the case, and medicine is indeed a (relatively) soft science, many of the images in the corpus, i.e. graphs and tables, [suggest] a different field or domain, namely that of hard science. According to Cleveland (1984), Smith et al. (2000), and Arsenault et al. (2006), the overall number and extent of graphs, tables, and other visual inscriptions (e.g. diagrams and equations) in research articles in different disciplines correlate with the perceived "hardness" of those disciplines (see Chapter 3, Section 3.1). In MRAC, there is a mean of 2.24 graphs and 3.88 tables per research article (6.56 in total, including combined graphs and tables). This compares with approximately 3.50 graphs and 2.00 tables per research article (5.50 in total) for hard science and 1.00 graphs and 2.40 tables per research article (3.40 in total) for soft science in Arsenault et al.'s (2006, 397) study.[13] Based on those numbers alone, the number of graphs in MRAC 'suggests' a relatively hard science, while the number of tables is more indicative of the soft sciences.

The key-messages box, shown above as (6.9) and reproduced below as (6.24), may also represent an instance of [suggest]. According to one set of *British Medical Journal* guidelines, key messages "should contain three or four bullet points of no more than 25 words each, highlighting the main

features of, and lessons from, the paper" (BMJ 2018). Key messages do not summarize the study in the same way as abstracts do (see Chapter 3, Section 3.2); rather, they play a more educational role, serving as a guide or suggestion as to what the putative reader might learn from the article. Key-messages boxes like that in (6.24) are indicative of educational textbooks and longer-read newspaper articles. Their inclusion in MRAC could be 'suggestive' of those discursive fields.

published. Intensive
etic subgroup of the
Follw-up Program
tality.[32]
duction in the rate of
or more steps using
he 47% reduction in
by three lines using
change from 6/6 to
1 chart) suggests that
lso prevented the
pathy, which is the
1 type 2 diabetes.[33] In
diabetic maculopa-
quiring retinal pho-
pathy responds less
on than proliferative
of maculopathy by
ht provide a major
of blindness. To our
1 patients with type 2
od pressure control
ations from diabetic

1 of patients in the

**Key messages**

- This study showed that tight control of blood pressure based on captopril or atenolol as first agents and aiming for both a systolic blood pressure <150 mm Hg and diastolic pressure <85 mm Hg achieved a mean 144/82 mm Hg compared with 154/87 mm Hg in a control group
- 29% of patients in the tight control group required three or more hypotensive treatments
- Tight control of blood pressure reduced the risk of any non-fatal or fatal diabetic complications and of death related to diabetes; deterioration in visual acuity was also reduced
- Reducing blood pressure needs to have high priority in caring for patients with type 2 diabetes

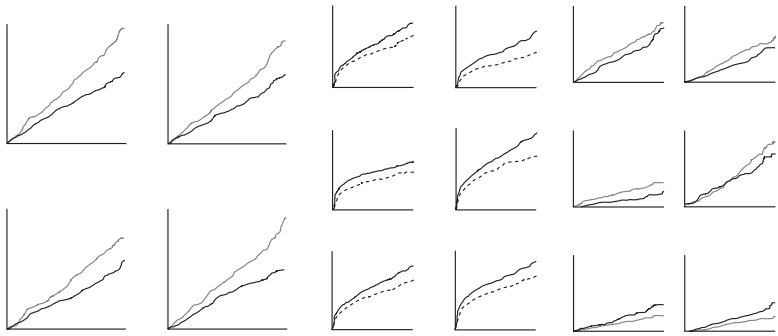
and in patients with type 1 diabetes with microalbuminuria or established nephropathy.[18,19] Guidelines were formulated on the assumption that data relating to hypertensive non-diabetic subjects and

(6.24)

(screenshot from MRAC_40)

### *6.1.2 Monogloss*

From the perspective of scientific medical research, many of the diagrams, graphs, and tables in MRAC appear to be congruent, unmarked visual representations of scientific reality, ones in which the material, mental, and social worlds of the laboratory, the clinic, and other sites of observation and data collection are transformed into two-dimensional visual inscriptions (Latour 1990, 21–22, Economou 2009, 203). For the most part, those inscriptions seem to make no overt reference to an internal, subjective voice or to any external voices or positions; they are "objective and true" (Economou 2009, 203). Such visual elements are 'monoglossic', in that they appear to be bare assertions about some form of objective reality.

(6.25) 

(adapted from MRAC_08, MRAC_30, and MRAC_34)

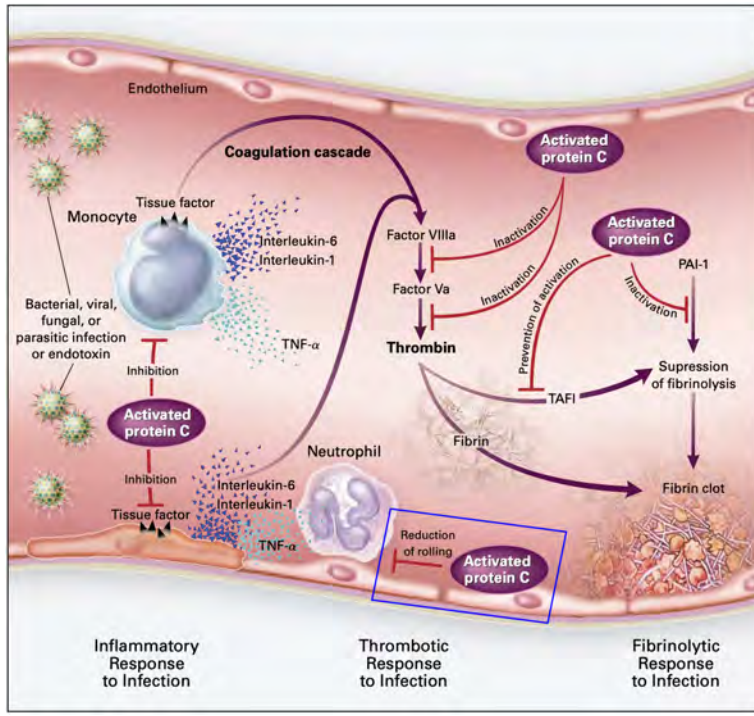
The examples in (6.25) demonstrate the potentially 'monoglossic', highly conventionalized, typical-for-science visual representations in the corpus. Detached from their original co-texts and contexts and viewed side by side like this, these (simplified) graphical images seem unremarkable, displaying little or no marked ideation or marked expression (cf. Economou 2009, 214). However, as the analyses in the previous section (Section 6.1.1) suggest, it is not necessarily here, at the level of the diagram, graph, or table as a discrete whole, that all of the semiotic work is done. The extent to which an image can be described as 'monoglossic'—or 'heteroglossic'—depends on visual prompts and generic conventions as well as on the interests and experiences of individual readers. A cursory reading of any of the graphical images in (6.25) might imply a relatively 'monoglossic' interpretation: "variable Y increases over time X". Closer readings, however, are likely to reveal a more 'heteroglossic' state of affairs, in which different elements of the graphical image can be seen to 'expand' or 'contract' the dialogic space for alternatives, e.g. that the differences observed between two groups are likely or unlikely to be a matter of chance.[14] In such cases, 'heteroglossic' choices realized lower down the rank scale, e.g. at the level of figure or figure-part, might be less salient than those higher up the scale, at the level of the episode, work, or beyond, allowing images to be read, at one level, as 'monoglossic' and, at another, as 'heteroglossic'. Similar examples can be seen in verbal-mathematical instantiations in MRAC, where a seemingly 'monoglossic' utterance such as *The effect of pravastatin was greater among women than among men* can be construed as multi-voiced by the parenthetical addition *(P = 0.05 for the interaction between the patient's sex and treatment)* (MRAC_35).

### *6.1.3 Scope and Interaction of Visual Dialogic Resources*

Like the verbal and mathematical examples presented in Chapters 4 and 5, the images presented or described in this chapter often encode multiple instances of [engagement]. The degree to which those instantiations are likely to overlap and interact depends to a large extent on their realization

and distribution, the kinds of reading paths prompted by a particular image, and the interests and experiences of the reader.

The blood-vessel image discussed above, and reproduced below as (6.26), includes several instances of [heterogloss]. Arrows, curves, and verbal-within-visual labels suggest dialogic 'contraction' (see Section 6.1.1.1), while verisimilar representations and the relatively wide range of deployed colours imply dialogic 'expansion' (see Section 6.1.1.2). Considered as a whole, from the rank of work, the putative reader is likely to engage first and foremost with the colours and the potentially subjectivized position implied by their use, i.e. [expand: entertain], noting secondarily, perhaps, which figures, episodes, and episode-nexuses are naturalistic ('entertain') and/or schematic ('monogloss').




(6.26)

(MRAC_01)

Assuming a left-to-right (and possibly top-to-bottom) reading, in which infection on the left results in a fibrin clot on the lower right, there are certain episodes and figures-within-episodes that overlap and construe different types of [engagement]. One example of this is marked in (6.26) by a rectangle. The episode, which we might describe verbally as "activated protein C reduces neutrophil rolling on damaged endothelium", counters the overall left-to-right flow or 'rhythm' of the work and potentially construes [contract: disclaim].[15] The episode contains a combination of naturalistic and

schematic figures. Some, e.g. the relatively iconic *neutrophil* and *endothelium*, may [entertain] the possibility of alternative representations; others, e.g. *activated protein C* and the red line labelled *Reduction of rolling*, are more likely to be considered abstract, 'monoglossic', standard-for-science representations. All or most of the figures in the episode are labelled, allowing the image-producer to assert or 'proclaim' a particular reading and thus contract the space for alternative interpretations.[16] From the perspective of the episode, and looking down the rank scale, we have an activity or episode that 'disclaims', i.e. one that counters the left-to-right narrative structure of the image, but one that also contains figures that variously 'entertain' and 'proclaim' as well as figures that represent more 'monoglossic' positions. If we look "round about", in relation to other episodes in the image, several of them offer complementary [contract: disclaim] readings, i.e. all of those containing red lines and curves. Looking up the rank scale, this and other episodes are part of an image or work that, first and foremost it seems, presents a model, a guide for how the body *might* respond to infection when treated with activated protein C (cf. Hirschauer 1991, 312 on images as aesthetic models for actual patient-bodies; Chapter 3, Section 3.1). That model, as with models more generally, presents one among a number of possible responses and thus construes, overall, a type of engagement that 'entertains' alternative responses and alternative ways of representing those responses.

In the case of English-language texts, verbal and mathematical resources are generally read linearly, from left to right, top to bottom. Visual resources need not be read in this way. Readers are not obliged to start from the left and move to the right, to go from top to bottom on a page, even if certain visual prompts suggest they should. A cursory reading of (6.26), seen as a whole, might be of a blood vessel in which some highly salient object, *activated protein C*, is performing or involved in a number of different actions, the exact details of which are provided elsewhere in the written text. A reader with a particular interest in, say, the properties and functions of neutrophils, however, might be drawn to specific figures or episodes in which those objects are implicated, without giving too much thought to the rest of the image. Moreover, readers are likely to return to different parts of the image, and to attend to different levels of detail, as and when they read the rest of the text.

Graphs and tables in MRAC also exhibit instances of overlapping [engagement]. At the level of the image or work, the examples in (6.27) and (6.28) might appear 'monoglossic'. They are unmarked or congruent visual representations of scientific reality (to paraphrase Economou 2009, 203), ones that might be taken as given, generally accepted, or "authoritative" (Bakhtin 1981 [1935], 342, White 2003, 263, Martin and White 2005, 98–102), especially if read "at a glance" (see Section 6.1.2). On closer inspection, however, we find several instances of visually and mathematically construed 'heteroglossia'—[proclaim], [disclaim], and [entertain]—occurring at different levels of the work.

Each column and row in (6.27) represents a major episode. The table-heading describes the overall work and is separated from the major episodes by horizontal lines. The footnotes, as minor episodes in the work, are also separated from the major episodes by a horizontal line. Two episodes, those labelled *z statistic* and *p value*, realize [expand: entertain], since they encode, mathematically, the likelihood of certain observations for *ramipril* and *placebo* differing by chance (see Chapter 5, Section 5.1.1.2). Within each of those vertically organized 'entertain' episodes, certain numerical values indicate that the relations between *ramipril* and *placebo* should *not* be treated as statistically significant. This numerically encoded negation or countering is a form of 'disclaim'. For example, the difference in numbers of patients who were hospitalized for unstable angina in the *ramipril* and *placebo* groups is *not* statistically significant according to the high *z*-score (*-0.41*) and high *p*-value (*0.68*). The values thus reject or counter any expectation that the difference is, should be, or might be statistically significant.

(6.27)

**TABLE 4.** INCIDENCE OF SECONDARY AND OTHER OUTCOMES.

| OUTCOME | RAMIPRIL GROUP (N=4645) | PLACEBO GROUP (N=4652) | RELATIVE RISK (95% CI)* | Z STATISTIC | P VALUE† |
|---|---|---|---|---|---|
| | no. (%) | | | | |
| Secondary outcomes‡ | | | | | |
| Revascularization | 742 (16.0) | 852 (18.3) | 0.85 (0.77–0.94) | −3.17 | 0.002 |
| Hospitalization for unstable angina | 554 (11.9) | 565 (12.1) | 0.98 (0.87–1.10) | −0.41 | 0.68 |
| Complications related to diabetes§¶ | 299 (6.4) | 354 (7.6) | 0.84 (0.72–0.98) | −2.16 | 0.03 |
| Hospitalization for heart failure | 141 (3.0) | 160 (3.4) | 0.88 (0.70–1.10) | −1.16 | 0.25 |
| Other outcomes | | | | | |
| Heart failure§ | 417 (9.0) | 535 (11.5) | 0.77 (0.67–0.87) | −4.09 | <0.001 |
| Cardiac arrest | 37 (0.8) | 59 (1.3) | 0.62 (0.41–0.94) | −2.28 | 0.02 |
| Worsening angina§ | 1107 (23.8) | 1220 (26.2) | 0.89 (0.82–0.96) | −2.91 | 0.004 |
| New diagnosis of diabetes‖ | 102 (3.6) | 155 (5.4) | 0.66 (0.51–0.85) | −3.31 | <0.001 |
| Unstable angina with electrocardiographic changes‡ | 175 (3.8) | 180 (3.9) | 0.97 (0.79–1.19) | −0.30 | 0.76 |

*CI denotes confidence interval.

†P values were calculated with use of the log-rank test.

‡These events were centrally adjudicated.

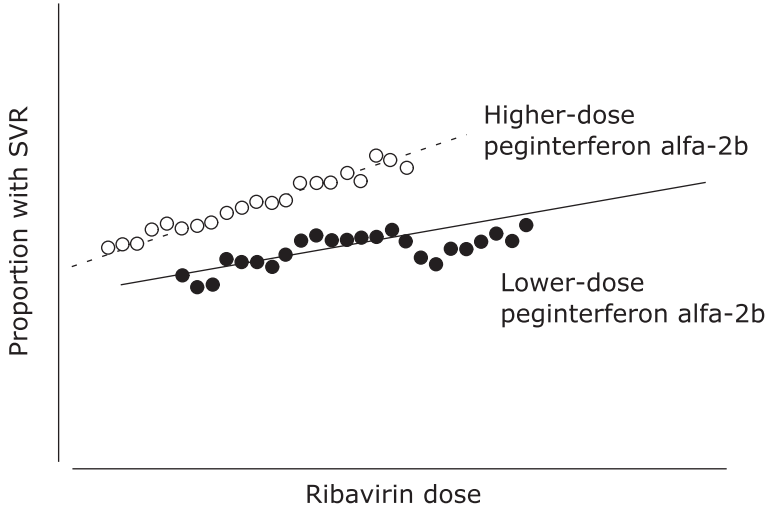
§All cases are included, whether or not hospitalization was required.

¶Complications related to diabetes include diabetic nephropathy (defined as urinary albumin excretion of at least 300 mg per day or urinary protein excretion of 500 mg per day), the need for renal dialysis, and the need for laser therapy for diabetic retinopathy.

‖The denominator in the ramipril group is the 2837 patients who did not have diabetes at base line. The denominator in the placebo group is the 2883 patients who did not have diabetes at base line.

(screenshot from MRAC_50)

In (6.28), one major episode is contrasted with another, through the use of solid and dashed lines, and certain figures within those episodes are given greater prominence through labelling and the use of solid rather than open circles ('proclaim') (see example (6.5) in Section 6.1.1.1.2). Moreover, the labels used for the solid-circle figures indicate how likely it is that differences between figures are due to chance. Some indicate low probability (*P<0.001*) (i.e. statistically significant → 'entertain'), others somewhat higher (*P=0.014*) (i.e. not statistically significant → 'disclaim', 'entertain').




(6.28)

(adapted from MRAC_01)

In summary, visual [engagement] features can overlap and interact to create dialogic spaces that are potentially both 'contractive' and 'expansive', and that can also construe a more authoritative single-voicedness. Like verbal and mathematical [engagement], visual [engagement] is realized at different levels of the rank scale for visual display.

### *6.1.4 Summary of Realization and Instantiation of Visual Engagement*

Seen from the rank-scale perspective of work, the majority of images in the corpus appear to be 'monoglossic', making no overt reference to an internal, subjective voice or to any external voices or positions. However, on closer inspection, episodes, figures, and figure-parts within those works often construe a more 'heteroglossic' backdrop. Dialogically 'contractive' resources include lines and arrows that stop, block, or diverge from some expected narrative flow, the omission or exclusion of otherwise expected visual, verbal, and numerical elements, the highlighting or foregrounding of certain visual elements through choices of shading, colour, size, and placement, and the use of verbal labels to assert particular interpretations. Dialogically 'expansive' resources include choices of marked ideation or expression (e.g. naturalistic representations), error-bars and standard deviations, hypertext objects, as well as interdiscursive borrowings such as key-messages boxes that draw upon visual resources more typical of other discursive fields. Several visual resources, e.g. the use of solid and dashed lines in diagrams

and graphs, may simultaneously express dialogically 'expansive' and dialogically 'contractive' positions.

A single page or a single image in MRAC generally encodes multiple instances of [engagement]. Those instances overlap, often due to their relations across and within the rank scale for visual display. The exact interaction of [engagement] features and the overall effect they create depends on visual prompts in the image and on readers' interests. For example, a particular episode may be dialogically 'contractive', while also containing figures and figure-parts that are considered dialogically 'expansive'. The overall effect of such an example is a relatively narrow dialogic space that can be maintained or perturbed ('expanded' or 'contracted' further) by choices made at different levels of the rank scale. This interactional hierarchy, however, may be overridden by a reader's personal or professional interest in certain figures and figure-parts within the episode.

With regard to intersubjective positioning, the relative [monogloss] of most graphs and tables is likely to be 'taken for granted' and is unlikely to 'disalign' the textual voice and the reader. However, some forms of marked ideation or expression—for example, certain uses of colour and naturalistic representation—may affect intersubjective relations if the reader considers such choices unnecessary or superfluous to the construction of scientific-medical knowledge (cf. Rowley-Jolivet 2004). Images or parts of images that make explicit the inclusion or exclusion of certain measurements, observations, or interpretations may also put writer–reader solidarity at risk.

## 6.2 Visual Engagement across Generic Stages and Phases of the Medical Research Article

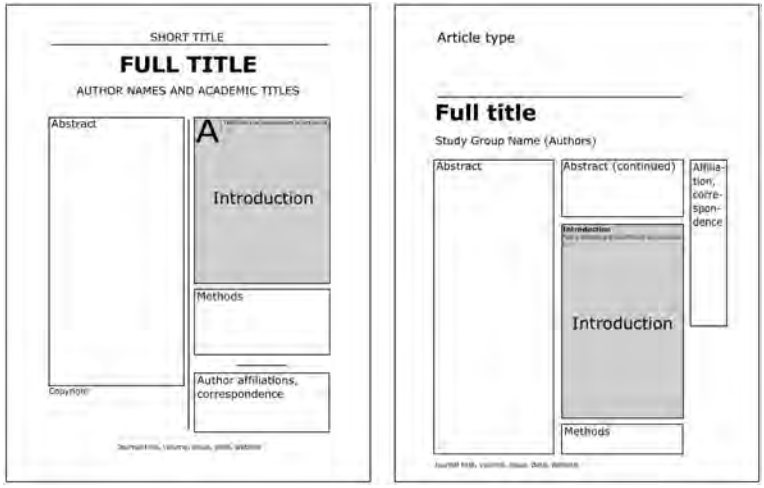
In the following sections, we examine how visual [engagement] resources are distributed across different generic stages and phases of medical research articles, considering how visual [engagement] evolves as texts unfold. We begin with the four main sections of the medical research article: Introduction, Methods, Results, and Discussion.

### *6.2.1 Introductions*

The Introduction section of the contemporary medical research article has three main functions or phases: describing the field of study, identifying a gap in the field, and stating the main research purposes (see Chapter 3, Section 3.2). As a visual unit, the Introduction is relatively small or short compared with the other three main sections of the research article (Methods, Results, Discussion). Typically, the Introduction occupies one-third to one-half of a

page in the print and PDF versions, and comprises two to three paragraphs, with each paragraph roughly corresponding to each of the three main phases in the section. See page layout examples in (6.29) (Introductions marked in grey).[17]

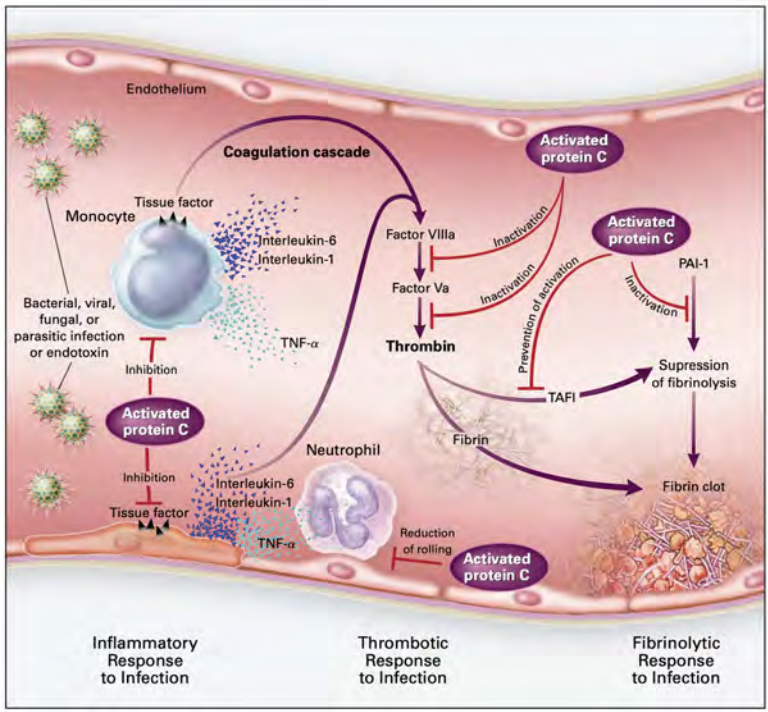
(6.29)




(adapted from MRAC_12 and MRAC_40)

The start of the Introduction is marked in one of three ways: most typically by a two-to-four-line 'drop-cap' with block-capital first word, or, less commonly, by the heading *Introduction* or a block-capital first word without drop-cap or heading (see (6.29) for examples of the first two). The visual prominence of the drop-cap adds to the general thematic prominence of the Introduction as one of the first main units in the research article. The association of this type of lettering with manuscripts from late antiquity may also lend the text a sense of tradition and/or authority.

With regard to visual inscriptions, most Introductions contain no graphical, figurative, or numerical images. Only two Introductions—MRAC_01 and MRAC_13—contain visual inscriptions, both of which are graphical images (see (6.30) and (6.31)). Example (6.30) has been discussed several times already. Its main purpose, as mentioned above, is to introduce a proposed model. The model is part of the background for a study that aims to test whether increasing amounts of activated protein C might help to reduce the number of deaths in cases of severe sepsis. The image in (6.30), and verbal reference to the image in the research article, is part of the first phase of the Introduction, describing the field of study.



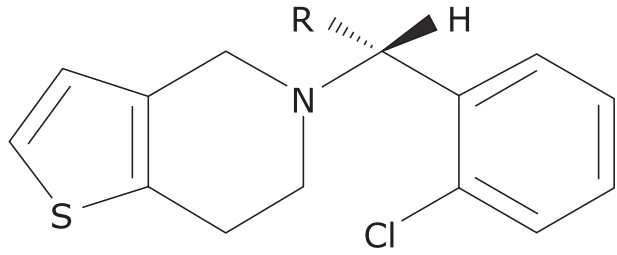

(6.30)

(MRAC_01)

The image in (6.31), a skeletal structural formula, depicts the molecular structure of two related antiplatelet drugs. Like (6.30), (6.31) is part of the background of the study, which aims to test the efficacy of the then recently approved drug *clopidogrel*. In terms of [engagement], the image is not only prominent for its appearance in the Introduction, a marked placement in the corpus specifically and in medical research articles in general; it is also marked for its image-type, since there are no other structural formulae in MRAC. Structural formulae like (6.31) are two-dimensional representations of three-dimensional objects; they depict the spatial arrangement of atoms and molecules, parts of which are directed specifically towards or away from the reader. In (6.31), the solid wedge labelled *H* represents a chemical bond that points out of the plane of the screen or paper towards the viewer, while the dashed wedge labelled *R* points away from the viewer. The chemical bond labelled *R* indicates both the similarity and difference between the two chemical compounds. It represents an either/or potential, where the bond connects either a hydrogen atom *H* or the molecule $CO_2CH_3$, but not both. The representation is amalgamative, similar in some ways to the heart diagram in (6.11), in which sites of interest across several patients are represented collectively in a single diagram. However, unlike

the heart diagram, the structural formula in (6.31) is not representative of any data collected in the study.

(6.31)




(adapted from MRAC_13)

The relative lack of visual inscriptions in Introductions is perhaps unsurprising, given that—according to Latour (1990, 22) at least—visual inscriptions tend to be products of the laboratory, generated by a variety of instruments and methods that have yet to be introduced at this point in the research article. If, like the International Committee of Medical Journal Editors (ICMJE 2008), we read the research article as "a direct reflection of the process of scientific discovery", we might not expect such inscriptions until later in the research article (see, in particular, Sections 6.2.2 and 6.2.3). In the two instances described above, both images are part of a description of the overall field of study (phase 1); they are not part of identifying a gap in the field (phase 2) or stating how that gap might be occupied (phase 3). With regard to [engagement], the images seem to be 'suggestive' of other domains or text-types, i.e. infographics, popular science, and scientific textbooks (see Section 6.1.1.2.3).

### *6.2.2 Methods*

Methods sections usually have two or three main functions or phases: describing the study material and explaining how (and why) that material was selected, and recounting the experimental and data-analysis procedures (see Chapter 3, Section 3.2). In MRAC, the Methods section typically occupies somewhere between one and two pages in print and PDF. The start of the section is indicated by the heading *Methods*, *Subjects and Methods*, or *Patients and Methods*.

One of the most striking visual features of the Methods section in MRAC is that, in print and PDF, the section is often reproduced at a smaller font size than the other main sections of the research article. While the reasons for this are debatable,[18] the dialogic effect of reducing font size is a reduction in visual prominence and a relative backgrounding of the Methods compared with the three other main sections. This backgrounding complements the relatively 'monoglossic' taken-for-grantedness of the verbal resources in the Methods section (see Chapter 4, Section 4.2.2).[19] An example of this reduction in font size can be seen in (6.32) (compare with the Results section, visible in the lower right of the image).

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was to estimate the effects of air pollution on mortality, with control for individual smoking status, sex, age, and other risk factors.

## Methods

### Study Population

We selected random samples of adults from six communities[18]: Watertown, Massachusetts (where study enrollment was conducted in 1974); Harriman, Tennessee, including Kingston (1975); specific census tracts of St. Louis (1975); Steubenville, Ohio (1976); Portage, Wisconsin, including Wyocena and Pardeeville (1976); and Topeka, Kansas (1977). The sample was restricted to the 8111 white subjects who were 25 through 74 years of age at enrollment, had undergone spirometric testing, and had completed a standardized questionnaire. The questionnaire included questions about age, sex, weight, height, education level, complete smoking history, occupational exposures, and medical history.

Informational letters and postage-paid return postcards including a question on vital status were mailed to the subjects annually. The vital status of the subjects who did not respond was determined by questioning family members, friends, or neighbors. In addition, we searched the National Death Index[19] for the years 1979 through 1989. Death certificates were obtained for 1401 of the 1430 subjects who had died (98 percent); the causes of death were coded according to the *International Classification of Diseases, 9th Revision* (ICD-9) by an independent certified nosologist who was blinded both to pollution levels and to the study design and objectives. The ending date of the study for each city was March or June of 1991, depending on the date of the last follow-up contact; the total duration of follow-up was 14 to 16 years (111,076 person-years).

For subjects who died, survival times were calculated by subtracting the date of enrollment from the exact date of death. For surviving participants who were not lost to follow-up, censored survival times were defined as the date of the end of the study minus the enrollment date. For those who were lost to follow-up before the period covered by our National Death Index search (i.e., before 1979), censored survival times were estimated by subtracting the enrollment date either from the date of the last follow-up contact plus six months or from the first day of the National Death Index search period (January 1, 1979), whichever came first. For those who were lost to follow-up after the National Death Index search period (i.e., after 1989), censored survival times were estimated by subtracting the enrollment date either from the date of the last follow-up contact plus six months or from the last day of the study period, whichever came first. For those who were lost to follow-up during the period covered by the National Death Index search, the censored survival times were estimated by subtracting the date of enrollment from the last date in the search period (December 31, 1989).

### Air-Pollution Data

As part of the original study design, ambient (outdoor) concentrations of total suspended particulate matter, sulfur dioxide, ozone, and suspended sulfates were measured in each community at a centrally located air-monitoring station.[18] Size-selective aerosol samplers were placed at these sites in the late 1970s; data were collected for two classes of particle: fine particles (aerodynamic diameter <2.5 μm) and inhalable particles (aerodynamic diameter, <15 μm before 1984 and <10 μm starting in 1984). In the mid-1980s, supplemental 24-hour integrated sampling of aerosol acidity by the measurement of hydrogen ion concentrations[17] was conducted for approximately one year in each city. Mean pollution levels for each pollutant were calculated for periods that were consistent and comparable among the six cities.

### Statistical Analysis

Life-table survival probabilities for each year of follow-up were estimated for each city, and differences between city-specific mortality rates were assessed with a log-rank test.[20] We estimated adjusted mortality-rate ratios for air pollution by simultaneously adjusting for other risk factors in Cox proportional-hazards regression models.[18,22] In these models the subjects were stratified according to sex and five-year age groups, and each sex–age group had its own baseline hazard. Each model also included indicator variables for current or former smokers, the number of pack-years of smoking (evaluated separately for current and former smokers), an indicator variable for less than a high-school education, and body-mass index (defined as the weight in kilograms divided by the square of the height in meters).

Two approaches were used to evaluate the effects of air pollution in the Cox proportional-hazards models. First, indicator variables for the city of residence were included, with Portage, Wisconsin, the city with the lowest levels of particulate air pollution, as the reference category. Adjusted mortality-rate ratios for each of the six cities were then compared graphically with the mean pollution levels in those cities. Next, adjusted mortality-rate ratios were estimated by including city-specific pollution levels directly in the Cox proportional-hazards models. Adjusted rate ratios were calculated and reported for a difference in air pollution equal to that between the city with the highest levels of air pollution and the city with the lowest levels — that is, the adjusted rate ratios across the range of exposure for each pollutant among the six cities.

Analyses were conducted to evaluate the robustness of the models and the possibility of residual confounding. Models were estimated after the data were separated according to the subjects' smoking status, sex, and occupational exposure to dust, gases, or fumes. The effect of the inclusion of different covariates on the estimated effect of pollution was evaluated. Models were also estimated after the exclusion of subjects who had been treated for high blood pressure within 10 years of enrollment in the study and subjects who had ever been told by a doctor that they had diabetes, had glucose in their urine, or had too much glucose in their blood. We also used a variety of approaches to estimate censored survival times.

Mortality-rate ratios from the Cox proportional-hazards models (with adjustment for cigarette smoking, education, and body-mass index) were estimated separately for the following cause-of-death categories: cardiopulmonary (ICD-9 codes 400 through 440 and 485 through 496), lung cancer (162), and all others. For each cause-of-death category, data on subjects whose deaths were not in that specific category were censored at the time of death.

## Results

### Characteristics of the Cohort and Air-Pollution Data

The characteristics of the cohort and the values for air-pollution measures are summarized in Table 1. For all measures of air pollution except the ozone level and aerosol acidity, ambient concentrations were highest in Steubenville and lowest in Portage or Topeka. The mean acidity of the aerosol was highest in Harriman, but second-highest in Steubenville. The mean ozone concentrations were highest in Portage and Topeka. The concentrations of total particles declined during the study period, especially in Steubenville and St. Louis; the annual average concentrations of fine and sulfate particles varied relatively little during the study period (Fig. 1). Crude mortality rates (Table 1) and survival curves (Fig. 2) both show that mortality was highest in Steubenville and St. Louis and lowest in Portage and Topeka. Differences in the probability of survival among the cities were statistically significant ($P<0.001$).

### Adjusted Mortality Rates

On the basis of the proportional-hazards model, mortality was most strongly associated with cigarette smoking (Table 2). Increased mortality was also associated with having less than a high-school educa-



(6.32)

(screenshot from MRAC_07)

There are 25 visual inscriptions in the Methods sections of MRAC. Of these, 13 are tables, five are flowchart diagrams, five are separated mathematical equations, and two are photomicrographs. (There are no graphs.) These inscriptions play different roles with regard to the different generic phases of Methods sections.

Tables typically provide information on baseline characteristics of study groups, contributing primarily to phase 1 of the Methods section, i.e. describing the study material. Tables in Methods sections tend to be 'monoglossic', displaying little or no marked ideation or marked expression. To the degree that they do express some kind of multi- or other-voicedness, 'heteroglossic' resources in Methods tables tend to be dialogically 'contractive'

rather than dialogically 'expansive' (cf. tables in Results, Section 6.2.3). For example, Table 1 in MRAC_26, while ostensibly 'monoglossic', contains some instances of verbal [disclaim] and visual [proclaim], e.g. the categorization of patients in terms of their *not* belonging to a particular group (*Non-Hispanic*, *not shown*; cf. Chapter 4, Section 4.1.1.1.1 on negation) and the relative foregrounding and backgrounding of certain categories through the use of boldface and indentation. Mathematically construed [entertain] and verbally-numerically construed [attribute] are not common features of tables in Methods sections.

The five flowcharts in the MRAC Methods sections represent processes in which patients are categorized into different treatment groups. Like tables in this section, flowcharts provide information about the type and size of groups, and thus contribute to generic phase 1 of the Methods, describing the study material. However, flowcharts can also indicate how the study material was collected and categorized, and, in some cases, how that material is to be analysed, contributing to the second phase of the section, explaining how and why certain material was selected. From a dialogic perspective, flowcharts in Methods sections are ostensibly 'monoglossic', with potentially 'contractive' ([disclaim]) elements that include the disruption of visual flow or 'rhythm' and verbal negation (see Section 6.1.1.1.1). Flowcharts may imply greater interpersonal risk compared with tables, especially if decisions to include or exclude certain groups are based on disputed or "nonstandard" criteria.

There are five separated mathematical equations in MRAC, all of which appear in Methods sections (four in MRAC_47, one in MRAC_49). These equations are part of the generic phase that recounts data-analysis procedures. The four instances in MRAC_47 are shown below in (6.33), reproduced earlier as (5.21); the single instance from MRAC_49 is reproduced earlier as (6.13).

(6.33)

The probability of metastasis was calculated from our logistic-regression model, which basically fit the following equation[18]:

$$\log (P/1 - P) = a + B_1x_1 + B_2x_2 \ldots,$$

where P denotes the probability of the outcome (metastasis). However, our model could be simplified:

$$\log (P/1 - P) = a + Bx,$$

where x denotes the vessel count at 200×. With the microvessel count determined at 200×, this model yielded an intercept (constant), a, of −2.614 and a slope, B, of 0.0464. Using these numbers and rearranging the above equation, we calculated the predicted probability of metastasis with a given vessel count according to the following equation:

$$P = e^{a+Bx}/(1 + e^{a+Bx}).$$

For example, if the highest microvessel count per 200× field was 80, the probability of metastasis would be

$$P = e^{-2.614+0.0464(80)}/(1 + e^{-2.614+0.0464(80)}) = 0.735.$$

(screenshot from MRAC_47)

Verbally and mathematically, the equations in (6.33) seem to be bare assertions, mathematical statements of what *P* and other functional elements are equal to; but they also express varying degrees of 'entertain' (see Sections 4.1.1.2.1 and 5.2.2 in Chapters 4 and 5, respectively). Visually, as noted in Section 6.1.1.1.2, they are highly conspicuous, disrupting the flow of verbiage and staking out or 'proclaiming' a certain importance in relation to the rest of the text. The cumulative effect of not just one but four equations on the same page, in the same column of text, further emphasizes the relative importance and potential "epistemological authority" (Jones 2013, 40) such equations can convey.

The two instances of photomicrographs in the Methods sections are both from MRAC_47. As discussed previously, in Section 6.1.1.2.1, these type-II figurative images are relatively unusual in MRAC and certainly marked in comparison with other image-types, especially tables and graphs. This markedness may be more pronounced in the Methods section, since figurative and graphical-figurative images, to the extent they are used in MRAC, appear more often in Results sections, as part of the report of specific observations or findings (see Section 6.2.3). In the Methods section, however, their role is to serve as examples, as potential models for what is typically observed under different circumstances (cf. Hirschauer 1991 on images as models), which is part of the generic phase of recounting the experimental procedure. The photomicrographs in the Methods of MRAC_47 are described as "representative" in the figure legends and main verbal text. Their use as models in the Methods section suggests that they are instances of 'entertain'—as one among a number of possible alternative representations—an interpretation that may only be possible when considering the images from a generic, multisemiotic perspective.

### *6.2.3 Results*

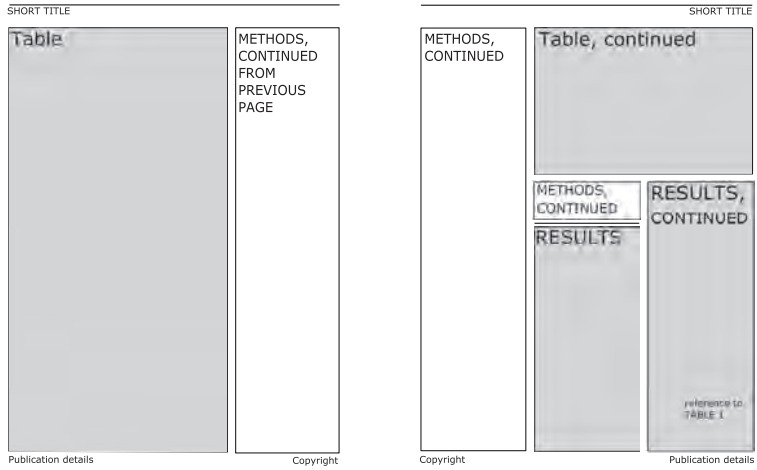
The Results section typically comprises three or four generic phases: reporting the main findings, presenting data, describing any adjustments made to the data or data analysis, and explaining or evaluating selected findings (see Section 3.2). Because of the large numbers of inscriptions, and the space taken up by those inscriptions, Results tend to be relatively long, covering between two and four pages in MRAC articles. Every Results section in MRAC (n=50) starts with the heading *Results*.

Results sections contain more visual inscriptions than any of the other sections. Of a total of 358 visual inscriptions in MRAC, 327 (91.34%) appear in the Results. These inscriptions contribute primarily to two generic phases: reporting findings and presenting data.

Tables (n=180) and graphs (n=111) dominate the visual profile of Results sections. While these inscriptions have similar functions—reporting or presenting data and findings—tables usually contain a larger number of variables than do two- or three-axis line-graphs and bar charts. Moreover, the tables in Results sections are considerably larger than those in Methods

sections (see Section 6.2.2), spanning not only two or more columns, but in some cases extending over two pages. The double-page spread in (6.34) shows an example of this (marked in grey). (Note that the first part of the table appears before the Results section it belongs to. The verbal reference to this table, however, appears in the final paragraph in the lower-right part of the double-page spread.)

(6.34)



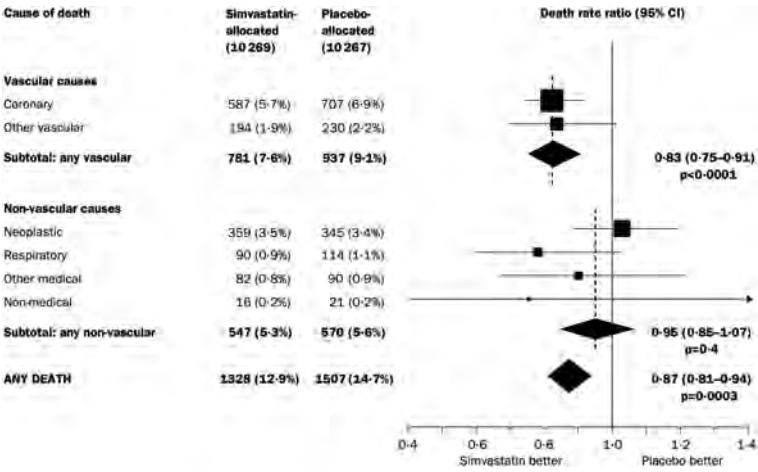

(adapted from MRAC_34)

With regard to [engagement], tables and graphs in Results sections are ostensibly 'monoglossic'; they present the variables studied and the values observed. However, they can also represent (possible) relations between different variables. This can have the effect, on the one hand, of opening up a dialogic space in which alternative values might be 'entertained', and, on the other, of closing down the dialogic space for alternatives by rejecting or countering hypothesized relations ('disclaim').[20] This is one of the ways in which tables in Results sections differ from those in the Methods, in that the latter tend not to instantiate the kinds of dialogic 'expansion' or 'contraction' typically construed by mathematical-verbal (statistical) resources such as *p*-values, *z*-scores, risk, and confidence intervals.

Other image-types in the Results section include table-graph hybrids, numerical-graphical flowcharts, photomicrographs and computed tomography images, and graphical-figurative hybrids (one combined Western blot and graph, and one combined electrogram and angiogram). All of those images contribute to the phase of the Results section that reports findings or presents data.

Table-graph hybrids like the one in (6.20)—reproduced as (6.35) below—provide verbal and visual comparisons of study data, in this case a comparison of rates of death according to cause and treatment group. The right-hand column of the inscription visualizes and numericizes the

similarities and differences between the two treatment groups and provides numerical measures of their statistical significance. In terms of [engagement], prominence/'proclaim' is variously encoded by the use of boldface, capitalization, and solid geometric forms, while 'entertain' is construed by *p*-values, 95% confidence intervals, and the relative widths of geometric forms. Although there are 20 of these table-graph hybrids in MRAC, they appear in only six articles (three on heart disease, three on diabetes mellitus), all of which deal with the comparison of two treatment groups.




(6.35)

(MRAC_03)

The flowcharts in Results sections provide similar information to those in Methods sections, but their placement in one section rather than another suggests different functionality. Flowcharts in Methods sections, as noted above, usually provide information about the categorization and size of study groups; the same applies to flowcharts in Results sections. The main difference, however—beyond mere happenstance—seems to be a matter of how well established the research project is. If the study or parts of the study have been reported previously, the flowchart is placed in the Methods section. If the study is new, or certain patient groups have not been described before, the flowchart appears at the start of the Results section. In other words, Methods flowcharts function to describe the material, the basis for the study; Results flowcharts are construed as being part of the data generated by the study. This distinction may be difficult to make at the level of the flowchart as work and needs to be considered "from above" with regard to generic staging.

With regard to [engagement], Results flowcharts, like most visual inscriptions in MRAC, are ostensibly 'monoglossic'. As works, they present a series of interrelated categories and numerical values that seem to represent a taken-for-granted, authoritative discourse in which, "for the

brief textual moment" (Martin and White 2005, 99), no other voices or viewpoints are invoked. On closer inspection, however, certain episodes and figures within those works suggest readings that may be more multivoiced. These include visual resources such as dashed arrows that indicate possibility, shapes and colours that create varying degrees of prominence, and episodes that run perpendicular and counter to vertically organised episode-nexuses, as well as verbal resources that counter or negate certain propositions.

### *6.2.4 Discussions*

Discussion sections typically comprise several generic stages: reporting main findings (a reiteration of the Results section), exploring connections with the literature, explaining or discussing possible mechanisms or causes, discussing limitations, recommending possible applications and future research, and summarizing or concluding (see Chapter 3, Section 3.2). In MRAC, the Discussion section covers one to three pages, the start of which is marked *discussion* (n=44) or *commentary* (n=6; JAMA articles only).

Like Introduction sections, Discussions are characterized visually by verbiage and few or no inscriptions. Of the four visual inscriptions in MRAC Discussions, two are tables, one is a graph, and one is a key-messages box. Tables contribute to explaining possible mechanisms and study limitations as well as, in one case, providing a possible application for study findings; the graph reiterates the main findings, and the key-messages box contributes to summarizing the study.

With regard to [engagement], the 'rhythm' or flow of the main verbiage in the Discussion is occasionally interrupted by subheadings, e.g. *Strengths and Limitations* and *Conclusion*, typically making explicit the start of a new phase in the text and guiding readers through what is otherwise a relatively short stage in the research article. (Only seven MRAC articles contain subheadings in the Discussion.) More rarely, the 'rhythm' or flow of the verbiage is disrupted by visual inscriptions. These inscriptions have differing dialogic functionality, but all are highly marked or prominent. To take one of the tables mentioned above as an example, it appears to be much the same as other tables in MRAC, with its typical major and minor episodes, variables and values, and the selective deployment of boldface and capitalization—a highly prominent but largely 'monoglossic' visual unit. However, on closer inspection, verbal elements within the table suggest a reading that is more dialogically 'expansive' than other tables in MRAC. The table-heading makes clear that what is presented are *expected* numbers (not actual numbers), and the conjoined footnote emphasizes assumptions made by the authors. The table essentially functions as a model that utilizes the predictive power of the study's findings.

### *6.2.5 Other Sections or Segments of the Medical Research Article*

In this section, we take a closer look at how visual [engagement] is instantiated in other (sometimes overlooked) parts of the medical research article. We begin with the Abstract, before considering titles, acknowledgments and appendices, references, and sections headed "Conflict of Interest" or "Role of the Funding Source".

#### *6.2.5.1 Abstracts*

Abstracts typically comprise four main phases: stating the purpose of the study, describing the material and recounting the methods, reporting results, and concluding. In the paper and PDF versions of MRAC, Abstracts typically occupy half a page and are separated from the rest of the text by horizontal and vertical lines and/or additional white space (see examples in (6.29) above). The section is explicitly marked as *Abstract* in 37 articles; seven use a different heading (*Summary*), and six do not explicitly label the section. All 50 research articles in MRAC include subheadings in bold, italic, or block-capital typeface, indicating the main phases in the Abstract, most typically *Background*, *Objective*, *Results*, and *Conclusions*.

Abstracts in MRAC are reproduced in a different typeface and at a different font size from the verbiage in the main text. Sans-serif typefaces are used in all PDF and paper versions of MRAC Abstracts; the main written text (excluding headings) is always in a serifed typeface. The font size of Abstracts is generally smaller than the verbiage of the main text—usually the same size as reduced-font Methods sections, in articles where this applies (cf. Section 6.2.2).

Abstracts are a highly salient part of the medical research article. They appear on the opening page of research articles, immediately below or adjacent to the title and author names and affiliations. Choices in typeface and size combined with framing resources such as vertical and horizontal lines and/or extra white spacing further emphasize this prominence. They also emphasize a distinction and potential separateness of the Abstract from the rest of the research article (cf. Lane 1992 in Gledhill 1995 on abstract as peritext; Chapter 3, Section 3.2). Abstracts (as well as titles and author names) are often the only parts of the research article that are indexed in databases. As such, they are the most readily accessible parts of the text and usually the first point of contact for readers. They may also be the only part of the research article a reader engages with (ICMJE 2008, 12). For those who choose to read on, the Abstract provides a model for how the rest of the article might be read and a basis for 'alignment' or 'disalignment' with the textual voice.

From a visual perspective, the Abstract is not a research article in miniature (cf. previous chapter, in which verbal and mathematical [engagement]

resources generally mirror those of the four main stages), since it contains no visual inscriptions, e.g. tables, graphs, and diagrams. While the prominence and importance of the section is expressed visually, through choices in positioning, framing, and foregrounding, specific instances of [entertain] and [disclaim] expressed in the visual inscriptions and discussed at length in Sections 6.2.1–6.2.4 are not reproduced visually in the Abstract.

### *6.2.5.2 Titles*

As the opening segment of the HTML version of MRAC_23 demonstrates (see (6.36)), two of the most prominent parts of the research article are the article title and the journal name. The same is also true of the PDF and paper versions (see (6.37)). With regard to [engagement], the high saliency of these visual verbal units 'proclaims' their relative importance or attention-worthiness. Those 'proclamations' represent the subjectivity of the textual voice, but it is a subjectivity that is clearly multifaceted. It is not the authors' voice alone, or the voice of the editors, designers, typesetters, or printers, but an amalgamation of those involved in producing the text. Note that, in (6.37), the journal logo is one of only a few instances of colour in the article. Its visual prominence, together with the journal title, acts as a seal of approval, 'proclaiming' a certain authority for the article and 'attributing' that authority to the source journal (cf. use of drop-cap discussed in Section 6.2.1).

(6.36)


(screenshot from MRAC_23)

The New England Journal of Medicine



VOLUME 342 JANUARY 20, 2000 NUMBER 3

EFFECTS OF AN ANGIOTENSIN-CONVERTING–ENZYME INHIBITOR, RAMIPRIL, ON CARDIOVASCULAR EVENTS IN HIGH-RISK PATIENTS

THE HEART OUTCOMES PREVENTION EVALUATION STUDY INVESTIGATORS*

ABSTRACT

*Background* Angiotensin-converting–enzyme inhibitors improve the outcome among patients with left ventricular dysfunction, whether or not they have heart failure. We assessed the role of an angiotensin-converting–enzyme inhibitor, ramipril, in patients who were at high risk for cardiovascular events but who did not have left ventricular dysfunction or heart failure.

*Methods* A total of 9297 high-risk patients (55 years of age or older) who had evidence of vascular disease or diabetes plus one other cardiovascular risk factor and who were not known to have a low ejection fraction or heart failure were randomly assigned to receive ramipril (10 mg once per day orally) or matching placebo for a mean of five years. The primary outcome was a composite of myocardial infarction, stroke, or death from cardiovascular causes. The trial was a two-by-two factorial study evaluating both ramipril and vitamin E. The effects of vitamin E are reported in a companion paper.

*Results* A total of 651 patients who were assigned to receive ramipril (14.0 percent) reached the primary end point, as compared with 826 patients who were assigned to receive placebo (17.8 percent) (relative risk, 0.78; 95 percent confidence interval, 0.70 to 0.86; P<0.001). Treatment with ramipril reduced the rates of death from cardiovascular causes (6.1 percent, as compared with 8.1 percent in the placebo group; relative risk, 0.74; P<0.001), myocardial infarction (9.9 percent vs. 12.3 percent; relative risk, 0.80; P<0.001), stroke (3.4 percent vs. 4.9 percent; relative risk, 0.68; P<0.001), death from any cause (10.4 percent vs. 12.2 percent; relative risk, 0.84; P=0.005), revascularization procedures (16.0 percent vs. 18.3 percent; relative risk, 0.85; P=0.002), cardiac arrest (0.8 percent vs. 1.3 percent; relative risk, 0.63; P=0.03), heart failure (9.0 percent vs. 11.5 percent; relative risk, 0.77; P<0.001), and complications related to diabetes (6.4 percent vs. 7.6 percent; relative risk, 0.84; P=0.03).

*Conclusions* Ramipril significantly reduces the rates of death, myocardial infarction, and stroke in a broad range of high-risk patients who are not known to have a low ejection fraction or heart failure. (N Engl J Med 2000;342:145-53.)



ALTHOUGH dyslipidemia, diabetes, smoking, and hypertension are major risk factors for cardiovascular disease, they do not fully account for the risk. Therefore, other risk factors must be identified in order to reduce mortality and morbidity even further. Epidemiologic and experimental data suggest that activation of the renin–angiotensin–aldosterone system has an important role in increasing the risk of cardiovascular events.[1] Angiotensin-converting–enzyme inhibitors block the activation of the renin–angiotensin system and could retard the progression of both heart failure and atherosclerosis. In a meta-analysis of three studies[2,3] that included more than 9000 patients with low ejection fractions, treatment with angiotensin-converting–enzyme inhibitors reduced the risk of myocardial infarction by 23 percent. This finding, which has not been widely accepted, was independent of the ejection fraction, the cause of heart disease, concomitant use of medications, diabetes status, and blood pressure, suggesting that angiotensin-converting–enzyme inhibitors may have a role in preventing myocardial infarction in a broad range of patients, not just those with low ejection fractions. Angiotensin-converting–enzyme inhibitors may also reduce the risk of stroke, by lowering blood pressure, and may prevent complications related to diabetes.[3] These hypotheses require direct confirmation in prospective, randomized clinical trials.

Therefore, in a high-risk population, we evaluated the effects of an angiotensin-converting–enzyme inhibitor, ramipril, in preventing the primary out-

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The writing group (Salim Yusuf, D.Phil., Peter Sleight, D.M., Janice Pogue, M.Sc., Jackie Bosch, M.Sc., Richard Davies, Ph.D., and Gilles Dagenais, M.D.) assumes responsibility for the overall content and integrity of the manuscript.

*The investigators are listed in the Appendix.





(6.37)

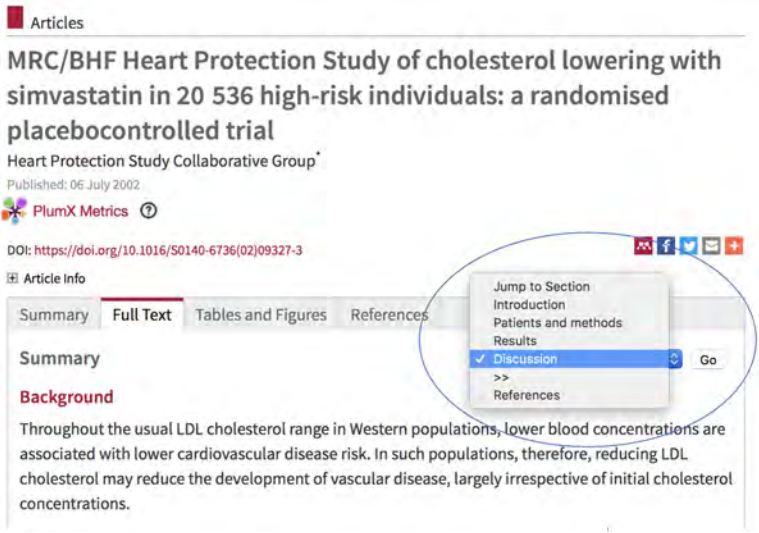
(screenshot from MRAC_50)

### 6.2.5.3 *Acknowledgments and Appendices*

Acknowledgments and Appendices function in similar ways in MRAC: both typically acknowledge and/or thank study participants and collaborators for their roles in the research. Visually, these sections are backgrounded by placing them at the end of articles and at a lower font size than the main text in PDF and paper versions. They are generally considered ancillary to or even separate from the medical research article, as is

often reflected in their omission from genre studies (see Chapter 3, Section 3.2 for review). This is also reflected in example (6.38), from the HTML version of MRAC_03, in which a *Jump to Section* scroll-down menu (circled for reference) includes links to only the four main sections and the reference list; there are no links to the Appendix, Acknowledgements, or Conflict-of-Interest sections of the article.[21] Acknowledgements and Appendices do not generally contain visual inscriptions, although it is not uncommon for medical research articles to include large tables of data in Appendices (ICMJE 2008, 13).[22]

(6.38)




(screenshot from MRAC_03)

### *6.2.5.4 References*

References and reference lists are central to and characteristic of academic writing. They represent an explicit form of [engagement] that 'acknowledges' and 'attributes' the work of others. In medical research articles, references lists are expected to be relatively short—*The Lancet*, for example, suggests a cap of 30 references (LAN 2018)—and ICMJE (2008, 13) argues that "extensive lists of references to original work on a topic can use excessive space on the printed page". In MRAC, reference lists are placed at the end of research articles and in a reduced font size. From a dialogic perspective, this conventionalized, relatively low visual prominence emphasizes how readers might expect and be expected to engage with references—as 'attributions', 'endorsements', and 'justifications' that are auxiliary to claims made by the textual voice in the main body of the research article. There are no visual inscriptions in reference sections.

#### *6.2.5.5 Conflict of Interest and Role of the Funding Source*

Conflict-of-Interest (COI) and Role-of-the-Funding-Source (ROFS) sections are disclosures of any positions or relations that could "inappropriately influence (bias)" researchers' actions and more generally "undermine the credibility of the journal, the authors, and of science itself" (ICMJE 2008, 4). Those disclosures include "financial relationships" as well as "personal relationships, academic competition, and intellectual passion" (ICMJE 2008, 4). Like References, Acknowledgments, and Appendices, COI and ROFS statements in MRAC are reproduced at smaller font sizes than the four main sections of the research article. While they are important parts of the research articles they appear in, COI and ROFS statements are subordinate and ancillary to the main body of text. In terms of [engagement], their inclusion helps maintain trust and credibility in the scientific process, acting as a potential 'endorsement' of the study and the integrity of the textual voice.

## 6.3 Visual Engagement and the Discipline(s) of Medicine

Visually, medical research articles appear to be primarily 'monoglossic', especially with regard to visual inscriptions, with instances of [heterogloss] largely instantiated in episodes, figures, and figure-parts within more ostensibly 'monoglossic' works. This differs somewhat from verbal and mathematical [engagement], in which [heterogloss] predominates (see Chapters 4 and 5). Choices of visual [engagement] in medical research articles imply a discourse in which a backdrop of other voices, positions, and propositions is not generally invoked. This may be in contradistinction to the findings of Chapters 4 and 5, but visual display plays a crucial role in construing for the text the authoritative position that Bakhtin (1981 [1935], 351) identifies as being central to scientific thought. Bakhtin (1981 [1935], 342) describes this as a "prior discourse" whose authority is already established—or 'taken for granted', to use Martin and White's (2005) terminology. The ostensible [monogloss] of graphs and tables in medical research articles can be seen as a visual expression of that authoritative discourse.[23]

The apparent contradiction between a primarily 'heteroglossic' verbal and mathematical text and a primarily 'monoglossic' visual text largely disappears when one considers medical research articles from a generic perspective. Here, the [monogloss] of graphs and tables complements the relative [monogloss] of the Methods and Results, strengthening the claim made in Sections 4.3 and 5.3 in Chapters 4 and 5, respectively, that different generic stages and phases construe potentially different epistemological positions and writer–reader relations as the text unfolds. The Methods and Results are a textual instantiation of research as action, where the graphs and tables produced, along with the verbiage, are an artefact or documentation of actual laboratory or clinical activities as well as an

idealized account of the discipline-specific work carried out by researchers (see Lynch 1985, 57–58). Tables and graphs allow objects of interest to be perceived and analysed (Lynch 1985, 37) and can give the impression that the objects and relations they represent are inherently numerical or mathematical (Lynch 1990, 169). In contrast, Introduction and Discussion sections, with fewer visual inscriptions but more overt visual [heterogloss], construe for the text a discourse in which other voices and other positions are invoked, and one in which the singular discourse of mathematics plays a lesser role.

The instantiation of visual [engagement] in medical research articles seems to be determined primarily by an abstract/technological coding orientation (Bernstein 1981, Kress and van Leeuwen 1996, 2006, van Leeuwen 1999). Semiotic choices are valued by the extent to which they can represent the generalizable rather than the specific, and the schematic rather than the naturalistic, e.g. colour-coding and lines of best fit. However, there are also certain choices of visual [engagement], e.g. a broad palette of colours and the iconic representation of certain figures, that suggest a more sensory or naturalistic coding orientation. Overall, while an abstract/technological coding orientation arguably predominates, certain semiotic choices at certain points in the text imply a hybrid set of regulative principles that are dynamic and seem to be influenced by other discursive fields.

## Notes

1 For copyright reasons, several figures in this chapter have been redrawn.
2 Sustained virologic response (SVR) is the absence of any detectable virus at the end of a study period.
3 For more on visual-verbal relations, see Chapter 7.
4 The terms *tight* and *less tight* refer here to two groups of patients: those whose blood pressure was kept under 150/85 mmHg by treatment with captopril or atenolol, and those whose blood pressure was kept under 180/105 mmHg without resorting to treatment with captopril or atenolol, respectively.
5 Rowley-Jolivet (2004, 161–162) notes a left-to-right, general-to-particular relation in multi-panel images like that in (6.12). Such visual structures are typically used for "spatial focusing, or zoom-in", where right-hand panels tend to have higher information value than left-hand panels, and where the implied relation is one of whole–part metonymy (Rowley-Jolivet 2004, 162).
6 These two (potentially overlapping) uses of colour, for (semi-)naturalistic representation and for colour-coding, might usefully be described as iconic and indexical, respectively (see Peirce 1894 in Peirce 1998).
7 Standard errors (SE) quantify the uncertainty in the estimate of a mean, while standard deviations quantify the variability or dispersion of individual observations (see Barde and Barde 2012). Although SE and SD are different statistical measurements, they may be used and/or read interchangeably in medical research articles (Barde and Barde 2012, 113).
8 Although hypertext links can be considered a visual realization of [entertain], the linked text or text-element itself may 'engage' in different ways. For example, a link to a previous study or a table, while optional and dialogically 'expansive', might also seek to [justify] or [endorse] a particular position advanced in the text.

9 Despite the quotation marks, the propositions contained within them are not direct quotes from individual patients. They represent standardized, rubric responses that are provided to patients by the researchers.
10 Although only briefly mentioned in MRAC_43, the method of self-reporting in medical research is often discussed as a source of potential bias. In another MRAC text, MRAC_09, this issue is discussed more explicitly in terms of the accuracy of recollection in such surveys.
11 The [suggest] category has no direct equivalent in the verbal ENGAGEMENT systems proposed by Martin and White (2005) and others. It could be argued that [suggest], to the extent that it can be construed visually, verbally, and mathematically, is a property of the ENGAGEMENT system as a whole. When seen from a trinocular perspective, ENGAGEMENT attempts to account for the ways in which texts refer to, respond to, and are influenced by other actual or anticipated texts. There is no reason why this would not include texts both within and across different fields or domains.
12 Rowley-Jolivet (2002, 24, 2004, 148) describes physics and geology as "hard sciences", "representing the two main loci of scientific investigation, namely fieldwork (geology) and the laboratory (physics [electromagnetism])". In contrast, medicine is described as a "life sciences discipline" (Rowley-Jolivet 2002, 24, 2004, 148).
13 The mean total number of inscriptions per research article in the hard-science journals in Arsenault et al.'s (2006, 394) study is 14.90. This is much higher than the 7.16 inscriptions per article for MRAC. The high number of inscriptions in Arsenault et al. (2006) is partly a result of the large number of mathematical equations in their physics (hard) and economics (soft) research articles. Arsenault et al. (2006, 398, 405–407) use these findings to argue that the display of equations, unlike graph use, is not necessarily indicative of hardness or the "scientificity of disciplines".
14 The HTML versions of certain MRAC texts allow readers to download graphical, numerical, and figurative images as standalone files. The ability to download those individual images may afford closer readings than those in print or PDF. For example, if I download a graphical image from *The Lancet* or the *British Medical Journal*, I might be more easily able to read off values in that image, by zooming in on specific parts of the graph, than if I view the same image in PDF or paper format.
15 The name of this episode is based in part on the written description accompanying the image. For more on the intersemiotic relations between verbal, mathematical, and visual text, see Chapter 7.
16 Although *endothelium* is not labelled within this particular episode, it is labelled as such elsewhere in the image (top left corner).
17 The images in (6.29) show the opening pages of two articles, MRAC_12 and MRAC_40, both in PDF. The Introductions are indicated by grey boxes.
18 Smaller font size is generally concerned with space constraints associated with print publishing and the relative uniformity of the content of the Methods section compared with other sections of the medical research article. In a letter-to-the-editor published in *The Lancet* in 2001, one author (Rothman 2001, 890) notes that the reduced font size of some Methods sections "conveys the message that the description of what was actually done in a study is low-priority information". A similar point is made by Ferrill, Norton, and Blalock (1999, 371) in a study of pharmacists' interpretations of statistics in medical journals, in which they suggest that smaller font size "may lead the reader to mistakenly conclude the information presented in the smaller font is of lesser importance". An editorial published in *New England Journal of Medicine* in 2003 (Drazen, Anderson, and Curfman 2003) regarding the journal's decision to restore the

Methods section to "full-size type" acknowledges how "critical to research" methods sections are. No reason is given in the editorial for why the journal originally adopted the smaller-font-size Methods section.

19 As a further example of the relative backgrounding of Methods sections in scientific research articles, Wu (2011, 1348), in a review of the IMRaD model, notes that the journal *Nature* publishes Methods at the end of research articles as well as at a smaller font size.

20 These relations are usually set up in the Introduction section, as hypotheses or study aims, as part of the stating-the-research-purpose phase (see Chapter 3, Section 3.2).

21 The symbol >> is a separator between the four main sections and the references; it does not perform a hyperlink function.

22 The only exception in MRAC is MRAC_01, which contains two numerical images in its Appendix (see Chapter 7).

23 That authority can be questioned, of course, even if it is framed as 'taken for granted'.

## References

Arsenault, Darin J., Laurence D. Smith, and Edith A. Beauchamp. 2006. "Visual inscriptions in the scientific hierarchy: mapping the 'treasures of science'." *Science Communication* 27 (3):376–428. doi: 10.1177/1075547005285030.

Bakhtin, Mikhail Mikhailovich. 1981 [1935]. *The Dialogic Imagination: Four Essays*. Translated by Caryl Emerson and Michael Holquist. Edited by Michael Holquist. Austin, TX: University of Texas Press.

Barde, Mohini, and Prajakt Barde. 2012. "What to use to express the variability of data: standard deviation or standard error of mean?" *Perspectives in Clinical Research* 3 (3):113–116. doi: 10.4103/2229-3485.100662.

Barthes, Roland. 1977. *Image Music Text*. London: Fontana Press.

Bernstein, Basil. 1981. "Codes, modalities and the process of cultural reproduction: a model." *Language and Society* 10:327–363.

BMJ. 2018. "Authors." accessed 13 April 2018. https://sti.bmj.com/pages/authors/.

Chen, Yumin. 2008. "Heteroglossic harmony: multimodal ENGAGEMENT resources and their gradability in China's EFL context." In *Proceedings of ISFC 35: Voices around the World*, edited by Canzhong Wu, Christian M. I. M. Matthiessen and Maria Herke, 296–301. Sydney: The 35th ISFC Organizing Committee.

Chen, Yumin. 2009. "Interpersonal meaning in textbooks for teaching English as a foreign language in China: a multimodal approach." PhD thesis, Department of Linguistics, University of Sydney.

Chen, Yumin. 2010. "Exploring dialogic engagement with readers in multimodal EFL textbooks in China." *Visual Communication* 9 (4):485–506.

Cleveland, William S. 1984. "Graphs in scientific publications." *The American Statistician* 38 (4):261–269.

Dick, Murray. 2014. "Interactive infographics and news values." *Digital Journalism* 2 (4):490–506. doi: 10.1080/21670811.2013.841368.

Drazen, Jeffrey M., Kent R. Anderson, and Gregory D. Curfman. 2003. "A new look: form follows function." *New England Journal of Medicine* 348 (1):66–66. doi: 10.1056/NEJMe020160.

Economou, Dorothy. 2009. "Photos in the news: appraisal analysis of visual semiosis and verbal-visual intersemiosis." PhD thesis, University of Sydney.

Fairclough, Norman. 1992. *Discourse and Social Change*. Cambridge: Polity Press.
Feng, Dezheng, and Peter Wignell. 2011. "Intertextual voices and engagement in TV advertisements." *Visual Communication* 10 (4):565–588.
Ferrill, Mary J., Linda L. Norton, and Susan J. Blalock. 1999. "Determining the statistical knowledge of pharmacy practitioners: a survey and review of the literature." *American Journal of Pharmaceutical Education* 63:371–376.
Gledhill, Chris. 1995. "Collocation and genre analysis. The phraseology of grammatical items in cancer research articles and abstracts." *Zeitschrift für Anglistik und Amerikanistik* XLIII (1):11–36.
Gupta, Sandeep K. 2011. "Intention-to-treat concept: a review." *Perspectives in Clinical Research* 2 (3):109–112. doi: 10.4103/2229-3485.83221.
Herrando-Rodrigo, Isabel. 2010. "'If you suffer from check the Internet': the role of engagement and self-mention devices in medical research articles and electronic popularizations." In *Constructing Interpersonality: Multiple Perspectives on Written Academic Genres*, edited by Rosa Lorés-Sanz, Pilar Mur-Dueñas and Enrique Lafuente-Millán, 255–274. Newcastle upon Tyne: Cambridge Scholars Publishing.
Hirschauer, Stefan. 1991. "The manufacture of bodies in surgery." *Social Studies of Science* 21:279–319.
International Committee of Medical Journal Editors (ICMJE). 2008. *Uniform Requirements for Manuscripts Submitted to Biomedical Journals: Writing and Editing for Biomedical Publication*. Vancouver: International Committee of Medical Journal Editors.
Jones, Rodney H. 2013. *Health and Risk Communication: An Applied Linguistic Perspective*. Abingdon: Routledge.
Kress, Gunther, and Theo van Leeuwen. 1996. *Reading Images: The Grammar of Visual Design*. London: Routledge.
Kress, Gunther, and Theo van Leeuwen. 2006. *Reading Images: The Grammar of Visual Design*. 2nd ed. Abingdon: Routledge.
LAN. 2018. "Information for authors." accessed 5 September 2018. https://www.thelancet.com/lancet/information-for-authors.
Latour, Bruno. 1990. "Drawing things together." In *Representation in Scientific Practice*, edited by Michael Lynch and Steve Woolgar, 19–68. Cambridge, MA: MIT Press.
Lemke, Jay L. 1998. "Multiplying meaning: visual and verbal semiotics in scientific text." In *Reading Science: Critical and Functional Perspectives on Discourses of Science*, edited by J. R. Martin and Robert Veel, 87–113. London: Routledge.
Lynch, Michael. 1985. "Discipline and the material form of images: an analysis of scientific visibility." *Social Studies of Science* 15 (37–66).
Lynch, Michael. 1990. "The externalized retina: selection and mathematization in the documentation of objects in the life sciences." In *Representation in Scientific Practice*, edited by Michael Lynch and Steve Woolgar, 153–186. Cambridge, MA: MIT Press.
Martin, J. R., and P. R. R. White. 2005. *The Language of Evaluation: Appraisal in English*. Basingstoke: Palgrave Macmillan.
Myers, Greg. 1990. "Every picture tells a story: illustrations in E. O. Wilson's *Sociobiology*." In *Representation in Scientific Practice*, edited by Michael Lynch and Steve Woolgar, 231–265. Cambridge, MA: MIT Press.

O'Halloran, Kay L. 2005. *Mathematical Discourse: Language, Symbolism and Visual Images*. London: Continuum.

O'Toole, Michael. 1994. *The Language of Displayed Art*. London: Continuum.

Peirce, Charles Sanders. 1998. *Essential Peirce: Selected Philosophical Writings, 1893–1913*. Bloomington, IN: Indiana University Press.

Rothman, Kenneth J. 2001. "Sizing up research." *The Lancet* 357 (9259):890. doi: 10.1016/S0140-6736(05)71832-8.

Rowley-Jolivet, Elizabeth. 2002. "Visual discourse in scientific conference papers: a genre-based study." *English for Specific Purposes* 21:19–40.

Rowley-Jolivet, Elizabeth. 2004. "Different visions, different visuals: a social semiotic analysis of field-specific visual composition in scientific conference presentations." *Visual Communication* 3 (2):145–175. doi: 10.1177/147035704043038.

Salager-Meyer, Françoise. 1994. "Hedges and textual communicative function in medical English written discourse." *English for Specific Purposes* 13 (2):149–170.

Smith, Laurence D., Lisa A. Best, D. Alan Stubbs, John Johnston, and Andrea Bastiani Archibald. 2000. "Scientific graphs and the hierarchy of the sciences: a Latourian survey of inscription practices." *Social Studies of Science* 30 (1):73–94.

Tan, Sabine. 2010. "Modelling engagement in a web-based advertising campaign." *Visual Communication* 9 (1):91–115. doi: 10.1177/1470357209352949.

van Leeuwen, Theo. 1999. *Speech, Music, Sound*. Basingstoke: Macmillan.

Vihla, Minna. 1999. *Medical Writing: Modality in Focus*. Amsterdam: Rodopi.

White, Peter R. R. 2003. "Beyond modality and hedging: a dialogic view of the language of intersubjective stance." *Text* 23 (2):259–284.

Wu, Jianguo. 2011. "Improving the writing of research papers: IMRAD and beyond." *Landscape Ecology* 26 (10):1345–1349. doi: 10.1007/s10980-011-9674-3.

# 7 Intersemiotic Engagement in Medical Research Articles

In this chapter, we examine [engagement] from an intersemiotic perspective, by considering how verbal, mathematical, and visual resources are co-deployed and integrated. Section 7.1 examines intersemiotic [engagement] in a single text, while Section 7.2 takes a broader approach, looking at intersemiotic [engagement] across the various generic stages and phases of the medical research article as a whole. The chapter concludes with a discussion of the potential relations between intersemiotic [engagement] and the disciplines and ideologies of medical research.[1]

## 7.1 Intersemiotic Engagement: A Close Reading

In order to understand [engagement] from an intersemiotic perspective, we zoom in here on one single text. A close reading of one text allows for a detailed and fine-grained account of how and where verbal, mathematical, and visual [engagement] resources are co-deployed, how and where those resources intersect and interact (their complementarity and divergence), and how and where (in some instances) they can combine to create meanings that can only be appreciated intersemiotically (i.e. something other than the sum of their mono-semiotic parts).

The text under consideration, MRAC_01, is a research article from a multicentre, clinical, randomized controlled trial examining the effects of a particular drug—drotrecogin alfa (activated), also known as recombinant human activated protein C—on the rate of death among patients with severe sepsis. The article was published in the *New England Journal of Medicine* in 2001.

MRAC_01 contains 6,046 word-tokens (1,666 word-types), eight numerical images, and three graphical images, including the blood-vessel diagram discussed in Chapter 6. In its paper and PDF versions, the article comprises 11 pages.

### *7.1.1 Verbal Engagement in MRAC_01*

Most of the verbal [engagement] resources in MRAC_01 are 'heteroglossic', with relatively few instances of [monogloss] (although the distribution of

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verbal [monogloss] varies across the text; see below). Among the instances of verbal [heterogloss] in MRAC_01, the majority are 'expansive' and are of the 'entertain' and 'acknowledge' subtypes, typically realized by *may* and *if*, and superscript numbers and references, respectively. 'Deny' and 'endorse' are the most commonly instantiated dialogically 'contractive' features, most frequently realized by *not* and *non-*, and *find*, *demonstrate*, and *show*, respectively. There are no instances of verbal [pronounce] or [distance] in the text. Examples of some of the verbal dialogic resources used in MRAC_01 can be seen in (7.1)–(7.4).

(7.1) The conversion of protein C to activated protein C *may* be impaired during sepsis as a result of the down-regulation of thrombomodulin by inflammatory cytokines.[19] (MRAC_01)

(7.2) The incidence of thrombotic events was *not* increased by treatment with drotrecogin alfa activated, and the antiinflammatory effect was *not* associated with an increased incidence of new infections. Treatment with drotrecogin alfa activated was *not* associated with the development of neutralizing antibodies against activated protein C. (MRAC_01)

(7.3) The antiinflammatory activity of drotrecogin alfa activated *may* be mediated indirectly through the inhibition of the generation of thrombin, which leads to decreased activation of platelets, recruitment of neutrophils, and degranulation of mast cells.[8] Furthermore, preclinical studies *demonstrated* that activated protein C has direct antiinflammatory properties, *including* the inhibition of neutrophil activation, the production of cytokines by lipopolysaccharide-challenged monocytes, and E-selectin-mediated adhesion of cells to vascular endothelium.[32–34] (MRAC_01)

(7.4) *We conducted a randomized, double-blind, placebo-controlled, multicenter trial. Patients with systemic inflammation and organ failure due to acute infection were enrolled and assigned to receive an intravenous infusion of either placebo or drotrecogin alfa activated (24 μg per kilogram of body weight per hour) for a total duration of 96 hours*. (MRAC_01)

The distribution of verbal [engagement] varies across different generic stages of the article. The Introduction is characterized by a lack of verbal [monogloss] and by a relative abundance of [entertain] and [attribute], as the text describes the background for the study and presents the study aims. Although few in number, 'contractive' resources in the Introduction include [counter], [endorse], and [justify], but no instances of [deny]. The Methods section of MRAC_01 is characterized by an abundance of verbal [monogloss] and [acknowledge], as the text describes the study material and recounts experimental and data-analysis procedures. The section contains a

relative lack of verbal [entertain] and no instances of [counter]. In reporting findings and presenting data, the Results section contains a large amount of verbal [monogloss] (more than the Introduction and Discussion, but less than the Methods). There are also several instances of [deny] and [counter]. The Discussion section is characterized as having a relative abundance of [entertain], [endorse], and [deny] and a relative lack of [monogloss] and [justify], as the authors offer explanations for their findings and make suggestions for application and further research; there are relatively few 'acknowledgments' compared with the Introduction and Methods sections. Examples of verbal [engagement] from each of these four main generic stages are given below, in (7.5)–(7.8).

(7.5) The inflammatory and procoagulant host responses to infection are closely related.[7] Inflammatory cytokines, *including* tumor necrosis factor α, interleukin-1β, and interleukin-6, are capable of activating coagulation and inhibiting fibrinolysis, *whereas* the procoagulant thrombin is capable of stimulating multiple inflammatory pathways.[7–11] The end result *may* be diffuse endovascular injury, multiorgan dysfunction, and death. (MRAC_01 Introduction)

(7.6) *Changes from base-line levels of plasma D-dimer and serum interleukin-6 were analyzed in patients who had subsequent measurements with the use of analysis of variance of ranked data. For patients with missing data, we used the last-observation-carried-forward method of imputation. The proportion of patients who had serious adverse events and new infections was compared in the two groups with the use of Pearson's chi-square tests. All reported P values are two-sided.* (MRAC_01 Methods)

(7.7) *Of 1728 patients who underwent randomization, 1690 received the study drug or placebo.* Thirty-eight patients (17 in the placebo group and 21 in the drotrecogin alfa activated group) *never* received any study drug. In the drotrecogin alfa activated group, 14 patients met *at least* one *exclusion* criterion, 4 patients became moribund before the infusion *could* be started, *and consent was withdrawn before the infusion in the case of 3 patients*. In the placebo group, 15 patients did *not* meet the entry criteria for the study, *and 2 patients became moribund before the infusion was begun.* (MRAC_01 Results)

(7.8) Activated protein C inhibits the generation of thrombin by inactivating factor Va and factor VIIIa.[30,31] As compared with the patients who received placebo, patients who received drotrecogin alfa activated had greater decreases in plasma D-dimer levels during the first seven days after the infusion was initiated, *indicating* a reduction in the generation of thrombin. The rise in D-dimer levels after the completion of the 96-hour infusion of drotrecogin alfa activated *indicates*

> incomplete resolution of the procoagulant state seen in patients with sepsis. An evaluation of longer periods of infusion of drotrecogin alfa activated *may* be warranted. (MRAC_01 Discussion)

Among the other sections or segments in MRAC_01, the abstract can be summarized as instantiating an abundance of verbal [monogloss], some [entertain], relatively little [deny] and [justify], and no [counter], [concur], [pronounce], [endorse], [acknowledge], or [distance]. The title is 'non-heteroglossic' (see Chapter 4, Section 4.2.5.2), and the acknowledgments section is 'monoglossic'. There are three appendices in the article, the first two of which are tables. The tables describe inclusion and exclusion criteria, and they enact a variety of dialogic positions, most notably [deny] and [entertain] (cf. Chapter 4, Section 4.2.2). The third appendix, a list of participating researchers and institutions, is 'monoglossic'. Some of these verbal resources are discussed in more detail in Section 7.1.4.

### *7.1.2 Mathematical Engagement in MRAC_01*

Mathematical [engagement] in MRAC_01 is realized by a relatively limited set of mathematical-verbal and mathematical-symbolic resources. The two most common of these are *relative risk* and *p* (or *p*-value), resources that, dialogically, enact [expand: entertain] (see Chapter 5, Section 5.1.1.2 and example (7.9)). Other mathematical-verbal or -symbolic resources include components such as =, < and >, ≤ and ≥, and ±, as well as *95% confidence interval* (*95% CI*). The first three usually enact [monogloss] and the last four [entertain], but this depends on other components in the mathematical clause or proposition. In MRAC_01, = is always used with component *p*, making the proposition dialogically 'expansive', while < and > are generally part of 'monoglossic' propositions or semantic elements, realized at the clause or expression levels of the rank scale for mathematics (see (7.9) and (7.10)). There are no separated mathematical equations or formulae in MRAC_01 (see sections 5.2.2, 6.1.1.1.2, 6.1.1.2.1, and 6.2.2, in Chapters 5 and 6, respectively).

(7.9) Twenty-eight days after the start of the infusion, 259 of 840 patients in the placebo group (30.8 percent) and 210 of 850 (24.7 percent) of the patients in the drotrecogin alfa activated group had died. This difference in the rate of death from any cause was significant (P=0.005 in the nonstratified analysis) (Table 4) and was associated with an absolute reduction in the risk of death of 6.1 percent. (MRAC_01)

(7.10) APPENDIX 2. SUMMARY OF EXCLUSION CRITERIA.
Pregnancy or breast-feeding
Age <18 yr or weight >135 kg
Platelet count <30,000/$mm^3$ (MRAC_01)

Instances of mathematical [engagement] are scattered across MRAC_01, but the majority are found in the Methods and Results sections, as part of the phases that recount data-analysis procedures and report findings and statistical analyses (cf. Chapter 5, Sections 5.2.2 and 5.2.3). It is here that we find mathematical [entertain] encoded and quantified by *risk* and *p* (see (7.9) above, from MRAC_01 Results). The Introduction contains just one instance of mathematical-verbal [engagement], in the form of *risk* (without quantification), as part of the background and rationale for the study (see (7.11)). The Discussion contains two instances of mathematical-verbal [entertain], both encoded by *relative risk*—the first is found in the phase summarizing main findings, the second is in the phase explaining or discussing possible mechanisms or causes (see (7.12) and (7.13), respectively). As for other sections of MRAC_01, the abstract contains several instances of mathematical [entertain] in its results phase (see (7.14)); the appendices contain mathematical [monogloss] and [entertain] (see (7.10) above for instances of [monogloss]); and the title and the acknowledgments section contain no instances of mathematically construed [engagement].

(7.11) Reduced levels of protein C are found in the majority of patients with sepsis and are associated with an increased *risk* of death.[20–23] (MRAC_01 Introduction)

(7.12) In this study, the administration of drotrecogin alfa activated reduced the rate of death from any cause at 28 days in patients with a clinical diagnosis of severe sepsis, resulting in a 19.4 percent reduction in the *relative risk* of death and an absolute reduction of 6.1 percent. A survival benefit was evident throughout the 28-day study period, whether or not the groups were stratified according to the severity of disease. Our results indicate that in this population, 1 additional life would be saved for every 16 patients treated with drotrecogin alfa activated. (MRAC_01 Discussion)

(7.13) Reductions in the *relative risk* of death were observed regardless of whether the patients had a deficiency of protein C at base line, suggesting that drotrecogin alfa activated has pharmacologic effects that go beyond simple physiologic replacement of activated protein C. (MRAC_01 Discussion)

(7.14) On the basis of the prospectively defined primary analysis, treatment with drotrecogin alfa activated was associated with a reduction in the *relative risk* of death of 19.4 percent (95 percent confidence interval, 6.6 to 30.5) and an absolute reduction in the *risk* of death of 6.1 percent (*P=0.005*). The incidence of serious bleeding was higher in the drotrecogin alfa activated group than in the placebo group (3.5 percent vs. 2.0 percent, *P=0.06*). (MRAC_01 Abstract)

### *7.1.3 Visual Engagement in MRAC_01*

The visuality of MRAC_01 is characterized by verbiage and other inscriptions of varying prominence. Those degrees of prominence, and the relative importance such prominence might 'proclaim' for different parts of the text, are affected by choices of typeface, formatting, size, positioning, framing, and colour. Among the highly prominent visual elements in MRAC_01 are the placement of a notice at the top of the opening page above the title (PDF only), the block capitals and high central placement of the title, the sans-serif typeface and use of bold in the abstract, the three- or four-line drop-cap and caps-first-words of the Introduction (four-line drop for paper and PDF; three-line drop for HTML), a full-colour, full-page graphical image in the Introduction, and a series of single- and double-column tables and graphs in the Results and Appendix.[2] These visual elements are presented and discussed in more detail in the next section.

Visual inscriptions in MRAC_01 are characterized by their relative [monogloss]—i.e. their somewhat typical-for-science representations (cf. Economou 2009)—but one image in particular, the blood-vessel diagram (see, for example, (6.30)), contains several episodes and figures that clearly construe [heterogloss], especially [proclaim] and [entertain] (see Chapter 6, Sections 6.1.1.1.2 and 6.1.1.2.1), and that [suggest] a set of semiotic choices that are partially characteristic of other domains or image-types (see Chapter 6, Section 6.1.1.2.3). It is in this respect that visual [engagement] in MRAC_01 differs most from MRAC as a whole.

Visual inscriptions are distributed across different stages and phases of the article. The first, and perhaps most notable, is the blood-vessel diagram in the Introduction, presented as part of the describing-the-field-of-study phase (see Chapter 6, Section 6.2.1). There are no visual inscriptions in the Methods section, but reference is made to the verbal-numerical inscriptions in appendices 1 and 2—two tables presenting inclusion and exclusion criteria, respectively. The Results section contains five numerical and two graphical images. At the level of the inscription as work, all of these images might be described as 'monoglossic', or typical for science, with little or no marked ideation or expression (cf. Economou 2009, 214), but they all contain certain visual, verbal, or mathematical elements that, at the level of the episode, figure, or figure-part, express [proclaim] or [entertain]. These kinds of dialogic meanings are variably realized by bold typeface, capitalization, horizontal lines or spacing, indentations, dashed and solid lines and circles, and/or expressions of probability and risk.

### *7.1.4 Intersemiotic Engagement in MRAC_01*

#### *7.1.4.1 Reading Paths*

Certain texts—tightly packed written texts or conventionalized comic strips, for example—may be designed to be read in a linear fashion, from

left to right and from top to bottom, one line or panel at a time (Kress and van Leeuwen 2006, 204).[3] Others, including scientific articles, may be designed to allow for multiple reading paths, which permit or encourage the reader to move more freely across the text. That freedom is not unlimited, and the composition of a page typically sets up hierarchies of prominence that make some readings more likely than others. In the case of a scientific text, the preferred reading path may be a relatively linear one, but the footnotes and visual inscriptions, the headed sections and subsections, allow the reader to navigate the text according to interest, looking first, perhaps, at tables and graphs before examining the written text, or moving back and forth between sections (Lemke 1998, 95). An expert reader with particular interests is likely to follow a different reading path from a nonexpert reader or an expert reader with other interests. Medium and materiality also affect possible reading paths, with paper, PDF, and HTML versions of articles all having different potentials for engagement (Kress and van Leeuwen 2001, chapter 4). As a nonexpert or peripheral reader (see Chapter 1, Section 1.1), the analysis I offer here is one based on a relatively linear reading path that largely follows a left-to-right, top-to-bottom, column-by-column direction, but may occasionally be disrupted by verbal references to visual elements or by the presence of visual inscriptions that encourage the reader to move back and forth across the text in a potentially nonlinear manner.

#### *7.1.4.2 A Close Reading of Selected Passages from MRAC_01*

The PDF version of MRAC_01 starts with a visual verbal unit—an announcement—at the top of the opening page, placed directly above the title (see title page in (7.15)).[4] The size of the typeface in the announcement is the same as that of the title, but the formatting is in sentence case rather than block capitals. The importance or warrantability 'proclaimed' for this highly prominent visual unit is also signalled verbally. The text reads: *Notice: Because of its possible clinical implications, this article is being released before its publication date. The report will be published on March 8*. The scope of this visual-verbal 'proclamation', which also includes a verbal 'justification' for the advanced publication of the article, is not restricted to the announcement itself.[5] Rather, it extends or projects over the entire article, making explicit a sense of urgency and importance for the text that is not specified elsewhere in MRAC. A reader of the PDF version of MRAC_01, one who begins from the top of the first page, is made immediately aware of this importance, and their reading is likely to be affected by that.[6]

Notice: Because of its possible clinical implications, this article is being released before its publication date. The report will be published on March 8.

## EFFICACY AND SAFETY OF RECOMBINANT HUMAN ACTIVATED PROTEIN C FOR SEVERE SEPSIS

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**ABSTRACT**

***Background*** Drotrecogin alfa (activated), or recombinant human activated protein C, has antithrombotic, antiinflammatory, and profibrinolytic properties. In a previous study, drotrecogin alfa activated produced dose-dependent reductions in the levels of markers of coagulation and inflammation in patients with severe sepsis. In this phase 3 trial, we assessed whether treatment with drotrecogin alfa activated reduced the rate of death from any cause among patients with severe sepsis.

***Methods*** We conducted a randomized, double-blind, placebo-controlled, multicenter trial. Patients with systemic inflammation and organ failure due to acute infection were enrolled and assigned to receive an intravenous infusion of either placebo or drotrecogin alfa activated (24 μg per kilogram of body weight per hour) for a total duration of 96 hours. The prospectively defined primary end point was death from any cause and was assessed 28 days after the start of the infusion. Patients were monitored for adverse events; changes in vital signs, laboratory variables, and the results of microbiologic cultures; and the development of neutralizing antibodies against activated protein C.

***Results*** A total of 1690 randomized patients were treated (840 in the placebo group and 850 in the drotrecogin alfa activated group). The mortality rate was 30.8 percent in the placebo group and 24.7 percent in the drotrecogin alfa activated group. On the basis of the prospectively defined primary analysis, treatment with drotrecogin alfa activated was associated with a reduction in the relative risk of death of 19.4 percent (95 percent confidence interval, 6.6 to 30.5) and an absolute reduction in the risk of death of 6.1 percent (P=0.005). The incidence of serious bleeding was higher in the drotrecogin alfa activated group than in the placebo group (3.5 percent vs. 2.0 percent, P=0.06).

***Conclusions*** Treatment with drotrecogin alfa activated significantly reduces mortality in patients with severe sepsis and may be associated with an increased risk of bleeding.



SEVERE sepsis, defined as sepsis associated with acute organ dysfunction, results from a generalized inflammatory and procoagulant response to an infection.[1] The rate of death from severe sepsis ranges from 30 to 50 percent despite advances in critical care.[2-5] In the United States, approximately 750,000 cases of sepsis occur each year, at least 225,000 of which are fatal.[6]

The inflammatory and procoagulant host responses to infection are closely related.[7] Inflammatory cytokines, including tumor necrosis factor-α, interleukin-1β, and interleukin-6, are capable of activating coagulation and inhibiting fibrinolysis, whereas the procoagulant thrombin is capable of stimulating multiple inflammatory pathways.[7-11] The end result may be diffuse endovascular injury, multiorgan dysfunction, and death. Activated protein C, an endogenous protein that promotes fibrinolysis and inhibits thrombosis and inflammation, is an important modulator of the coagulation and inflammation associated with severe sepsis (Fig. 1).[12] Activated protein C is converted from its inactive precursor, protein C, by thrombin coupled to thrombomodulin.[13] The conversion of protein C

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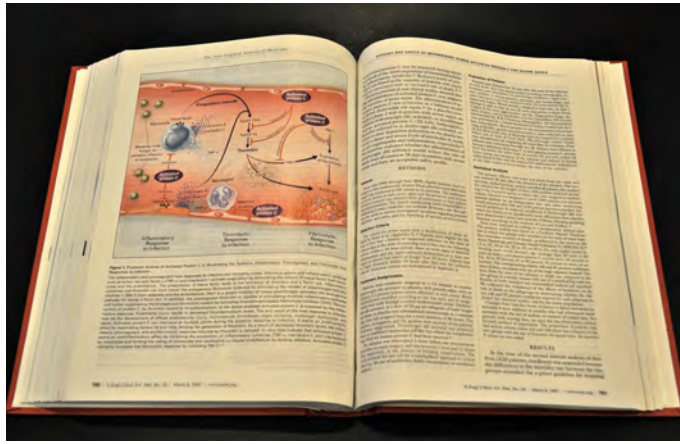
*Additional institutions and investigators participating in the study are listed in Appendix 3.



(7.15)

(screenshot from MRAC_01)

As discussed in the previous chapter and in Section 7.1.3, MRAC_01 contains a visual inscription that, in many respects, stands apart from other visual inscriptions in MRAC. The blood-vessel diagram discussed in Chapter 6 is reproduced below in its paper, PDF, and HTML 2013 and 2019 editions (examples (7.16), (7.17), (7.18), and (7.19), respectively), showing some of its co-textual environment. Its prominence in MRAC_01, and in the corpus as a whole, makes it a prime example for discussing in more detail the intersemiotic realization of [engagement] and issues relating to the (non) linearity of reading paths in scientific-medical texts (see Fryer 2019 and Section 7.1.4.1).



(7.16)

(photograph of MRAC_01)

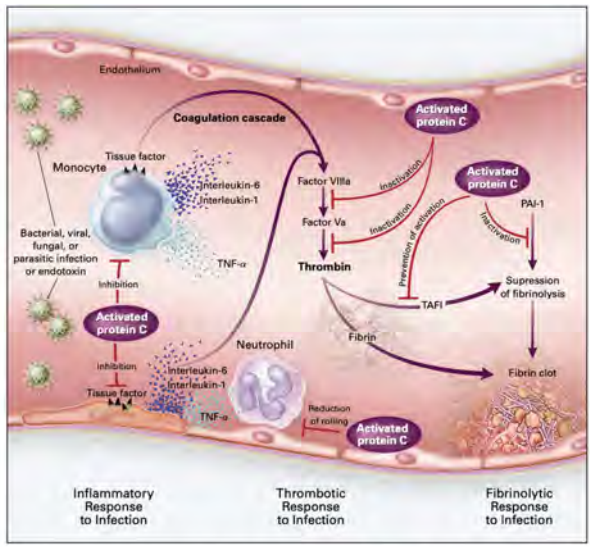



**Figure 1.** Proposed Actions of Activated Protein C in Modulating the Systemic Inflammatory, Procoagulant, and Fibrinolytic Host Responses to Infection.

The inflammatory and procoagulant host responses to infection are intricately linked. Infectious agents and inflammatory cytokines such as tumor necrosis factor α (TNF-α) and interleukin-1 activate coagulation by stimulating the release of tissue factor from monocytes and the endothelium. The presentation of tissue factor leads to the formation of thrombin and a fibrin clot. Inflammatory cytokines and thrombin can both impair the endogenous fibrinolytic potential by stimulating the release of plasminogen-activator inhibitor 1 (PAI-1) from platelets and the endothelium. PAI-1 is a potent inhibitor of tissue plasminogen activator, the endogenous pathway for lysing a fibrin clot. In addition, the procoagulant thrombin is capable of stimulating multiple inflammatory pathways and further suppressing the endogenous fibrinolytic system by activating thrombin-activatable fibrinolysis inhibitor (TAFI). The conversion of protein C, by thrombin bound to thrombomodulin, to the serine protease activated protein C is impaired by the inflammatory response. Endothelial injury results in decreased thrombomodulin levels. The end result of the host response to infection may be the development of diffuse endovascular injury, microvascular thrombosis, organ ischemia, multiorgan dysfunction, and death. Activated protein C can intervene at multiple points during the systemic response to infection. It exerts an antithrombotic effect by inactivating factors Va and VIIIa, limiting the generation of thrombin. As a result of decreased thrombin levels, the inflammatory, procoagulant, and antifibrinolytic response induced by thrombin is reduced. In vitro data indicate that activated protein C exerts an antiinflammatory effect by inhibiting the production of inflammatory cytokines (TNF-α, interleukin-1, and interleukin-6) by monocytes and limiting the rolling of monocytes and neutrophils on injured endothelium by binding selectins. Activated protein C indirectly increases the fibrinolytic response by inhibiting PAI-1.[12-17]



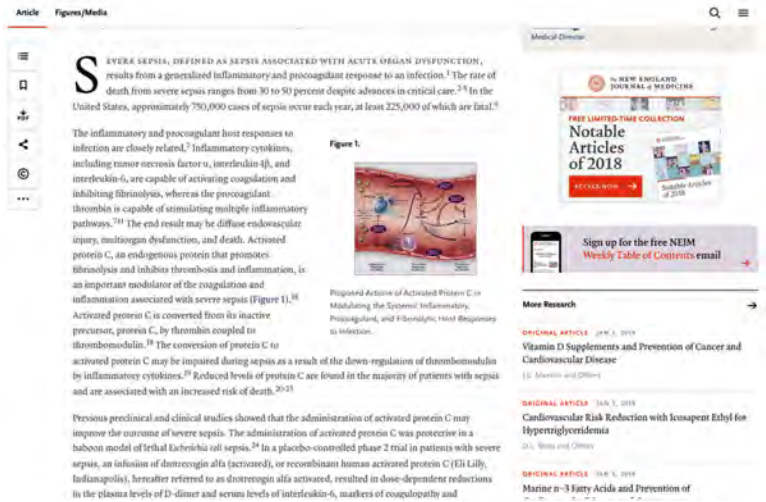
(7.17)

(screenshot of MRAC_01)

(7.18)


(screenshot of MRAC_01)

(7.19)




(screenshot of MRAC_01)

As can be seen in (7.16)–(7.19), these four versions of MRAC_01 differ in their materiality and layout, and in the "items" (Kok 2004, O'Halloran 2005), "clusters" (Baldry and Thibault 2006), or "focus groups" (Painter et al. 2013) that predominate in each version. A reader is likely to engage

with these texts in different ways. For example, in (7.16), the full-colour image may not be immediately visible to the reader, appearing as it does on the second (verso) page of the article. Only after turning the title page is the image fully revealed.[7] This is also the case for the PDF version in (7.17), since the reader must scroll before seeing the image for the first time. The 2013 HTML version in (7.18) shows the image as a thumbnail and is likely to be immediately visible to the reader upon accessing the article. In the 2019 HTML version in (7.19), the reader has to scroll or move via hyperlink to the Introduction or select the *Figures/Media* tab on the top right of the screen before seeing the image.

With these different materials, layouts, and potential reading paths in mind, we might assume that, upon seeing the full-colour image for the first time, the reader immediately engages and interacts with it in some way, however fleetingly. For readers of the HTML version of MRAC_01, this is likely to happen before they see or read the verbal reference to the image in the Introduction. For the paper and PDF versions, the reader is more likely to read the verbal reference before seeing the image, since the verbal reference appears on the previous page. The verbal reference to the image is reproduced in (7.20); it can also be seen in the right-hand column of (7.15).

(7.20) Activated protein C, an endogenous protein that promotes fibrinolysis and inhibits thrombosis and inflammation, is an important modulator of the coagulation and inflammation associated with severe sepsis (Figure 1).[18] (MRAC_01)

Already, a potentially crucial difference in the reading of the image and the kind of [engagement] construed becomes apparent. The [monogloss] of the verbal prompt in the main text (see (7.20)) emphasizes the role and importance of activated protein C in response to sepsis. The image caption, however—see (7.21) below—opens with a 'heteroglossic' statement that emphasizes a more subjective position and encourages a reading that is potentially more tentative than definitive. For a brief textual moment, the two readings, based on the PDF/paper and HTML versions, may differ: one shows what happens, the other shows what might happen. For some readers, such a reading—the 'monoglossic', definitive one—may not create a lasting (or, indeed, any) impression. Nevertheless, it serves as an interesting example of how verbal and visual semiotics combined with the alternative reading paths offered by different materials and layouts might affect reader engagement.[8]

(7.21) Figure 1. Proposed Actions of Activated Protein C in Modulating the Systemic Inflammatory, Procoagulant, and Fibrinolytic Host Responses to Infection.

> The inflammatory and procoagulant host responses to infection are intricately linked. Infectious agents and inflammatory cytokines such as tumor necrosis factor α (TNF-α) and interleukin-1 activate coagulation by stimulating the release of tissue factor from monocytes and the endothelium. The presentation of tissue factor leads to the formation of thrombin and a fibrin clot. Inflammatory cytokines and thrombin can both impair the endogenous fibrinolytic potential by stimulating the release of plasminogen-activator inhibitor 1 (PAI-1) from platelets and the endothelium. PAI-1 is a potent inhibitor of tissue plasminogen activator, the endogenous pathway for lysing a fibrin clot. In addition, the procoagulant thrombin is capable of stimulating multiple inflammatory pathways and further suppressing the endogenous fibrinolytic system by activating thrombin-activatable fibrinolysis inhibitor (TAFI). The conversion of protein C, by thrombin bound to thrombomodulin, to the serine protease activated protein C is impaired by the inflammatory response. Endothelial injury results in decreased thrombomodulin levels. The end result of the host response to infection may be the development of diffuse endovascular injury, microvascular thrombosis, organ ischemia, multiorgan dysfunction, and death. Activated protein C can intervene at multiple points during the systemic response to infection. It exerts an antithrombotic effect by inactivating factors Va and VIIIa, limiting the generation of thrombin. As a result of decreased thrombin levels, the inflammatory, procoagulant, and antifibrinolytic response induced by thrombin is reduced. In vitro data indicate that activated protein C exerts an antiinflammatory effect by inhibiting the production of inflammatory cytokines (TNF-α, interleukin-1, and interleukin-6) by monocytes and limiting the rolling of monocytes and neutrophils on injured endothelium by binding selectins. Activated protein C indirectly increases the fibrinolytic response by inhibiting PAI-1.[12–17] (MRAC_01)

Returning to the verbal prompt in the Introduction (see (7.20) above), the reader seems to be faced with three, somewhat idealized choices: (1) to click on the reference to the diagram (*Figure 1*), or scroll, swipe, or page-turn to the appropriate place; (2) to click on the reference to the external source (superscript *18*), or scroll, swipe, or page-turn to the appropriate place; or (3) to read the next sentence. Three different reading paths are 'entertained' based on a single proposition, creating a "heteroglossic space" (Tan 2010, 98) in which the reader is actively engaged in determining how the text unfolds. Assuming option 1 is the preferred reading path—preferred, that is, by the textual voice—we might expect the reader to go to the diagram (by clicking, scrolling, swiping, or page-turning). There, the reader is *shown*, after having been *told*, how important activated protein C is. ("You doubt what I say? I'll show you," as Latour (1990, 38) puts it.) This "show and

tell" exchange continues as the reader engages with the caption, moving back and forth between the caption and the diagram, as the caption explains (in considerable detail; see (7.21)) how the diagram should be read, potentially fixing, anchoring, or 'proclaiming' the validity of certain meanings or interpretations over visually invoked alternatives in the image. Indeed, much of what appears in the caption is repetition of what appears in the second paragraph of the Introduction. Both texts describe the processes by which inflammation, coagulation, and fibrinolysis (might) occur, helping to reinforce or complement certain 'monoglossic' and 'heteroglossic' positions in the text. Compare, for example, the [heterogloss] in (7.22) and (7.23) from the second paragraph of the Introduction and the diagram-caption, respectively, as well as their similar ideational meanings.

(7.22) The end result *may* be diffuse endovascular injury, multiorgan dysfunction, and death. (MRAC_01)
(7.23) The end result of the host response to infection *may* be the development of diffuse endovascular injury, microvascular thrombosis, organ ischemia, multiorgan dysfunction, and death. (MRAC_01)

A multisemiotic analysis of the dialogic space created around the diagram in (7.16)–(7.19) shows how that space varies, not just from the perspective of different readers and their differing interests and experiences, but also from the perspective of layout and materiality and the different prompts those choices imply. While the diagram might generally be treated as a model that 'entertains' what happens or what usually happens in the event of sepsis and its treatment with activated protein C (see visual analysis in Chapter 6 and Fryer 2019), it can also be read in a more 'monoglossic' or dialogically 'contractive' sense, especially (in the case of the latter) if we consider the effect of the projected visual-verbal 'proclamation' at the start of the article.

As demonstrated above, one of the ways of exploring relations between verbal and visual elements in texts is to look at how images are integrated into the text through language, by explicit verbal reference to and comment on visual inscriptions (cf. Matthiessen 2009, 19). There are several additional examples of this in MRAC_01 that are examined in more detail below.

Although the Methods section of MRAC_01 contains no visual inscriptions, it does contain two verbal references to visual inscriptions in the appendices (see (7.24)). Those inscriptions are both tables. However, they differ from other tables in MRAC by virtue of their being primarily verbal rather than numerical images. An excerpt from one of those tables is provided in (7.10).

(7.24) The criteria for severe sepsis were a modification of those defined by Bone et al. (Appendix 1).[26] Patients were eligible for the trial if they had a known or suspected infection on the basis of clinical data at

> the time of screening and if they met the following criteria within a 24-hour period: three or more signs of systemic inflammation and the sepsis-induced dysfunction of at least one organ or system that lasted no longer than 24 hours. Patients had to begin treatment within 24 hours after they met the inclusion criteria. Exclusion criteria are summarized in Appendix 2. (MRAC_01)

The first reference in (7.24) 'attributes' part of Appendix 1 to some external voice (*Bone et al.* and superscript *26*). The textual voice continues by summarizing some of the main inclusion criteria. Here, the textual voice 'entertains' the possibility of alternative propositions (e.g. *if they had a known or suspected infection*) and highlights the criteria it deems most relevant to the communicative context, essentially a 'pronouncement' in which some criteria from the appendix are made explicit in the Methods section, while others are not. In the second reference in (7.24), Appendix 2 is not explicitly attributed to any external source, and the textual voice provides no guide as to which criteria are most relevant or important to the current communicative context. The placement of both tables in appendices implies that they are considered "[e]xtra or supplementary" material that need "not interrupt the flow of the text" (ICMJE 2008, 13). More generally, their placement in the appendices complements the general backgrounding effect of the reduced-font Methods in the paper and PDF versions of MRAC_01, and the relative [monogloss] of the Methods section remains largely unaffected by the potential [heterogloss] of the atypical, non-numerical tables in the appendices ([entertain] in Economou 2009).

As noted in Section 7.1.3, the majority of visual inscriptions in MRAC_01 are found in the Results section. All those inscriptions are reproduced in black and white. The tables in the Results section have more or less the same layout: a column of variables or characteristics, a column of numerical values for those variables for patients given placebo, and a similar column for those given activated protein C.[9] Similarly, graphs in MRAC_01 present visualized numerical changes in dependent variables over time according to the administration of placebo or activated protein C (an example of this can be seen in the previous chapter, in (6.5)/(6.28)).

Verbal references to tables 1–3 are made in one and the same paragraph (see (7.25)). Here, the textual voice invites the reader to examine the data in the tables and, at the same time, highlights certain numerical values and their relations, construing from a dialogic perspective similar kinds of [entertain] + [pronounce] pairings as identified in (7.24). Taking *Table 3* as an example, we see that the verbal invitation in (7.25) to examine the data creates a 'heteroglossic' space in which certain parts of the ostensibly 'monoglossic' table are highlighted or 'proclaimed' as being particularly noteworthy. Those 'proclamations' or 'pronouncements', however, are not instantiated verbally (the propositions referring to *Table 3* are all bare assertions);

rather, they are the consequence of a combination of verbal, numerical, and visual resources, none of which independently are likely to be understood as emphasizing some maximally warrantable position or proposition.

(7.25) At base line, the demographic characteristics and severity of disease were similar in the placebo group and the drotrecogin alfa activated group (Table 1). Approximately 75 percent of the patients had at least two dysfunctional organs or systems at the time of enrollment. The lungs and the abdomen were the most common sites of infection, occurring in 53.6 percent and 19.9 percent of the patients, respectively, in the two groups combined (Table 2). The incidence of gram-positive and gram-negative infections was similar within each group and between the two groups. Base-line levels of indicators of coagulopathy and inflammation were also similar in the two groups (Table 3). Protein C deficiency was present in 87.6 percent of the patients (1379 of 1574) for whom levels were obtained. In addition, plasma D-dimer and serum interleukin-6 levels were elevated in 99.7 and 98.5 percent of the patients, respectively. Among treated patients, 82.4 percent of those in the placebo group and 81.8 percent of those in the drotrecogin alfa activated group received at least 90 percent of the intended infusion and 8.2 percent and 6.4 percent, respectively, died during the 96-hour period of infusion. (MRAC_01)

Verbal reference to *Fig. 3* in MRAC_01 is made two pages before the graph itself, partly it seems because of the large number of visual inscriptions in the Results section and the amount of space those inscriptions occupy relative to the verbiage. The paragraph in which verbal reference is made to *Fig. 3* is reproduced in (7.26). Before inviting the reader to examine the data presented in *Fig. 3*, the paragraph begins by highlighting a particular reading, namely that plasma D-dimer levels were significantly lower among patients taking drotrecogin alfa activated (activated protein C) than among patients taking placebo. While this may seem like an obvious interpretation of the data (see example (6.5)/(6.28) in the previous chapter), other readings, such as the difference was greater on days 2–4 or that plasma D-dimer levels among patients taking drotrecogin alfa activated decrease and then increase, are not acknowledged; this is not primarily what the reader is being encouraged to focus on. Like the previous example, the textual voice privileges one reading over another, potentially contracting the dialogic space for alternative interpretations of the data. This dialogic 'contraction' is not construed verbally (the opening sentence in (7.26) is 'monoglossic'); it results from a combination of verbal, mathematical, and visual resources. Interestingly, the data described in the second sentence of (7.26) are not presented graphically, though obviously they could have been. One might argue, using this as an example, that the meaning of a text, the way that text engages its readers,

is not only a matter of what the writer chooses to instantiate, but also what the writer chooses not to instantiate in a particular text (cf. Halliday 2013, 25–26).

(7.26) Plasma D-dimer levels were significantly lower in patients in the drotrecogin alfa activated group than in patients in the placebo group on days 1 through 7 after the start of the infusion (Fig. 3). Decreases in serum interleukin-6 levels were significantly greater in the patients in the drotrecogin alfa activated group than in the patients in the placebo group on day 1 (P=0.009) and on days 4, 5, 6, and 7 (P=0.025, P=0.017, P=0.016, and P=0.022, respectively). (MRAC_01)

Although the Discussion section of MRAC_01 contains no visual inscriptions and no verbal references to inscriptions elsewhere in the article, it does offer explanations for some of the patterns presented in the tables and graphs. For example, a possible explanation for the increase in serum D-dimer levels presented in Fig. 3 is given, i.e. *The rise in D-dimer levels after the completion of the 96-hour infusion of drotrecogin alfa activated indicates incomplete resolution of the procoagulant state seen in patients with sepsis*, along with a potential solution: *An evaluation of longer periods of infusion of drotrecogin alfa activated may be warranted*.

The examples discussed above show how instances of verbal, mathematical, and visual [engagement] might converge and diverge in the text. The choices of a wide range of colours and naturalistic representations in the blood-vessel diagram, for example, construe a 'heteroglossic' space that 'entertains' various alternative representations. Those choices complement and are complemented by verbal resources in the diagram-caption, such as *proposed*, *may*, and *can* (see (7.21)), which construe a similarly 'expansive' dialogic space. In contrast, observations regarding the placement of tables in the appendices suggest potentially diverging instances of [engagement] that are kept separate so as not to affect the overall integrity of the Methods section: compare the visual [heterogloss] of the appendix-tables with the verbal and visual [monogloss] of the Methods section as a whole. Other instances of divergent couplings might include dialogically 'contractive' verbal labels alongside dialogically 'expansive' naturalistic representations of biological entities, or dialogically 'expansive' mathematical resources such as *p* and *95% CI* in ostensibly 'monoglossic' graphs and tables.

The examples above look at the intra- and intersemiotic relations of [engagement], i.e. the way in which [engagement] resources are connected or integrated across or within different semiotic systems. It is important to note, however, that the coupling of semiotic resources described by Martin and others (e.g. Martin 1999, 2008b, 2011, Zappavigna et al. 2008, Painter et al. 2013) also includes cross-metafunctional and intersystemic relations that go beyond the scope of this study. Such couplings, although

not examined here, may need to be borne in mind when considering how intersemiosis and intersemiotic [engagement] work as a whole.

## 7.2 Intersemiotic Engagement across Generic Stages and Phases of the Medical Research Article

In this section, we briefly examine intersemiotic [engagement] across MRAC as a whole. Based on a synthesis of Chapters 4–6, and drawing on analyses in Section 7.1, I highlight some of the broader patterns of intersemiotic [engagement] across and within the main generic stages of the medical research article.

### *7.2.1 Introductions*

The dialogically 'expansive' spaces typically construed by Introductions are realized by a combination of verbal and visual resources. Verbal 'attribution' and 'entertain' combine, in some cases, with visual 'entertain' to create a space in which different voices, positions, and representations are invoked (part of the phase that describes the field of study). As the space for dialogic alternatives narrows (in the phases that identify a gap in the field and state the main research purposes), verbal [engagement] predominates. The relevance or importance of the research (the research warrant; Hood 2010) is often made explicit by verbal 'justifications' and the more general visual prominence of the section itself. Mathematical [engagement] plays little or no role in construing for the text a relatively open dialogic space in which the reader may need to be convinced of the rationale of the study but is otherwise generally assumed to be 'aligned' with the textual voice.

### *7.2.2 Methods*

The relatively 'monoglossic' or dialogically 'contractive' space of the Methods is characterized by verbal and visual [monogloss] and verbal [justify], as the stage progresses through its phases of describing the study material and recounting the experimental and data-analysis procedures. In the latter phase, mathematical resources may be deployed, in the form of separated mathematical equations or expressions and tests of probability, but these are not generally numericized (cf. Results section, which follows). Verbal 'justifications' and the relative 'monogloss' of visual inscriptions help to construe a text in which the integrity of the textual voice and its choice(s) of methodology are likely to be 'taken as given'.

### *7.2.3 Results*

Like Methods sections, Results sections tend to be relatively 'monoglossic' or dialogically 'contractive'. The narrow dialogic space of the Results

is maintained by verbal and visual [monogloss] and by verbal [deny]. 'Engagement' in Results sections, however, tends to be more 'expansive' than that of the Methods, especially in phases that present data and describe adjustments made to the data analysis. Here, mathematical [entertain] combines with and potentially diverges from visual and verbal [monogloss] to construe for the text a dialogic space that, while narrow, is more 'expansive' than that construed by visual and verbal resources alone. It is the quantified or ideationalized expression of probability that construes this narrow 'expansion' and that may lend the text a certain epistemological authority. While this authority may be challenged, the verbal and visual [monogloss], verbal [deny], and mathematical [entertain] are unlikely to 'disalign' the writer and reader.

### *7.2.4 Discussions*

Discussions are primarily 'heteroglossic'. Verbal [engagement] variously 'endorses', 'acknowledges', 'entertains', 'counters', and 'justifies' as the stage unfolds. Visual inscriptions are rare, but, to the extent that they are deployed in Discussion sections, they generally construe a space that is more 'heteroglossic' than the visual inscriptions in Methods and Results, complementing in general the verbal [heterogloss] of, for example, the phases that discuss mechanisms and causes and recommend possible applications. Mathematical resources do not generally feature in the Discussion, except in the opening phase where main findings are repeated from the previous section.

The Discussion is one of the generic stages in which the potential for writer–reader 'disalignment' may be greatest. Verbally, instances of [pronounce], [concur], and text-internal [endorse], all of which are more common in the Discussion than the other sections of the research article, may put writer–reader solidarity at risk, since they imply "heightened personal investment" (White 2003, 269). Some instances of verbal [entertain], as well as visual [entertain] expressed by certain inscriptions, i.e. those that present predictive models, may compound this effect.

### *7.2.5 Abstracts*

Abstracts are characterized by verbal and mathematical [engagement] resources that mirror to a large extent those of the Introduction, Methods, Results, and Discussion, but with generally more instances of [monogloss] and fewer instances of [acknowledge]. Visual [engagement] is primarily concerned with the general prominence of the section (there are no visual inscriptions) and plays a crucial role in establishing the section's importance. Its function as a standalone text means that the abstract (along with the title) may be the first or only stage of the article a reader engages with. For those who read on, the abstract provides a model for how the rest of the

article might be read and a general basis for 'alignment' or 'disalignment' with the textual voice.

## 7.3 Intersemiotic Engagement and the Discipline(s) of Medicine

Considered separately, the verbal, mathematical, and visual instantiations of [engagement] identified and discussed in Chapters 4–6 highlight different aspects of the disciplines and ideologies of medical research. Overall, the deployment of verbal [engagement] resources, which are primarily 'heteroglossic', suggests a discourse that attempts to build alliances, to seek consensus and 'alignment', through propositions and positions that are generally supported by evidence and argumentation or are explicitly grounded in the (un)certainty of the textual voice. Mathematical resources are generally 'expansive', but the dialogic space they help to construe is narrower than that typically construed by verbally 'expansive' resources, reflecting the more objectified position often associated with mathematics and an empirical, positivist epistemology. Visual resources are ostensibly 'monoglossic', implying a discourse in which a background of other voices, positions, and propositions is not generally invoked, and which plays a crucial role in construing for the text an authoritative position. From a more fine-grained generic perspective, those verbal, mathematical, and visual resources help to construe a text that variously 'expands' and 'contracts' the dialogic space, and that implies evolving writer–reader relations and knowledge structures as the text unfolds.

From an intersemiotic perspective, verbal, mathematical, and visual [engagement] resources usually work in harmony, complementing and amplifying the overall dialogic effect. In Methods sections, for example, verbal and visual resources combine to accentuate the relative [monogloss] of the section, construing for the text a dialogic space in which alternative voices are not generally invoked or recognized. Seen from above, those resources are part of the textual instantiation of "doing research", realized by a combination of 'monoglossic' material clauses and ostensibly 'monoglossic' tables and diagrams.

Less commonly, instances of verbal, mathematical, and visual [engagement] diverge, creating moments of potential dialogic tension. Examples of divergent couplings include the visual 'expansion' of naturalistic episodes and figures with the verbal 'contraction' implied by their written labels, or the ostensibly 'monoglossic' graphs and tables with the mathematical 'expansion' construed by expressions and components such as *p* and *95% CI*. Both examples construe dialogic spaces that are not simply 'expansive' or 'contractive', but potentially both. Divergent combinations like these may play an important role in reducing interpersonal risk and tempering the potential for 'disalignment'—a crucial part of building and maintaining alliances with the reader.

As discussed in Section 7.1.4.2, there are several instances of intersemiosis where the kind of [engagement] construed is not explicitly carried by any one semiotic, but has to be understood as emerging from a combination of resources from different semiotic systems. Examples of this are found in MRAC_01 where instances of [proclaim: pronounce] are realized by a combination of verbal, numerical-mathematical, and visual resources, none of which explicitly construes [pronounce] on its own (most of the instances in question are 'monoglossic'). Those emergent forms of [engagement] can only be appreciated intersemiotically, meaning that they are essentially "invisible" to a strictly verbal, mathematical, or visual reading. 'Pronounce' is a category of [engagement] that generally expresses a high level of personal commitment and one that may threaten writer–reader solidarity. Emergent 'pronouncements' like those discussed in Section 7.1.4.2 may mitigate the threat to writer–reader solidarity while, at the same time, allowing for subjective emphasis by the textual voice. This has potentially important ideological implications, since it can allow the textual voice to express a subjectivized position through the resources of largely 'monoglossic' authoritative discourse.

## Notes

1 Parts of this chapter are based on Fryer (2019).
2 In the paper and PDF versions of MRAC_01, the Methods section is reproduced at a smaller font size than the Introduction, Results, and Discussion (see Chapter 6, Section 6.2.2).
3 Conventions vary, of course, but I am thinking in particular here of English as a left–right, top–bottom writing system.
4 The announcement is not part of the paper and HTML versions of MRAC_01.
5 Note, also, how the 'justification' includes [entertain *possible*], allowing for a diversity of propositions and positions concerning the clinical implications of the study.
6 The claim of warrantability is made by the textual voice, but it is a part of the textual voice that differs from that of the rest of the article. The announcement is primarily representative of the journal editors (an editorial stance or key; cf. Martin and White 2005, 163–164); the rest of the article is primarily representative of the authors (an authorial stance or key).
7 There is in fact considerable show-through due to paper type and low grammage (< 80 g/m$^2$), so the colour image is partially discernible from the title page.
8 It also raises the interesting question of whether we are dealing with different versions of the same text, or whether, from a multisemiotic perspective, we may wish to treat these as different texts—different instantiations—of the same work.
9 Two of the five tables in MRAC_01 Results contain an additional column of selected *p*-values.

## References

Baldry, Anthony, and Paul J. Thibault. 2006. *Multimodal Transcription and Text Analysis*. London: Equinox.

Economou, Dorothy. 2009. "Photos in the news: appraisal analysis of visual semiosis and verbal-visual intersemiosis." PhD thesis, University of Sydney.

Fryer, Daniel Lees. 2019. "Multiplying engagement: visual-verbal intersemiosis in an online medical research article." In *Engagement in Professional Genres: Deference and Disclosure*, edited by Carmen Sancho Guinda, 157–178. Amsterdam: John Benjamins.

Halliday, M. A. K. 2013. "Meaning as choice." In *Systemic Functional Linguistics: Exploring Choice*, edited by Lise Fontaine, Tom Bartlett and Gerard O'Grady, 15–36. Cambridge: Cambridge University Press.

Hood, Susan. 2010. *Appraising Research: Evaluation in Academic Writing*. Basingstoke: Palgrave Macmillan.

International Committee of Medical Journal Editors (ICMJE). 2008. *Uniform Requirements for Manuscripts Submitted to Biomedical Journals: Writing and Editing for Biomedical Publication*. Vancouver: International Committee of Medical Journal Editors.

Kok, Arthur Kum Chiew. 2004. "Multisemiotic mediation in hypertext." In *Multimodal Discourse Analysis: Systemic Functional Perspectives*, edited by Kay L. O'Halloran, 131–159. London: Continuum.

Kress, Gunther, and Theo van Leeuwen. 2001. *Multimodal Discourse: The Modes and Media of Contemporary Communication*. London: Hodder Arnold.

Kress, Gunther, and Theo van Leeuwen. 2006. *Reading Images: The Grammar of Visual Design*. 2nd ed. Abingdon: Routledge.

Latour, Bruno. 1990. "Drawing things together." In *Representation in Scientific Practice*, edited by Michael Lynch and Steve Woolgar, 19–68. Cambridge, MA: MIT Press.

Lemke, Jay L. 1998. "Multiplying meaning: visual and verbal semiotics in scientific text." In *Reading Science: Critical and Functional Perspectives on Discourses of Science*, edited by J. R. Martin and Robert Veel, 87–113. London: Routledge.

Martin, J. R. 1999. "Beyond exchange: appraisal systems in English." In *Evaluation in Text: Authorial Stance and the Construction of Discourse*, edited by Susan Hunston and Geoff Thompson, 142–175. Oxford: Oxford University Press.

Martin, J. R. 2008. "Tenderness: realisation and instantiation in a Botswanan town." In *Systemic Functional Linguistics in Use*, edited by Nina Nørgaard, 30–62. Odense: University of Southern Denmark.

Martin, J. R. 2011. "Multimodal semiotics: theoretical challenges." In *Semiotic Margins: Meaning in Multimodalities*, edited by Shoshana Dreyfus, Susan Hood and Maree Stenglin, 243–270. London: Continuum.

Martin, J. R., and P. R. R. White. 2005. *The Language of Evaluation: Appraisal in English*. Basingstoke: Palgrave Macmillan.

Matthiessen, Christian M. I. M. 2009. "Multisemiosis and context-based register typology: registerial variation in the complementarity of semiotic systems." In *The World Told and the World Shown: Multisemiotic Issues*, edited by Eija Ventola and Arsenio Jesús Moya Guijarro, 11–38. London: Palgrave Macmillan.

O'Halloran, Kay L. 2005. *Mathematical Discourse: Language, Symbolism and Visual Images*. London: Continuum.

Painter, Claire, J. R. Martin, and Len Unsworth. 2013. *Reading Visual Narratives: Image Analysis of Children's Picture Books*. Sheffield: Equinox.

Tan, Sabine. 2010. "Modelling engagement in a web-based advertising campaign." *Visual Communication* 9 (1):91–115. doi: 10.1177/1470357209352949.

White, Peter R. R. 2003. "Beyond modality and hedging: a dialogic view of the language of intersubjective stance." *Text* 23 (2):259–284.

Zappavigna, Michele, Paul Dwyer, and J. R. Martin. 2008. "Syndromes of meaning: exploring patterned coupling in a NSW youth justice conference." In *Questioning Linguistics*, edited by Ahmar Mahboob and Naomi K. Knight. Newcastle: Cambridge Scholars.

# 8 Engagement as Text, Engagement as System

## 8.1 Engagement in Medical Research Discourse

Medical research articles utilize a variety of verbal, mathematical, and visual resources to construe for the text a background of prior and anticipated utterances. Verbally, those resources include modality, negation, projection, and concession; mathematically, they include modality (probability) and negation, and their quantification; and visually, they include lines of action, choices of shading, colour, size, and placement, naturalistic and schematic representations, and hypertext objects. All of these resources can overlap and interact to construe dialogic spaces that are not simply open or closed to other voices, but that are often in a kind of dialogic tension that constantly perturbs the space for those voices. This dialogic space evolves logogenetically, as the text unfolds, with different stages and phases of the medical research article construing different types, different amounts, and different degrees of [engagement]. The findings here suggest a discipline that draws upon many of the characteristics of hard and soft, pure and applied sciences—as well as other, non-scientific domains—in which different generic stages and phases of the text construe different writer–reader relations and potentially different knowledge structures.

Compared with findings for the kinds of mass-communicative texts discussed by White (1998, 2003, 2012), Martin and White (2005), Economou (2009), Tan (2010), and Feng and Wignell (2011), as well as the educational English-as-foreign-language (EFL) texts discussed by Chen (2008, 2009, 2010), the medical research article appears to construe a dialogic space that is relatively narrow. This is an important cross-disciplinary observation that suggests that medical research discourse tends to restrict the scope of alternative voices in the communicative context, compared with mass-media and education discourses. However, this observation may obscure the fact that the majority of [engagement] resources in medical research articles, especially verbal and mathematical resources, appear to construe a dialogically 'expansive' space in which the presence and positions of other voices are 'acknowledged' and 'entertained'. A similar concern arises from applied-linguistic studies that compare medicine with other disciplinary fields. In

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those studies—several of which are summarized and discussed in Chapter 3—medicine is often described as a relatively objective discourse, in which other voices are not generally included or heard. The findings here, however, show that, despite the relative [monogloss] and dialogic 'contraction' of medical discourse suggested by comparative studies, medical research articles express remarkable dialogic diversity. That diversity can be seen in the instantiation and distribution of [engagement] as well as in its realization.

## 8.2 Engagement as Multisemiotic Discourse-Semantic System

The models of engagement used here are adapted from the literature, and the basic system of ENGAGEMENT is not my own. Part of the aim of this project is to test how well such models might apply to a particular field, or a particular collection of texts, for which they were not originally designed or intended.

The ENGAGEMENT system attempts to account for how a text, or the textual voice, refers to, responds to, and is influenced by prior and anticipated utterances, and how the textual voice attempts to 'align' or 'disalign' itself and the reader with the other voices and positions construed in the communicative context (see Chapter 2). The ENGAGEMENT system, and APPRAISAL more generally, is intended to give an "account of the resources of evaluation and intersubjective positioning as these operate within English" (Martin and White 2005, 161), but its development has largely been based on texts from the domains of journalism, advertising, and education.[1] The analyses in this book highlight how ENGAGEMENT as an interpersonal discourse-semantic system is instantiated in texts from a different domain or field, and across different semiotic systems.

With regard to the verbal construal of [engagement], there are notably no instances of the [concur: concede] feature in MRAC. Instantiations of the [concur: affirm], [pronounce], and [distance] features are also low compared with other choices of verbal [engagement] (see Chapter 4). This tells us something about the kinds of interpersonal risk construed verbally in MRAC, and perhaps about medical research discourse more generally, namely that medical research articles tend to avoid "heightened personal investment" (White 2003, 269) and the potential for writer–reader 'disalignment'. A system of ENGAGEMENT constructed around meanings instantiated in medical research articles, or similar academic texts, might miss the potential for construing [concur] or other low-frequency features in other texts or text-types. However, it might also reveal the potential for different types of [engagement] not typically associated with those other texts or text-types. The analyses in Chapter 4 suggest, for example, that some [engagement] features might usefully be extended in delicacy in order to account for differences in positions framed as text-internal or text-external. For those features—[deny], [counter], and [endorse] (see relevant sections in Chapter 4)—the text-internal position does not seem to be picked up in

current models of ENGAGEMENT. Yet the textual voice can 'deny', 'counter', or 'endorse' its own positions or propositions, set up earlier in the text, by construing those positions as part of the dialogic background of different voices in the ongoing communicative context.

Extending the ENGAGEMENT system to include more delicate options may allow for more fine-grained analyses within semiotic systems. However, this gain in delicacy *within* a particular semiotic may be offset by a loss in comparative power *across* semiotics. As the analyses in Chapters 4–6 show, there may not be a visual equivalent of verbal [justify] or a mathematical-symbolic equivalent of visual [attribute]. Instead, it may be more useful to make comparisons of visual and verbal [proclaim] or mathematical and visual [expand], taking a less fine-grained perspective, with reduced levels of delicacy, in order to account for intersemiotic complementarity or intersemiotic divergence among choices of [engagement]. Figure 8.1 presents this simplified system network, including example realizations from the verbal, mathematical, and visual grammar strata. Note that the example realizations in Figure 8.1 account for meanings construed at a given moment in the text. They do not account for the different kinds of meanings that can emerge or evolve as the text unfolds (see Chapter 7, Section 7.1.4.2) or the cumulative effects of scope and interaction in clusters of [engagement] features.

The analyses in Chapters 4–6 suggest that there are few if any instances of writer–reader 'disalignment' in MRAC. In instances where 'disalignment' is likely or possible, there are no obvious one-to-one relations between the choice of [engagement] and the degree of '(dis)alignment'. 'Alignment'–'disalignment' cannot be predicted on the basis of instantiation or realization of [engagement] alone; it can only be identified by considering the co-text and knowing something about the possible positions and interests of the reader. 'Pronouncements', for example, imply a subjectivized position that may lead to 'disalignment' between the textual voice and reader, but whether or not a particular instantiation of [pronounce] actually serves to 'disalign' depends on co-textual and contextual factors such as the realization of the feature, the interaction of other [engagement] features, the generic stage of the article, and whether or not the reader agrees with or is convinced by the kind of 'pronouncement' made. 'Alignment' works in tandem with [engagement] features, but it seems to operate in a plane that is separate from those features. Based on the findings in Chapters 4–6, I propose conceptualizing ALIGNMENT as a subsystem of ENGAGEMENT, one that can be considered alongside VOICE, i.e. [monogloss] and [heterogloss], and its various subsystems (see Figure 8.2).[2] ALIGNMENT is presented here as a simple scalar system along which varying degrees of 'alignment' or 'disalignment' might be mapped.

Such a proposal is not without its potential shortcomings, especially based on a limited number of texts and the relatively narrow field of this study. Indeed, 'alignment' might be better thought of in terms of the cline of

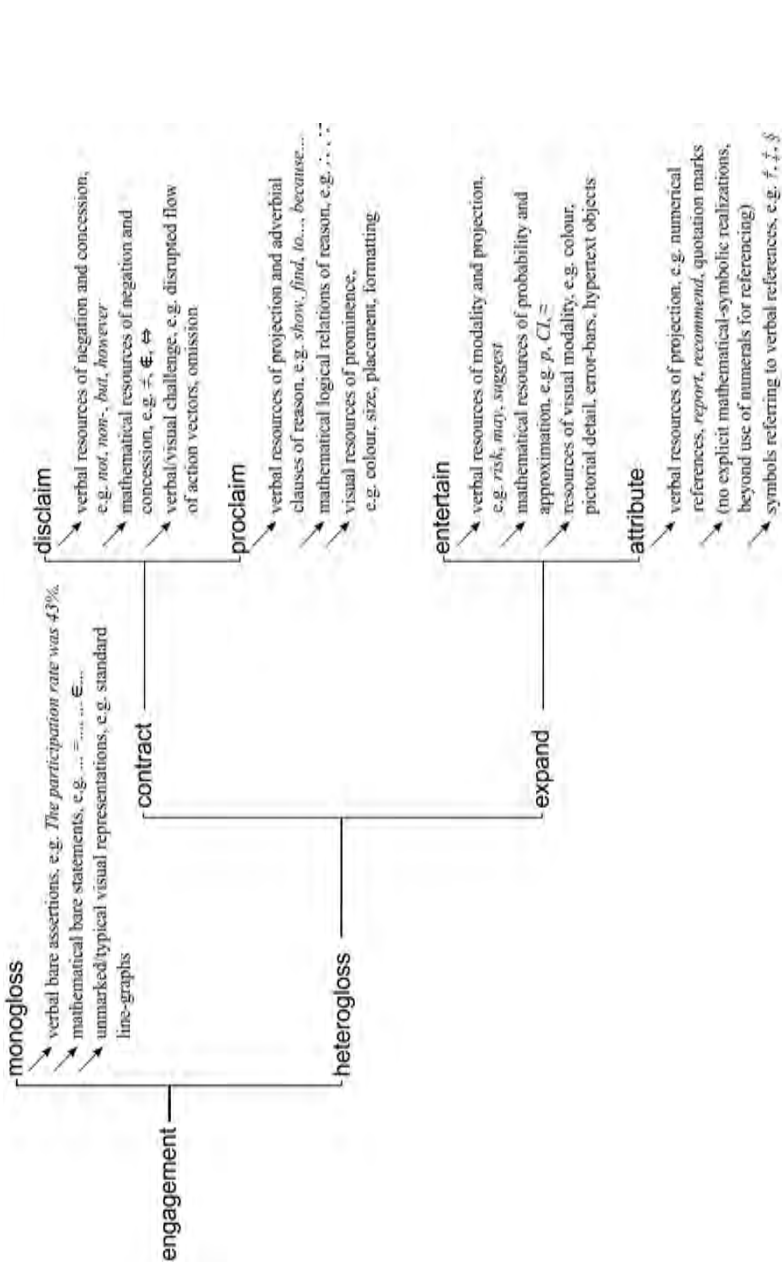


*Figure 8.1* Multisemiotic discourse-semantic system of ENGAGEMENT.

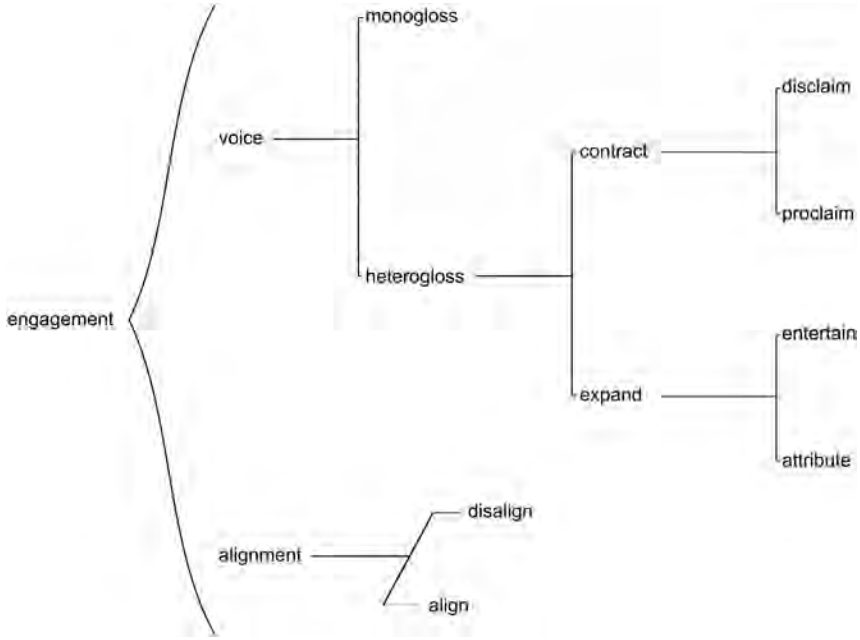


*Figure 8.2* ENGAGEMENT, VOICE, and ALIGNMENT.

instantiation (see Chapter 2, Section 2.2), as part of the subjectified meaning that emerges from individual readings (Martin and Rose 2007, 310–313). However, given the centrality of "intersubjective stance" or "dialogic positioning" in Martin and White's (2003, 2005) accounts of ENGAGEMENT, it seems prudent to try to account for 'alignment' systemically. In MRAC as a whole, the instantiation of 'alignment' is heavily skewed towards consensus and the [align] option rather than [disalign]. Only in certain stages and phases of the texts, e.g. the Discussion and the Conflict-of-Interest statement, is there any kind of increased potential for 'disalignment'.

## 8.3 Conclusions

Medical research articles use a wide range of verbal, mathematical, and visual resources to express [engagement]. The instantiation and realization of [engagement] varies across different generic stages and phases of the medical research article, reflecting in part the different kinds of relations and different kinds of knowledge structures encoded by those stages and phases.

This study emphasizes the importance of examining [engagement] from a multisemiotic perspective. It considers the different contributions made by each semiotic (verbal, mathematical, visual), as well as the

intersemiotic potential of those semiotic systems. As such, the study goes beyond monosemiotic (primarily linguistic) analyses of texts to consider [engagement] from a more holistic perspective, recognizing and treating the medical research article as a multisemiotic instantiation of meaning rather than a monosemiotic one.

## Notes

1 Notable exceptions include Hood's (2004, 2010) work on evaluative language in academic writing, although that work does not include material from the discipline of medicine.
2 Not to be confused with the system of grammatical VOICE, e.g. passive and active voice. A possible alternative here might be GLOSSA (cf. mono- and heterogloss).

## References

Chen, Yumin. 2008. "Heteroglossic harmony: multimodal ENGAGEMENT resources and their gradability in China's EFL context." In *Proceedings of ISFC 35: Voices Around the World*, edited by Canzhong Wu, Christian M. I. M. Matthiessen and Maria Herke, 296–301. Sydney: The 35th ISFC Organizing Committee.

Chen, Yumin. 2009. "Interpersonal meaning in textbooks for teaching English as a foreign language in China: a multimodal approach." PhD thesis, Department of Linguistics, University of Sydney.

Chen, Yumin. 2010. "Exploring dialogic engagement with readers in multimodal EFL textbooks in China." *Visual Communication* 9 (4):485–506.

Economou, Dorothy. 2009. "Photos in the news: appraisal analysis of visual semiosis and verbal-visual intersemiosis." PhD thesis, University of Sydney.

Feng, Dezheng, and Peter Wignell. 2011. "Intertextual voices and engagement in TV advertisements." *Visual Communication* 10 (4):565–588.

Hood, Susan. 2004. "Appraising research: taking a stance in academic writing." PhD thesis, Faculty of Education, University of Technology.

Hood, Susan. 2010. *Appraising Research: Evaluation in Academic Writing*. Basingstoke: Palgrave Macmillan.

Martin, J. R., and David Rose. 2007. *Working with Discourse: Meaning Beyond the Clause*. 2nd ed. London: Continuum.

Martin, J. R., and P. R. R. White. 2005. *The Language of Evaluation: Appraisal in English*. Basingstoke: Palgrave Macmillan.

Tan, Sabine. 2010. "Modelling engagement in a web-based advertising campaign." *Visual Communication* 9 (1):91–115. doi: 10.1177/1470357209352949.

White, Peter R. R. 1998. "Telling media tales: the news story as rhetoric." PhD thesis, Department of Linguistics, University of Sydney.

White, Peter R. R. 2003. "Beyond modality and hedging: a dialogic view of the language of intersubjective stance." *Text* 23 (2):259–284.

White, Peter R. R. 2012. "Exploring the axiological workings of 'reporter voice' news stories: attribution and attitudinal positioning." *Discourse, Context & Media* 1:57–67.

# Appendix

## Medical Research Article Corpus (MRAC)

| *MRAC code* | *Bibliographic reference* |
|---|---|
| MRAC_01 | Bernard, G. R., J. L. Vincent, P. Laterre, S. P. LaRosa, J. F. Dhainaut, A. Lopez-Rodriguez, J. S. Steingrub, G. E. Garber, J. D. Helterbrand, E. W. Ely, C. J. Fisher, and the Recombinant Human Activated Protein C Worldwide Evaluation in Severe Sepsis (PROWESS) Study Group. 2001. "Efficacy and safety of recombinant human activated protein C for severe sepsis." *New England Journal of Medicine* 344 (10):699–709. |
| MRAC_02 | Brenner, B. M., M. E. Cooper, D. de Zeeuw, W. F. Keane, W. E. Mitch, H. H. Parving, G. Remuzzi, S. M. Snapinn, Z. X. Zhang, S. Shahinfar, and Renaal Study Investigators. 2001. "Effects of losartan on renal and cardiovascular outcomes in patients with type 2 diabetes and nephropathy." *New England Journal of Medicine* 345 (12):861–869. |
| MRAC_03 | Collins, R., J. Armitage, S. Parish, P. Sleight, R. Peto, and Collaboration Heart Protection Study. 2002. "MRC/BHF Heart Protection Study of cholesterol lowering with simvastatin in 20536 high-risk individuals: a randomised placebo-controlled trial." *The Lancet* 360 (9326):7–22. |
| MRAC_04 | Connor, E. M., R. S. Sperling, R. Gelber, P. Kiselev, G. Scott, M. J. Osullivan, R. Vandyke, M. Bey, W. Shearer, R. L. Jacobson, E. Jimenez, E. Oneill, B. Bazin, J. F. Delfraissy, M. Culnane, R. Coombs, M. Elkins, J. Moye, P. Stratton, and J. Balsley. 1994. "Reduction of maternal-infant transmission of human immunodeficiency virus type 1 with zidovudine treatment." *New England Journal of Medicine* 331 (18):1173–1180. |
| MRAC_05 | Considine, R. V., M. K. Sinha, M. L. Heiman, A. Kriauciunas, T. W. Stephens, M. R. Nyce, J. P. Ohannesian, C. C. Marco, L. J. McKee, T. L. Bauer, and J. F. Caro. 1996. "Serum immunoreactive leptin concentrations in normal-weight and obese humans." *New England Journal of Medicine* 334 (5):292–295. |

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| *MRAC code* | *Bibliographic reference* |
|---|---|
| MRAC_06 | Dahlof, B., R. B. Devereux, S. E. Kjeldsen, S. Julius, G. Beevers, U. de Faire, F. Fyhrquist, H. Ibsen, K. Kristiansson, O. Lederballe-Pedersen, L. H. Lindholm, M. S. Nieminen, P. Omvik, S. Oparil, H. Wedel, and the LIFE Study Group. 2002. "Cardiovascular morbidity and mortality in the Losartan Intervention For Endpoint reduction in hypertension study (LIFE): a randomised trial against atenolol." *The Lancet* 359 (9311):995–1003. |
| MRAC_07 | Dockery, D. W., C. A. Pope, X. P. Xu, J. D. Spengler, J. H. Ware, M. E. Fay, B. G. Ferris, and F. E. Speizer. 1993. "An association between air pollution and mortality in six U.S. cities." *New England Journal of Medicine* 329 (24):1753–1759. |
| MRAC_08 | Downs, J. R., M. Clearfield, S. Weis, E. Whitney, D. R. Shapiro, P. A. Beere, A. Langendorfer, E. A. Stein, W. Kruyer, A. M. Gotto, and Afcaps TexCAPS Res Grp. 1998. "Primary prevention of acute coronary events with lovastatin in men and women with average cholesterol levels - Results of AFCAPS/TexCAPS." *JAMA: Journal of the American Medical Association* 279 (20):1615–1622. |
| MRAC_09 | Eisenberg, D. M., R. B. Davis, S. L. Ettner, S. Appel, S. Wilkey, M. van Rompay, and R. C. Kessler. 1998. "Trends in alternative medicine use in the United States, 1990-1997 - Results of a follow-up national survey." *Jama-Journal of the American Medical Association* 280 (18):1569–1575. |
| MRAC_10 | Fischman, D. L., M. B. Leon, D. S. Baim, R. A. Schatz, M. P. Savage, I. Penn, K. Detre, L. Veltri, D. Ricci, M. Nobuyoshi, M. Cleman, R. Heuser, D. Almond, P. S. Teirstein, R. D. Fish, A. Colombo, J. Brinker, J. Moses, A. Shaknovich, J. Hirshfeld, S. Bailey, S. Ellis, R. Rake, and S. Goldberg. 1994. "A randomized comparison of coronary-stent placement and balloon angioplasty in the treatment of coronary artery disease." *New England Journal of Medicine* 331 (8):496–501. |
| MRAC_11 | Flegal, K. M., M. D. Carroll, C. L. Ogden, and C. L. Johnson. 2002. "Prevalence and trends in obesity among US adults, 1999-2000." *Jama-Journal of the American Medical Association* 288 (14):1723–1727. |
| MRAC_12 | Fried, M. W., M. L. Shiffman, K. R. Reddy, C. Smith, G. Marinos, F. L. Goncales, D. Haussinger, M. Diago, G. Carosi, D. Dhumeaux, A. Craxi, A. Lin, J. Hoffman, and J. Yu. 2002. "Peginterferon alfa-2a plus ribavirin for chronic hepatitis C virus infection." *New England Journal of Medicine* 347 (13):975–982. |
| MRAC_13 | Gent, M., D. Beaumont, J. Blanchard, M. G. Bousser, J. Coffman, J. D. Easton, J. R. Hampton, L. A. Harker, L. Janzon, J. J. E. Kusmierek, E. Panak, R. S. Roberts, J. S. Shannon, J. Sicurella, G. Tognoni, E. J. Topol, M. Verstraete, and C. Warlow. 1996. "A randomised, blinded, trial of clopidogrel versus aspirin in patients at risk of ischaemic events (CAPRIE)." *The Lancet* 348 (9038):1329–1339. |

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| *MRAC code* | *Bibliographic reference* |
|---|---|
| MRAC_14 | Haffner, S. M., S. Lehto, T. Ronnemaa, K. Pyorala, and M. Laakso. 1998. "Mortality from coronary heart disease in subjects with type 2 diabetes and in nondiabetic subjects with and without prior myocardial infarction." *New England Journal of Medicine* 339 (4):229–234. |
| MRAC_15 | Haissaguerre, M., P. Jais, D. C. Shah, A. Takahashi, M. Hocini, G. Quiniou, S. Garrigue, A. Le Mouroux, P. Le Metayer, and J. Clementy. 1998. "Spontaneous initiation of atrial fibrillation by ectopic beats originating in the pulmonary veins." *New England Journal of Medicine* 339 (10):659–666. |
| MRAC_16 | Hansson, L., A. Zanchetti, S. G. Carruthers, B. Dahlof, D. Elmfeldt, S. Julius, J. Menard, K. H. Rahn, H. Wedel, S. Westerling, and H. O. T. Study Grp. 1998. "Effects of intensive blood-pressure lowering and low-dose aspirin in patients with hypertension: principal results of the Hypertension Optimal Treatment (HOT) randomised trial." *The Lancet* 351 (9118):1755–1762. |
| MRAC_17 | Hulley, S., D. Grady, T. Bush, C. Furberg, D. Herrington, B. Riggs, E. Vittinghoff, and Hers. 1998. "Randomized trial of estrogen plus progestin for secondary prevention of coronary heart disease in postmenopausal women." *JAMA: Journal of the American Medical Association* 280 (7):605–613. |
| MRAC_18 | Hurwitz, H., L. Fehrenbacher, W. Novotny, T. Cartwright, J. Hainsworth, W. Heim, J. Berlin, A. Baron, S. Griffing, E. Holmgren, N. Ferrara, G. Fyfe, B. Rogers, R. Ross, and F. Kabbinavar. 2004. "Bevacizumab plus irinotecan, fluorouracil, and leucovorin for metastatic colorectal cancer." *New England Journal of Medicine* 350 (23):2335–2342. |
| MRAC_19 | Knowler, W. C., E. Barrett-Connor, S. E. Fowler, R. F. Hamman, J. M. Lachin, E. A. Walker, D. M. Nathan, and G. Diabetes Prevention Program Res. 2002. "Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin." *New England Journal of Medicine* 346 (6):393–403. |
| MRAC_20 | Lewis, E. J., L. G. Hunsicker, R. P. Bain, and R. D. Rohde. 1993. "The effect of angiotensin-converting-enzyme inhibition on diabetic nephropathy." *New England Journal of Medicine* 329 (20):1456–1462. |
| MRAC_21 | Lewis, E. J., L. G. Hunsicker, W. R. Clarke, T. Berl, M. A. Pohl, J. B. Lewis, E. Ritz, R. C. Atkins, R. Rohde, I. Raz, and Grp Collaborative Study. 2001. "Renoprotective effect of the angiotensin-receptor antagonist irbesartan in patients with nephropathy due to type 2 diabetes." *New England Journal of Medicine* 345 (12):851–860. |
| MRAC_22 | Lynch, T. J., D. W. Bell, R. Sordella, S. Gurubhagavatula, R. A. Okimoto, B. W. Brannigan, P. L. Harris, S. M. Haserlat, J. G. Supko, F. G. Haluska, D. N. Louis, D. C. Christiani, J. Settleman, and D. A. Haber. 2004. "Activating mutations in the epidermal growth factor receptor underlying responsiveness of non-small-cell lung cancer to gefitinib." *New England Journal of Medicine* 350 (21):2129–2139. |

(*Continued*)

| *MRAC code* | *Bibliographic reference* |
|---|---|
| MRAC_23 | Manns, M. P., J. G. McHutchison, S. C. Gordon, V. K. Rustgi, M. Shiffman, R. Reindollar, Z. D. Goodman, K. Koury, M. H. Ling, J. K. Albrecht, and Thera Int Hepatitis Interventional. 2001. "Peginterferon alfa-2b plus ribavirin compared with interferon alfa-2b plus ribavirin for initial treatment of chronic hepatitis C: a randomised trial." *The Lancet* 358 (9286):958–965. |
| MRAC_24 | Marler, J. R., T. Brott, J. Broderick, R. Kothari, M. Odonoghue, W. Barsan, T. Tomsick, J. Spilker, R. Miller, L. Sauerbeck, J. Jarrell, J. Kelly, T. Perkins, T. McDonald, M. Rorick, C. Hickey, J. Armitage, C. Perry, K. Thalinger, R. Rhude, J. Schill, P. S. Becker, R. S. Heath, D. Adams, R. Reed, M. Klei, S. Hughes, J. Anthony, D. Baudendistel, C. Zadicoff, M. Rymer, I. Bettinger, P. Laubinger, M. Schmerler, G. Meirose, P. Lyden, K. Rapp, T. Babcock, P. Daum, D. Persona, M. Brody, C. Jackson, S. Lewis, J. Liss, Z. Mahdavi, J. Rothrock, T. Tom, R. Zweifler, J. Dunford, J. Zivin, R. Kobayashi, J. Kunin, J. Licht, R. Rowen, D. Stein, J. Grisolia, F. Martin, E. Chaplin, N. Kaplitz, J. Nelson, A. Neuren, D. Silver, T. Chippendale, E. Diamond, M. Lobatz, D. Murphy, D. Rosenberg, T. Ruel, M. Sadoff, J. Schim, J. Schleimer, R. Atkinson, D. Wentworth, R. Cummings, R. Frink, P. Heublein, J. C. Grotta, T. Degraba, M. Fisher, A. Ramirez, S. Hanson, L. Morgenstern, C. Sills, W. Pasteur, F. Yatsu, K. Andrews, C. Villarcordova, P. Pepe, P. Bratina, L. Greenberg, S. Rozek, K. Simmons, T. G. Kwiatkowski, S. H. Horowitz, R. Libman, R. Kanner, R. Silverman, J. Lamantia, C. Mealie, R. Duarte, R. Donnarumma, M. Okola, V. Cullin, E. Mitchell, S. R. Levine, C. A. Lewandowski, G. Tokarski, N. M. Ramadan, P. Mitsias, M. Gorman, B. Zarowitz, J. Kokkinos, J. Dayno, P. Verro, C. Gymnopoulos, R. Dafer, L. Dolhaberriague, K. Sawaya, S. Daley, M. Mitchell, M. Frankel, B. Mackay, C. Barch, J. Braimah, B. Faherty, J. Macdonald, S. Sailor, A. Cook, H. Karp, B. Nguyen, J. Washington, J. Weissman, M. Williams, T. Williamson, M. Kozinn, L. Hellwick, E. C. Haley, T. P. Bleck, W. S. Cail, G. H. Lindbeck, M. A. Granner, S. S. Wolf, M. W. Gwynn, R. W. Mettetal, C. W. J. Chang, N. J. Solenski, D. G. Brock, G. F. Ford, G. L. Kongable, K. N. Parks, S. S. Wilkinson, M. K. Davis, G. L. Sheppard, D. W. Zontine, K. H. Gustin, N. M. Crowe, S. L. Massey, M. Meyer, K. Gaines, A. Payne, C. Bales, J. Malcolm, R. Barlow, M. Wilson, C. Cape, T. Bertorini, K. Misulis, W. Paulsen, D. Shepard, B. C. Tilley, K. M. A. Welch, S. C. Fagan, M. Lu, S. Patel, E. Masha, J. Verter, J. Boura, J. Main, L. Gordon, N. Maddy, T. Chociemski, J. Windham, H. S. Zadeh, W. Alves, M. F. Keller, J. R. Wenzel, N. Raman, L. Cantwell, A. Warren, K. Smith, E. Bailey, J. Froehlich, J. Breed, J. D. Easton, J. F. Hallenbeck, G. Lan, J. D. Marsh, and M. D. Walker. 1995. "Tissue plasminogen activator for acute ischemic stroke." *New England Journal of Medicine* 333 (24):1581–1587. |

(*Continued*)

| *MRAC code* | *Bibliographic reference* |
|---|---|
| MRAC_25 | McHutchison, J. G., S. C. Gordon, E. R. Schiff, M. L. Shiffman, W. M. Lee, V. K. Rustgi, Z. D. Goodman, M. H. Ling, S. Cort, J. K. Albrecht, and the Hepatitis Interventional Therapy Group. 1998. "Interferon alfa-2b alone or in combination with ribavirin as initial treatment for chronic hepatitis C." *New England Journal of Medicine* 339 (21):1485–1492. |
| MRAC_26 | Ogden, C. L., M. D. Carroll, L. R. Curtin, M. A. McDowell, C. J. Tabak, and K. M. Flegal. 2006. "Prevalence of overweight and obesity in the United States, 1999-2004." *JAMA: Journal of the American Medical Association* 295 (13):1549–1555. |
| MRAC_27 | Packer, M., M. R. Bristow, J. N. Cohn, W. S. Colucci, M. B. Fowler, E. M. Gilbert, and N. H. Shusterman. 1996. "The effect of carvedilol on morbidity and mortality in patients with chronic heart failure." *New England Journal of Medicine* 334 (21):1349–1355. |
| MRAC_28 | Palella, F. J., K. M. Delaney, A. C. Moorman, M. O. Loveless, J. Fuhrer, G. A. Satten, D. J. Aschman, S. D. Holmberg, and H. I. V. Outpatient Study Investigators. 1998. "Declining morbidity and mortality among patients with advanced human immunodeficiency virus infection." *New England Journal of Medicine* 338 (13):853–860. |
| MRAC_29 | Parsonnet, J., G. D. Friedman, D. P. Vandersteen, Y. Chang, J. H. Vogelman, N. Orentreich, and R. K. Sibley. 1991. "*Helicobacter pylori* infection and the risk of gastric carcinoma." *New England Journal of Medicine* 325 (16):1127–1131. |
| MRAC_30 | Pfeffer, M. A., E. Braunwald, L. A. Moye, L. Basta, E. J. Brown, T. E. Cuddy, B. R. Davis, E. M. Geltman, S. Goldman, G. C. Flaker, M. Klein, G. A. Lamas, M. Packer, J. Rouleau, J. L. Rouleau, J. Rutherford, J. H. Wertheimer, and C. M. Hawkins. 1992. "Effect of captopril on mortality and morbidity in patients with left ventricular dysfunction after myocardial infarction: results of the Survival and Ventricular Enlargement trial." *New England Journal of Medicine* 327 (10):669–677. |
| MRAC_31 | Pitt, B., F. Zannad, W. J. Remme, R. Cody, A. Castaigne, A. Perez, J. Palensky, J. Wittes, and the Randomized Aldactone Evaluation Study Investigators. 1999. "The effect of spironolactone on morbidity and mortality in patients with severe heart failure." *New England Journal of Medicine* 341 (10):709–717. |
| MRAC_32 | Ridker, P. M., M. Cushman, M. J. Stampfer, R. P. Tracy, and C. H. Hennekens. 1997. "Inflammation, aspirin, and the risk of cardiovascular disease in apparently healthy men." *New England Journal of Medicine* 336 (14):973–979. |
| MRAC_33 | Ridker, P. M., C. H. Hennekens, J. E. Buring, and N. Rifai. 2000. "C-reactive protein and other markers of inflammation in the prediction of cardiovascular disease in women." *New England Journal of Medicine* 342 (12):836–843. |

(*Continued*)

| *MRAC code* | *Bibliographic reference* |
|---|---|
| MRAC_34 | Rossouw, J. E., G. L. Anderson, R. L. Prentice, A. Z. LaCroix, C. Kooperberg, M. L. Stefanick, R. D. Jackson, S. A. A. Beresford, B. V. Howard, K. C. Johnson, M. Kotchen, and J. Ockene. 2002. "Risks and benefits of estrogen plus progestin in healthy postmenopausal women - Principal results from the Women's Health Initiative randomized controlled trial." *JAMA: Journal of the American Medical Association* 288 (3):321-333. |
| MRAC_35 | Sacks, F. M., M. A. Pfeffer, L. A. Moye, J. L. Rouleau, J. D. Rutherford, T. G. Cole, L. Brown, J. W. Warnica, J. M. O. Arnold, C. C. Wun, B. R. Davis, and E. Braunwald. 1996. "The effect of pravastatin on coronary events after myocardial infarction in patients with average cholesterol levels." *New England Journal of Medicine* 335 (14):1001–1009. |
| MRAC_36 | Serruys, P. W., P. Dejaegere, F. Kiemeneij, C. Macaya, W. Rutsch, G. Heyndrickx, H. Emanuelsson, J. Marco, V. Legrand, P. Materne, J. Belardi, U. Sigwart, A. Colombo, J. J. Goy, P. Vandenheuvel, J. Delcan, and M. A. Morel. 1994. "A comparison of balloon-expandable-stent implantation with balloon angioplasty in patients with coronary artery disease." *New England Journal of Medicine* 331 (8):489–495. |
| MRAC_37 | Shamoon, H., H. Duffy, N. Fleischer, S. Engel, P. Saenger, M. Strelzyn, M. Litwak, J. Wylierosett, A. Farkash, D. Geiger, H. Engel, J. Fleischman, D. Pompi, N. Ginsberg, M. Glover, M. Brisman, E. Walker, A. Thomashunis, J. Gonzalez, S. Genuth, E. Brown, W. Dahms, P. Pugsley, L. Mayer, D. Kerr, B. Landau, L. Singerman, T. Rice, M. Novak, S. Smithbrewer, J. McConnell, D. Drotar, D. Woods, B. Katirgi, M. Litvene, C. Brown, M. Lusk, R. Campbell, M. Lackaye, M. Richardson, B. Levy, S. Chang, M. Heinheinemann, S. Barron, L. Astor, D. Lebeck, D. Brillon, B. Diamond, A. Vasilasdwoskin, B. Laurenzi, N. Foldi, M. Rubin, T. Flynn, V. Reppucci, C. Heise, A. Sanchez, F. Whitehouse, D. Kruger, D. Kahkonen, J. Fachnie, J. Fisk, J. Carey, M. Cox, B. Ahmad, E. Angus, H. Campbell, D. Fields, M. Croswell, K. Basha, P. Chung, A. Schoenherr, M. Mobley, K. Marchiori, J. Francis, J. Kelly, D. Etzwiler, P. Callahan, P. Hollander, G. Castle, R. Bergenstal, M. Spencer, J. Nelson, L. Bezecny, C. Roethke, M. Orban, C. Ulrich, L. Gill, K. Morgan, J. Laechelt, F. Taylor, D. Freking, A. Towey, M. Lieppman, S. Rakes, J. Mangum, N. Cooper, P. Upham, A. Jacobson, S. Crowell, J. Wolfsdorf, R. Beaser, O. Ganda, J. Rosenzweig, C. Stewart, B. Halford, E. Friedlander, D. Tarsy, P. Arrigg, G. Sharuk, S. Shah, G. Wu, J. Cavallerano, R. Poole, P. Silver, R. Cavicchi, D. Fleming, J. Marcus, C. Griffiths, N. Cappella, D. Nathan, M. Larkin, J. Godine, J. Lynch, D. Norman, C. McKitrick, C. Haggen, L. Delahanty, E. Anderson, P. Lou, C. Taylor, D. Cros, K. Folino, |

(*Continued*)

| *MRAC code* | *Bibliographic reference* |
|---|---|
| | S. Brink, K. Abbott, K. Sicotte, F. J. Service, A. Schmidt, R. Rizza, B. Zimmerman, W. Schwenk, J. Mortenson, G. Ziegler, A. Lucas, N. Hanson, S. Sellnow, J. Pach, D. Stein, B. Eickhoff, R. Woodwick, R. Tackmann, J. Trautmann, J. Rostvold, T. Link, P. Dyck, J. Daube, R. Colligan, A. Windebank, J. King, J. Colwell, D. Wood, R. Mayfield, J. Picket, M. Chitwood, D. Billings, Y. Dabney, J. Buse, L. King, S. Vale, T. Thompson, B. Bohm, T. Lyons, K. Hermayer, A. Rice, M. Molitch, B. Schaefer, C. Johnson, J. Lyons, B. Metzger, B. Cohen, T. Nishida, K. Parque, V. Yusim, M. Moore, L. Jampol, K. Dineen, J. Stahl, L. Richine, D. Weinberg, I. Loose, M. Kushner, A. Morrison, A. Jalbert, H. Tildesley, S. Leung, I. Begg, D. Johnson, S. Lalani, T. Kennedy, G. Meadows, O. Kolterman, G. Lorenzi, K. Jones, M. Goldbaum, M. Swenson, R. Lyon, M. Giotta, K. Kadlec, R. Reed, L. Kirsch, J. Goodman, S. Cahill, T. Clark, R. Abram, L. Sayner, R. Ochabski, R. Gloria, G. Birchler, J. Grant, B. Grasse, L. Christle, B. Abreu, I. Grant, R. Heaton, R. Zeitler, W. Sivitz, M. Bayless, H. Schrott, N. Olson, B. Tindal, L. Snetselaar, D. Mueller, A. Dudler, J. Swartzendruber, R. Hoffman, J. Macindoe, J. Kramer, T. Weingeist, A. Kimura, E. Stone, T. Grout, C. Fountain, S. Karakas, C. Vogel, P. Montague, D. Keyser, S. Mennen, C. Doggett, G. Rose, K. Devet, P. Muhle, A. Kowarski, D. Ostrowski, P. Levin, S. Chalew, J. Hylton, D. Younghyman, M. Barlow, R. Mayer, M. Elman, V. Lakhanpal, B. Weiner, M. Millar, S. Blum, W. Buie, B. Mace, D. Greene, C. Martin, J. Floyd, F. Dunn, D. Henry, S. Bennett, A. Lasichak, A. Vine, J. Albers, T. Sandford, J. Loftin, M. Stevens, S. Elner, C. Martonyi, F. McIver, S. Stanley, J. Willis, K. Ryan, T. Spiegelberg, S. Nalepa, B. Glasgow, E. Chan, P. Dotimas, J. Bantle, M. Mech, M. Balles, W. Kennedy, M. Khan, W. Knobloch, C. Kwong, L. McKenzie, J. Olson, R. Ramsay, W. Robiner, R. Warhol, A. Genia, G. McDonough, B. McMichael, D. Philiph, L. Ponwith, R. Sahinen, E. Stinson, J. Verness, L. Fimreite, J. Stein, D. Goldstein, M. Hall, T. Burns, D. Klachko, J. Giangiacomo, S. Rawlings, L. Aston, J. England, H. Wiedmeyer, M. Daugherty, M. Lightfoot, R. Wilson, G. Griffing, D. Gardner, R. Conway, K. Blinder, M. Brownleeduffeck, N. Palmer, L. Gash, D. Schade, C. Johannes, R. Reidy, J. Bicknell, A. Vogel, D. Drumm, P. Boyle, M. Burge, N. Jones, J. Canady, D. Nickell, L. Baker, P. Ilvescorressel, S. Schwartz, S. Braunstein, J. McBride, A. Brucker, L. Rendle, M. Brown, J. Sladky, B. Maschakcarey, D. Lawley, W. Nyberg, L. Weeney, E. Sandburg, S. Byrd, E. Aguado, N. Mulholland, D. Cahn, M. Suscavage, J. Egler, M. Vaughnnorton, C. Collins, H. Mameniskis, A. Drash, J. Wesche, M. Bratkowski, D. Becker, S. Arslanian, B. Doft, L. Lobes, J. Rinkoff, J. Warnicki, D. Curtin, D. Steinberg, G. Vagstad, C. Ryan, |

(*Continued*)

| *MRAC code* | *Bibliographic reference* |
|---|---|
| | F. Harris, L. Steranchak, J. Arch, K. Kelly, P. Ostroska, M. Guiliani, M. Good, T. Williams, K. Olsen, A. Campbell, C. Shipe, R. Conwit, D. Finegold, M. Zaucha, J. Malone, N. Grove, D. McMillan, L. Babione, T. Declue, P. Pavan, J. Korthals, H. Solc, A. Mangione, A. Kitabchi, L. Taylor, L. Jones, K. Pitts, T. Bertorini, J. Bittle, G. Burghen, J. Fisher, T. Hughes, J. Linn, D. Meyer, W. Murphy, M. Justice, A. Sherman, L. Wright, L. Murphy, P. Raskin, S. Strowig, M. Basco, S. Cercone, L. Ramirez, R. Anand, C. Wilson, R. Greenlee, W. Anderson, E. Mendelson, P. Vanacek, J. Howard, C. Ousley, B. Yates, D. Conger, B. Maguire, M. Biggs, B. Newton, K. Sherill, B. Zinman, A. Barnie, R. Ehrlich, D. Daneman, K. Perlman, L. Leiter, I. Gottesman, R. Devenyi, C. Mortimer, K. Moffat, A. Gordon, R. Ferguson, K. Camelon, S. Simkins, C. Littlefield, G. Rodin, K. Hartley, J. Kwan, D. Gnanapandithen, S. Rogers, L. Haye, J. Rose, S. Mezei, B. Bunphy, S. Maclean, L. Mackeen, M. Mandelcorn, P. Nellis, L. Ruttan, D. Wilsonsmith, J. Palmer, J. Ginsberg, I. Hirsch, J. Kinyoun, H. Doerr, R. Mauseth, K. Sweeney, L. Vanottingham, L. Thomson, C. Greenbaum, L. Sameshima, R. Farkashirsch, G. Rosenbaum, N. Rubner, T. Brown, G. Kraft, J. Broeckel, M. Karlsen, D. Khakpour, M. Ramirez, B. Smit, L. Mix, J. Dupre, P. Colby, W. Rodger, I. Hramiak, M. Jenner, C. Canny, W. Brown, T. Smith, J. Harth, S. Bondy, S. Beath, S. McCabe, C. Gouchie, K. Blanchard, J. McCallum, S. Jung, A. Suetang, R. Lorenz, J. Lipps, J. McRae, J. May, M. May, P. Campbell, S. Feman, A. Kilroy, C. Pulliam, D. Schlundt, K. Jannasch, D. Davis, N. Cullen, T. Adkins, M. Snell, K. Virts, L. Quesenberry, J. Santiago, L. Levandoski, N. White, J. McGill, J. Bubb, L. Schmidt, Y. Strasberg, M. Casso, M. Noetzel, R. Olk, I. Boniuk, M. Grand, M. Thomas, D. Williams, G. Nobel, R. Kacizak, E. Ort, J. Dahl, L. Breeding, G. Hoffmeyer, P. Bilyeu, J. Blank, C. Walters, J. Bodnar, P. Rodriguez, M. Erickson, S. Hedrick, W. Tamborlane, J. Ahern, R. Sherwin, P. Gatcomb, K. Stoessel, N. Held, J. Ebersole, I. Scanlon, R. Louard, C. Wildstein, D. Bilodeau, K. Fong, D. Ottaviano, C. Larson, O. B. Crofford, J. Lachin, P. Cleary, D. Thompson, D. Kenny, S. Lan, G. Lan, A. Brenneman, W. Owen, K. Adams, D. Arnold, R. Campanell, N. Loring, P. Scheirer, D. Lamas, C. Dunegan, H. Veeramachaneni, C. Williams, S. Abdulbaaqiy, A. Kassoff, J. Dorman, R. Spielman, R. Klein, C. Siebert, R. Silverman, M. Pfeifer, M. Schumer, M. Moran, J. Farquhar, C. Rohlfing, M. Davis, L. Hubbard, Y. Magli, S. Thomas, J. Onofrey, K. Jensen, R. Brothers, S. Ansay, J. Armstrong, D. Badal, M. Vanderhoofyoung, B. Esser, P. Geithman, D. Hurlburt, J. Reimers, K. Kewley, K. Miner, M. Steffes, J. Bucksa, R. Catanzaro, A. Lukes, G. Bagovich, T. Woodfill, R. Crow, J. Hughlett, C. Swanson, I. Buzzard, |

(*Continued*)

| *MRAC code* | *Bibliographic reference* |
|---|---|
| | B. Sielaff, B. Pickering, S. Schakel, W. Herman, E. Dasbach, T. Songer, G. Janes, L. Deeb, R. Ewart, T. Orchard, C. Clark, G. Cutter, D. Demets, F. Ferris, C. Furberg, E. Horton, J. Keen, D. Lockwood, P. Palmberg, B. Rourke, A. Tsiatis, R. Levy, R. Frank, J. Grizzle, A. Rubenstein, J. Schneider, J. Skyler, D. M. Nathan, O. Crofford, and L. Rand. 1993. "The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes-mellitus." *New England Journal of Medicine* 329 (14):977–986. |
| MRAC_38 | Shepherd, J., S. M. Cobbe, I. Ford, C. G. Isles, A. R. Lorimer, P. W. Macfarlane, J. H. McKillop, and C. J. Packard. 1995. "Prevention of coronary heart disease with pravastatin in men with hypercholesterolemia." *New England Journal of Medicine* 333 (20):1301–1307. |
| MRAC_39 | Slamon, D. J., B. Leyland-Jones, S. Shak, H. Fuchs, V. Paton, A. Bajamonde, T. Fleming, W. Eiermann, J. Wolter, M. Pegram, J. Baselga, and L. Norton. 2001. "Use of chemotherapy plus a monoclonal antibody against HER2 for metastatic breast cancer that overexpresses HER2." *New England Journal of Medicine* 344 (11):783–792. |
| MRAC_40 | Stearne, M. R., S. L. Palmer, M. S. Hammersley, S. L. Franklin, R. S. Spivey, J. C. Levy, C. R. Tidy, N. J. Bell, J. Steemson, B. A. Barrow, R. Coster, K. Waring, J. Nolan, E. Truscott, N. Walravens, L. Cook, H. Lampard, C. Merle, P. Parker, J. McVittie, I. Draisey, L. E. Murchison, A. H. E. Brunt, M. J. Williams, D. W. Pearson, X. M. P. Petrie, M. E. J. Lean, D. Walmsley, M. J. Lyall, E. Christie, J. Church, E. Thomson, A. Farrow, J. M. Stowers, M. Stowers, K. McHardy, N. Patterson, A. D. Wright, N. A. Levi, A. C. I. Shearer, R. J. W. Thompson, G. Taylor, S. Rayton, M. Bradbury, A. Glover, A. Smyth-Osbourne, C. Parkes, J. Graham, P. England, S. Gyde, C. Eagle, B. Chakrabarti, J. Smith, J. Sherwell, E. M. Kohner, A. Dornhurst, M. C. Doddridge, M. Dumskyj, S. Walji, P. Sharp, M. Sleightholm, G. Vanterpool, C. Rose, G. Frost, M. Roseblade, S. Elliott, S. Forrester, M. Foster, K. Myers, R. Chapman, J. R. Hayes, R. W. Henry, M. S. Featherston, G. P. R. Archbold, M. Copeland, R. Harper, I. Richardson, S. Martin, H. A. Davison, D. R. Hadden, L. Kennedy, A. B. Atkinson, A. M. Culbert, C. Hegan, H. Tennet, N. Webb, I. Robinson, J. Holmes, P. M. Bell, D. R. McCance, J. Rutherford, S. Nesbitt, A. S. Spathis, S. Hyer, M. E. Nanson, L. M. James, J. M. Tyrell, C. Davis, P. Strugnell, M. Booth, H. Petrie, D. Clark, B. Rice, S. Hulland, J. L. Barron, J. S. Yudkin, B. J. Gould, J. Singer, A. Badenock, M. Eckert, K. Alibhai, E. Marriot, C. Cox, R. Price, M. Fernandez, A. Ryle, S. Clarke, G. Wallace, E. Mehmed, S. MacFarlane, R. H. Greenwood, J. Wilson, M. J. Denholm, R. C. Temple, K. Whitfield, F. Johnson, C. Munroe, S. Gorick, E. Duckworth, M. Flatman, S. Rainbow, |

(*Continued*)

| *MRAC code* | *Bibliographic reference* |
|---|---|
| | L. J. Borthwick, D. J. Wheatcroft, R. J. Seaman, R. A. Christie, W. Wheatcroft, P. Musk, J. White, S. McDougal, M. Bond, P. Raniga, R. W. Newton, R. T. Jung, C. Roxburgh, B. Kilgallon, L. Dick, N. Waugh, S. Kilby, A. Ellingford, J. Burns, C. V. Fox, M. C. Holloway, H. M. Coghill, N. Hein, A. Fox, W. Cowan, M. Richard, K. Quested, S. J. Evans, R. B. Paisey, N. P. R. Brown, A. J. Tucker, R. Paisey, F. Garrett, J. Hogg, P. Park, K. Williams, P. Harvey, R. Wilcocks, S. Mason, J. Frost, C. Warren, P. Rocket, L. Bower, J. M. Roland, D. J. Brown, J. Youens, K. Stanton-King, H. Mungall, V. Ball, W. Maddison, D. Donnelly, S. King, P. Griffin, S. Smith, S. Church, G. Dunn, A. Wilson, K. Palmer, P. M. Brown, D. Humphriss, A. J. M. Davidson, R. Rose, L. Armistead, S. Townsend, P. Poon, I. D. A. Peacock, N. J. C. Culverwell, M. H. Charlton, B. P. S. Connolly, J. Peacock, J. Barrett, J. Wain, W. Beeston, G. King, P. G. Hill, A. J. M. Boulton, A. M. Robertson, V. Katoulis, A. Olukoga, H. McDonald, S. Kumar, F. Abouaesha, B. Abuaisha, E. A. Knowles, S. Higgins, J. Booker, J. Sunter, K. Breislin, R. Parker, P. Raval, J. Curwell, H. Davenport, G. Shawcross, A. Prest, J. Grey, H. Cole, C. Sereviratne, R. J. Young, T. L. Dornan, J. R. Clyne, M. Gibson, I. O'Connell, L. M. Wong, S. J. Wilson, K. L. Wright, C. Wallace, D. McDowell, A. C. Burden, E. M. Sellen, R. Gregory, M. Roshan, N. Vaghela, M. Burden, C. Sherriff, J. Clarke, J. Grenfell, J. E. Tooke, K. MacLeod, C. Searnark, M. Rammell, C. Pym, J. Stockman, C. Yeo, J. Piper, L. Leighton, E. Green, M. Hoyle, K. Jones, A. Hudson, A. J. James, A. Shore, A. Higham, B. Martin, and U.S. Prospective Diabetes Study Group. 1998. "Tight blood pressure control and risk of macrovascular and microvascular complications in type 2 diabetes: UKPDS 38." *British Medical Journal* 317 (7160):703–713. |
| MRAC_41 | Taylor, D. W. 1991. "Beneficial effect of carotid endarterectomy in symptomatic patients with high-grade carotid stenosis." *New England Journal of Medicine* 325 (7):445–453. |
| MRAC_42 | Tonkin, A., P. Aylward, D. Colquhoun, P. Glasziou, P. Harris, S. MacMahon, P. Magnus, D. Newel, P. Nestel, N. Sharpe, D. Hunt, J. Shaw, R. J. Simes, P. Thompson, A. Thomson, M. West, H. White, S. Simes, W. Hague, S. Caleo, J. Hall, A. Martin, S. Mulray, P. Barter, L. Beilin, R. Collins, J. McNeil, P. Meier, H. Willimott, D. Smithers, P. Wallace, D. Sullivan, A. Keech, and the Long-Term Intervention with Pravastatin in Ischaemic Disease (LIPID) Study Group. 1998. "Prevention of cardiovascular events and death with pravastatin in patients with coronary heart disease and a broad range of initial cholesterol levels." *New England Journal of Medicine* 339 (19):1349–1357. |

(*Continued*)

| *MRAC code* | *Bibliographic reference* |
|---|---|
| MRAC_43 | Tuomilehto, J., J. Lindstrom, J. G. Eriksson, T. T. Valle, H. Hamalainen, P. Ilanne-Parikka, S. Keinanen-Kiukaanniemi, M. Laakso, A. Louheranta, M. Rastas, V. Salminen, M. Uusitupa, S. Aunola, Z. Cepaitis, V. Moltchanov, M. Hakumaki, M. Mannelin, V. Martikkala, J. Sundvall, and the Finnish Diabetes Prevention Study Group. 2001. "Prevention of type 2 diabetes mellitus by changes in lifestyle among subjects with impaired glucose tolerance." *New England Journal of Medicine* 344 (18):1343–1350. |
| MRAC_44 | Turner, R. C., R. R. Holman, C. A. Cull, I. M. Stratton, D. R. Matthews, V. Frighi, S. E. Manley, A. Neil, K. McElroy, D. Wright, E. Kohner, C. Fox, D. Hadden, Z. Mehta, A. Smith, Z. Nugent, R. Peto, A. I. Adlel, J. I. Mann, P. A. Bassett, S. F. Oakes, T. L. Dornan, S. Aldington, H. Lipinski, R. Collum, K. Harrison, C. MacIntyre, S. Skinner, A. Mortemore, D. Nelson, S. Cockley, S. Levien, L. Bodsworth, R. Willox, T. Biggs, S. Dove, E. Beattie, M. Gradwell, S. Staples, R. Lam, F. Taylor, L. Leung, R. D. Carter, S. M. Brownlee, K. E. Fisher, K. Islam, R. Jelfs, P. A. Williams, F. A. Williams, P. J. Sutton, A. Ayres, L. J. Logie, C. Lovatt, M. A. Evans, L. A. Stowell, I. Ross, I. A. Kennedy, D. Croft, A. H. Keen, C. Rose, M. Raikou, A. E. Fletcher, C. Bulpitt, C. Battersby, J. S. Yudkin, R. Stevens, M. R. Stearn, S. L. Palmer, M. S. Hammersley, S. L. Franklin, R. S. Spivey, J. C. Levy, C. R. Tidy, N. J. Bell, J. Steemson, B. A. Barrow, R. Coster, K. Waring, L. Nolan, E. Truscott, N. Walravens, L. Cook, H. Lampard, C. Merle, P. Parker, J. McVittie, I. Draisey, L. E. Murchison, A. H. E. Brunt, M. J. Williams, D. W. Pearson, X. M. P. Petrie, M. E. J. Lean, D. Walmsley, F. Lyall, E. Christie, J. Church, E. Thomson, A. Farrow, J. M. Stowers, M. Stowers, K. McHardy, N. Patterson, A. D. Wright, N. A. Levi, A. C. I. Shearer, R. J. W. Thompson, G. Taylor, S. Rayton, M. Bradbury, A. Glover, A. Smyth-Osbourne, C. Parkes, J. Graham, P. England, S. Gyde, C. Eagle, B. Chakrabarti, J. Smith, J. Sherwell, N. W. Oakley, M. A. Whitehead, G. P. Hollier, T. Pilkington, J. Simpson, M. Anderson, S. Martin, J. Kean, B. Rice, A. Rolland, J. Nisbet, E. M. Kohner, A. Dornhorst, M. C. Doddridge, M. Dumskyij, S. Walji, P. Sharp, M. Sleightholm, G. Vanterpool, G. Frost, M. Roseblade, S. Elliott, S. Forrester, M. Foster, K. Myers, R. Chapman, J. R. Hayes, R. W. Henry, M. S. Featherston, G. P. R. Archbold, M. Copeland, R. Harper, I. Richardson, H. A. Davison, L. Alexander, J. H. B. Scarpello, D. E. Shiers, R. J. Tucker, J. R. H. Worthington, S. Angris, A. Bates, J. Walton, M. Teasdale, J. Browne, S. Stanley, B. A. Davis, R. C. Strange, D. R. Hadden, L. Kennedy, A. B. Atkinson, P. M. Bell, D. R. McCance, J. Rutherford, A. M. Culbert, C. Hegan, H. Tennet, N. Webb, I. Robinson, J. Holmes, S. Nesbitt, A. S. Spathis, S. Hyer, M. E. Nanson, L. M. James, J. M. Tyrell, C. Davis, P. Strugnell, |

(*Continued*)

| *MRAC code* | *Bibliographic reference* |
|---|---|
| | M. Booth, H. Petrie, D. Clark, S. Hulland, J. L. Barron, B. C. Gould, J. Singer, A. Badenoch, M. McGregor, L. Isenberg, M. Eckert, K. Alibhai, E. Marriot, C. Cox, R. Price, M. Fernandez, A. Ryle, S. Clarke, G. Wallace, E. Mehmed, J. A. Lankester, E. Howard, A. Waite, S. MacFarlane, R. H. Greenwood, J. Wilson, M. J. Denholm, R. C. Temple, K. Whitfield, F. Johnson, C. Munroe, S. Gorick, E. Duckworth, M. Fatman, S. Rainbow, L. Borthwick, D. J. Wheatcroft, R. J. Seaman, R. A. Christie, W. Wheatcroft, P. Musk, J. White, S. McDougal, M. Bond, P. Raniga, J. L. Day, M. J. Doshi, J. G. Wilson, J. R. Howard-Williams, H. Humphreys, A. Graham, K. Hicks, S. Hexman, P. Bayliss, D. Pledger, R. W. Newton, R. T. Jung, C. Roxburgh, B. Kilgallon, L. Dick, N. Waugh, S. Kilby, A. Ellingford, J. Burns, C. V. Fox, M. C. Holloway, H. M. Coghill, N. Hein, A. Fox, W. Cowan, M. Richard, K. Quested, S. J. Evans, R. B. Paisey, N. P. R. Brown, A. J. Tucker, R. Paisey, F. Garrett, J. Hogg, P. Park, K. Williams, P. Harvey, R. Wilcocks, S. Mason, J. Frost, C. Warren, P. Rocket, L. Bower, J. M. Roland, D. J. Brown, J. Youens, K. Stanton-King, H. Mungall, V. Ball, W. Maddison, D. Donnelly, S. King, P. Griffin, S. Smith, S. Church, G. Dunn, A. Wilson, K. Palmer, P. M. Brown, D. Humphriss, A. J. M. Davidson, R. Rose, L. Armistead, S. Townsend, P. Poon, I. D. A. Peacock, N. J. C. Culverwell, M. H. Charlton, B. P. S. Connolly, J. Peacock, J. Barrett, J. Wain, W. Beeston, G. King, P. G. Hill, A. J. M. Boulton, A. M. Robertson, V. Katoulis, A. Olukoga, H. McDonald, S. Kumar, F. Abouaesha, B. Abuaisha, E. A. Knowles, S. Higgins, J. Booker, J. Sunter, K. Breislin, R. Parker, P. Raval, J. Curwell, H. Davenport, G. Shawcross, A. Prest, J. Grey, H. Cole, C. Sereviratne, R. J. Young, J. R. Clyne, M. Gibson, I. O'Connell, L. M. Wong, S. J. Wilson, K. L. Wright, C. Wallace, D. McDowell, A. C. Burden, E. M. Sellen, R. Gregory, M. Roshan, N. Vaghela, M. Burden, C. Sherriff, S. Mansingh, J. Clarke, J. Grenfell, J. E. Tooke, K. MacLeod, C. Seamark, M. Rammell, C. Pym, J. Stockman, C. Yeo, J. Piper, L. Leighton, E. Green, M. Hoyle, K. Jones, A. Hudson, A. J. James, A. Shore, A. Higham, B. Martin, H. A. W. Neil, W. J. H. Butterfield, W. R. S. Doll, R. Eastman, F. R. Ferris, N. Kurinij, K. McPherson, R. F. Mahler, T. W. Meade, G. Shafer, P. J. Watkins, H. Keen, D. Siegel, D. J. Betteridge, R. D. Cohen, D. Currie, J. Darbyshire, J. V. Forrester, T. Guppy, D. G. Johnston, A. McGuire, M. Murphy, A. M. el-Nahas, B. Pentecost, D. Spiegelhalter, Kgmm Alberti, R. Denton, P. D. Home, S. Howell, J. R. Jarrett, V. Marks, M. Marmot, J. D. Ward, and the U.K. Prospective Diabetes Study (UKPDS) Group. 1998. "Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33)." *The Lancet* 352 (9131):837–853. |

(*Continued*)

| *MRAC code* | *Bibliographic reference* |
|---|---|
| MRAC_45 | Turner, R. C., R. R. Holman, I. M. Stratton, C. A. Cull, D. R. Matthews, S. E. Manley, V. Frighi, D. Wright, A. Neil, E. Kohner, H. McElroy, C. Fox, D. Hadden, and the U.K. Prospective Diabetes Study (UKPDS) Group. 1998. "Effect of intensive blood-glucose control with metformin on complications in overweight patients with type 2 diabetes (UKPDS 34)." *The Lancet* 352 (9131):854–865. |
| MRAC_46 | Van den Berghe, G., P. Wouters, F. Weekers, C. Verwaest, F. Bruyninckx, M. Schetz, D. Vlasselaers, P. Ferdinande, P. Lauwers, and R. Bouillon. 2001. "Intensive insulin therapy in critically ill patients." *New England Journal of Medicine* 345 (19):1359–1367. |
| MRAC_47 | Weidner, N., J. P. Semple, W. R. Welch, and J. Folkman. 1991. "Tumor angiogenesis and metastasis: correlation in invasive breast carcinoma." *New England Journal of Medicine* 324 (1):1–8. |
| MRAC_48 | Young, T., M. Palta, J. Dempsey, J. Skatrud, S. Weber, and S. Badr. 1993. "The occurrence of sleep-disordered breathing among middle-aged adults." *New England Journal of Medicine* 328 (17):1230–1235. |
| MRAC_49 | Yusuf, S. 1991. "Effect of enalapril on survival in patients with reduced left ventricular ejection fractions and congestive heart failure." *New England Journal of Medicine* 325 (5):293–302. |
| MRAC_50 | Yusuf, S., P. Sleight, J. Pogue, J. Bosch, R. Davies, G. Dagenais, and the Heart Outcomes Prevention Evaluation Study Investigators. 2000. "Effects of an angiotensin-converting-enzyme inhibitor, ramipril, on cardiovascular events in high-risk patients." *New England Journal of Medicine* 342 (3):145–153. |

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