The use and meaning of *nano* in American English: Towards a systematic description

Max Boholm

Gothenburg Research Institute, University of Gothenburg, PO. Box 603, SE-405 30, Göteborg, Sweden

HIGHLIGHTS

- The use and meaning of the morpheme nano is analyzed.
- Meaning of complex words are described by schemas.
- The morpheme nano is used in a variety of ways.
- The use of nano is systematic.

ABSTRACT

The morpheme *nano* is today used in various words, such as *nanometer*, *nanoscale*, *nanotechnology*, *nanomaterial*, *nanorobot*, *iPod nano*, and *nanotyrannus*. This range of uses is partly explained by an interest in nanotechnology manifest in many spheres of society, including science, politics, and popular culture. These varied uses of *nano* challenge semantic description, as the meaning of *nano* in use greatly exceeds its precise meaning of "billionth part", for example, in the modified SI unit *nanometer*. The aim is to analyze the use and meaning of the morpheme *nano* based on attested uses from the Corpus of Contemporary American English (COCA). The following six research questions are addressed: In what genres of COCA does *nano* occur? To what extent is *nano* a constituent of complex words? What are the most common positions of *nano* in complex words? In what types of words does *nano* occur? What do these words mean? How are they related? Contrary to the view that the morpheme *nano* is being misused (sometimes expressed in the literature), I argue that, while the use of *nano* is indeed varied, it can be systematically described.

1. Introduction

In the academic field that has emerged around the idea of nanotechnology, there has been interest in how the linguistic element *nano* is used (e.g., [3,28,32,35,40]). The benefits of nanotechnology to society are sometimes predicted to be immense [9]. However, concerns about its risks have been raised, for example, the potential effects of nanotechnology products (i.e., nanoparticles and nanomaterials) on the human body. Alongside the societal significance ascribed to nanotechnology, a wide variety of words containing the morpheme *nano* has emerged in English and other languages [7,13,32,39]. For example, consider the arbitrary sample of words containing *nano* extracted from the Corpus of Contemporary American English (COCA) listed in (1).

(1) iPod nano, nanoampere, nano-application, nanoassembler, nanobacterium, nanobiology, nanobusiness, nanocamera, nano-chemical, nanocircuit, nanoclay, nanocluster, nanocoating, nanocomputer, nanocreature, nanodevice, nanoengineer, nano-engineered, nanoevangelist, nanofabrication, nanofactory, nano-fiber, nanofood, nanofossil, nanogenerator, nanogram, nano-imprint-lithography, nanoindustrial, nanolab, nanoliter, nano-machine, nanomanufacturing, nanomaterial, nanomechanical, nanomedicine, nanometer, nanoparticle, nanophysics, nano-plasm, nano-replicator, nanorobot, nanorobotic, nanosatellite, nanoscale, nanoscience, nanoscientist, nanosecond, nanosensor, nanosized, nanospace, nanostructure, nanosurgery, nanosystem, nanotechnology, nanotechnology-based, nanotools, nanotube, nanotyrannus, nanowax, nanoweapons, subnanometer

Policy documents and research articles on nanotechnology and nanomaterials sometimes consider the variety of uses of *nano* a

E-mail address: max.boholm@gu.se.

problem, claiming that *nano* is "overused" or even "misused" [3]; [28,32,35,40]. More specific concerns include the "devaluation" of the term *nano* ([35]: 805), conceptual "confusion" [40], and "spoiling the transformative possibilities of nanotechnology" ([3]: 4).

This scholarly interest in the use of *nano* is dominantly normative — witness the concern that *nano* is being over/misused — and there are no attempts to systematically describe how *nano* is actually used except that of Bauer et al. [7]; but their description is short and limited. Besides its definition by the International System of Units (SI; the abbreviation derives from the French name of the system, *Système International d'Unités*), Bauer et al. ([7]: 397) suggest two senses of *nano*, namely, "extremely small" and "with regard to very small entities"; in contrast, they suggest many more senses of *micro* ([7]: 397). The rationale for this richer description of *micro* is somewhat unclear, since senses parallel to many of those suggested for *micro* seem to be valid for *nano*.

In this article, my aim is to empirically analyze the use and meaning of the linguistic element *nano* by investigating actual uses of *nano* in COCA data. The following research questions are addressed:

RQ1: In what genres of COCA does *nano* occur?
RQ2: To what extent is *nano* a constituent of complex words?
RQ3: What are the most common positions of *nano* in complex words?
RQ4: In what types of words does *nano* occur?
RQ5: What do these words mean?
RQ6: How are they related?

The broad use of *nano* in many spheres of society, including science, policy, and popular culture, calls for a general and systematic description. The morpheme *nano* is commonly defined simply as a prefix meaning "billionth part of …", following SI; for example, *nanometer* means "billionth part of a meter". However, this analysis does not encompass the variety of uses of *nano*. The semantic contribution of *nano* to each word in (1) is not the same; for example, *nanotechnology* is typically not interpreted as "billionth part of technology" and a *nanorobot* is not a billionth part of a robot. Such considerations suggest that the use and meaning of *nano* is in need of some other, more systematic, description.

2. Background: a brief history of *nano*

According to the *Oxford English Dictionary* (OED), the linguistic form *nano* originates from the classical Latin *nanus* or its ancient Greek etonym *nanos* (νᾶνος), meaning "dwarf" [41]. In 1958, *nano*, together with *giga*, *tera*, and *pico*, was adopted in the newly formed International System of units [20]. In 1974, Norio Taniguchi introduced the term *nanotechnology* at an engineering conference in Tokyo [47]. The idea of nanotechnology was later popularized and disseminated by, for example, Eric Drexler [26]. In 2000, so-called nanoscience and nanotechnology attracted considerable scientific and political interest when the US government initiated the National Nanotechnology Initiative (NNI). Nanotechnology has been deemed revolutionary, on par with information technology and Gutenberg's printing technology [18]. Due to its fantastic, futuristic, and thrilling associations, nanotechnology has become a topic of popular culture [17,37,38]. For example, in the bestselling novel *Prey* by Crichton [21]; the plot centers on the horror of nanotechnological devices escaping the laboratory.

From the very precise and technical meaning of "10^{-9}" in SI units, *nano* has grown into a political symbol with strong visionary associations [9,49]. However, parallel to this development, *nano* has also entered the English language through a more direct path, as a borrowing from the classical languages. Much like *anthro*, *astro*, *bio*, *biblio*, *electro*, *geo*, and *hydro*, *nano* is used mostly in academic English. For example, in *Webster's New Twentieth Century Dictionary of the English Language*, *nanosomia* is defined as the "condition of being dwarfed" ([36]: 1193). This word derives from the Greek words *nanos* for "dwarf" and *soma* for "body". Words composed of such neoclassical elements are referred to in the literature as neoclassical compounds [5,7].

3. Method

3.1. Corpus

To explore the use and meaning of *nano*, this study uses COCA, which now contains 520 million words in texts of five main genres from 1990 to 2015 [22]. The present work is based on data from an earlier version of the corpus, with texts from 1992 to 2012, containing 450 million words. The genres of COCA are as follows [23]: *spoken*, i.e., transcripts of unscripted conversation from TV and radio programs; *fiction*, i.e., fictive stories from books, movie scripts, and literary magazines; *magazine*, i.e., popular magazines, such as *Time*, *Men's Health*, and *Cosmopolitan*; *newspaper*, i.e., ten US newspapers, for example, *USA Today*, *New York Times*, and *San Francisco Chronicle*; and *academic*, i.e., academic texts from nearly 100 peer-reviewed journals covering the entire range of the Library of Congress classification system. Each of the five genres is classified into subgenres. Spoken is classified in accordance with various TV and radio channels (e.g., CBS, CNN, and Fox). Fiction is classified into general books, general journals (i.e., short stories from literary magazines), juvenile, movie scripts, and science fiction and fantasy. Magazines are classified according to the main topics of the magazines, for example, children, entertainment, financial, science and technology, and sports and outdoors. Newspapers are classified according to the section, or topic of coverage, for example, editorial, money, international news, local news, and sports. Academic is classified with regard to discipline, for example, history, education, science and technology, and medicine. COCA has been used to retrieve lists of words containing *nano*, the immediate linguistic contexts of these words, and the genres (sections) in which these occur.

COCA was chosen for this analysis because of its contemporariness, large size, and availability. Considering the first of these features, note that the nanotechnology concept and related notions have emerged quite recently. Public attention to *nano* over and above its use as an SI prefix was quite limited before the sociotechnological developments of the mid to late 1990s (discussed in section 2). To see the importance of temporal scope when choosing a corpus for a study of the use of *nano*, the limited frequency of *nano* in the British National Corpus (BNC) can be noted. The BNC, most texts of which were produced between 1985 and 1993, contains only 97 occurrences of *nano* (excluding homonyms) distributed over 22 word types. These basic findings show that, despite its considerable size, a non-contemporary corpus like BNC contains only limited information about the currently wide use of *nano*.

Another reason for choosing COCA is its large size. Although public awareness of *nano* has increased in recent years, it is still not that popular a term. In smaller corpora, which indeed contain more contemporary material than BNC, such as the Open American National Corpus (OANC), which contains 15 million words, and the Scottish Corpus of texts and Speech (SCOTS), which contains 4.6 million words, *nano* is much less frequent than it is in COCA. OANC contains 159 tokens of *nano* (excluding homonyms) distributed over 30 word types, while SCOTS contains only three occurrences of *nano*, all instances of *nanosecond*.

A third reason for choosing COCA is its availability. Choosing a