Numbers count: the importance of numeracy for journalists

by

Amelia Genis

Assignment presented in partial fulfillment of the requirements for the degree of M.Phil Journalism in the Faculty of Arts at the University of Stellenbosch

Study leader: Mr Bun Booyens

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Declaration

I, the undersigned, hereby declare that the work contained in this assignment is my own original work and that I have not previously in its entirety or in part submitted it at any university for a degree.

Signature:

Date:

Abstract

Few news subjects or events can be comprehensively covered in the media without numbers being used. Indeed, most reports are essentially 'number stories', or could be improved through the judicious use of numbers. Despite this there are frequent complaints about poor levels of numeracy among journalists.

Although numbers are fundamental to virtually everything they write, the most superficial review of South African newspapers indicates that most encounters between journalists and numbers of any sort are uncomfortable, to say the least. Reporters shy away from using numbers, and frequently resort to vague comments such as "many", "more", "worse" or "better". When reports do include numbers, they often don't make sense, largely because journalists are unable to do simple calculations and have little understanding of concepts such as the size of the world's population, a hectare, or a square kilometer. They frequently use numbers to lend weight to their facts without having the numerical skills to question whether the figures are correct.

Numeracy is not the ability to solve complicated mathematical problems or remember and use a mass of complicated axioms and formulas; it's a practical life skill. For journalists it is the ability to understand the numbers they encounter in everyday life – percentages, exchange rates, very large and small amounts – and the ability to ask intelligent questions about these numbers before presenting them meaningfully in their reports.

This thesis is not a compendium of all the mathematical formulas a journalist could ever need. It is a catalogue of the errors that are frequently made, particularly in newspapers, and suggestions to improve number usage. It will hopefully also serve to make journalists aware of the potential of numbers to improve reporting and increase accuracy.

This thesis emphasises the importance of basic numeracy for all journalists, primarily by discussing the basic numerical skills without which they cannot do their job properly, but also by noting the concerns of experienced journalists, mathematicians, statisticians and educators about innumeracy in the media. Although the contents of this thesis also apply to magazine,

radio and television journalists, it is primarily aimed at their counterparts at South Africa's daily and weekly newspapers.

I hope the information contained herein is of use to journalists and journalism students; that it will open their eyes to the possibility of improving number usage and thereby reporting, serve as encouragement to brush up their numerical skills, and help to shed light on the numbers which surround them and which they use so readily.

Amelia Genis
17 Januarie 2001

Opsomming

Min nuusonderwerpe of -gebeure kan in beriggewing tot hul reg kom sonder dat enige getalle gebruik word. Trouens, die meeste berigte is in wese 'syferstories', of kan verbeter word deur meer sinvolle gebruik van syfers. Tog is daar vele klagtes oor joernaliste se gebrekkige syfervaardigheid.

Ten spyte van die ingewortelheid van getalle in haas alles wat hulle skryf, toon selfs die mees oppervlakkige ondersoek na syfergebruik in Suid-Afrikaanse koerante joernaliste se ongemaklike omgang met die meeste syfers. Hulle is skugter om syfers te gebruik, en verlaat hulle dikwels op vae kommentaar soos "baie", "meer", "erger" of "beter". Indien hulle syfers gebruik, maak die syfers dikwels nie sin nie: meermale omdat joernaliste nie basiese berekeninge rondom persentasies en statistiek kan doen nie, en min begrip het vir algemene groothede soos die wêreldbevolking, 'n hektaar of 'n vierkante kilometer. Hulle sal dikwels enige syfer gebruik omdat hulle meen dit verleen gewig aan hul feite en omdat hulle nie die syfervaardigheid het om dit te bevraagteken nie.

Syfervaardigheid is nie die vermoë om suiwer wiskunde te doen of 'n magdom stellings en formules te onthou en gebruik nie; dis 'n praktiese lewensvaardigheid, die vermoë om die syferprobleme wat die daaglikse roetine oplewer – persentasies, wisselkoerse, baie groot en klein getalle – te verstaan en te hanteer.

Hierdie tesis is nie 'n versameling van alle berekeninge wat joernaliste ooit sal nodig kry nie; maar veel eerder 'n beskrywing van die potensiaal van syfers om verslaggewing te verbeter en joernaliste te help om ag te slaan op die getalle rondom hulle en die wat hulle in hul berigte gebruik.

Die doel van die tesis is om die belangrikheid van 'n basiese syfervaardigheid vir alle joernaliste te beklemtoon, veral dié basiese syfervaardighede waarsonder joernaliste nie die verslaggewingtaak behoorlik kan aanpak nie, te bespreek, en ook om ervare joernaliste,

wiskundiges, statistici en opvoeders se kommer oor joernaliste se gebrek aan syfervaardigheid op te teken. Hoewel alles wat in die tesis vervat is, ewe veel van toepassing is op tydskrif-, radio- en televisiejoernaliste, val die klem hoofsaaklik op hul eweknieë by Suid-Afrikaanse dag- en weekblaaie.

Ek hoop die inligting hierin vervat sal van nut wees vir praktiserende joernaliste en joernalistiekstudente om hulle bewus te maak van die moontlikhede wat bestaan om syfergebruik, en uiteindelik verslaggewing, te verbeter en as aanmoediging dien om hul syfervaardigheid op te skerp.

Amelia Genis
17 Januarie 2001

Contents

1. Introduction

Journalists like to think they deal mainly in facts and ideas, but numbers and statistics are involved in almost everything they report. Still, mathematicians, economists, statisticians and numerate readers frequently complain about the misuse of numbers in the media.

Their criticism is justified: even the most superficial survey of South African newspapers shows that journalists struggle to use numbers in a meaningful way. They often shy away from numbers, and prefer to use vague words like "many", "uncommon" or "better". When they do use numbers, the numbers often do not make sense, either because they were not examined for discrepancies or plausibility, or because they were not put in context.

Due to their poor numerical skills journalists often find it difficult to do the most straightforward calculations involving percentages, rates and conversions; or explain risk numbers to their readers, listeners or viewers, and lack the confidence to question or judge numbers or claims made by sources. This makes them vulnerable to abuse by people with dubious aspirations and pseudoscientists, as was demonstrated so clearly by the so-called Virodene saga.

In January 1997, when a team of researchers at Pretoria University announced their discovery of a cheap drug that could help AIDS sufferers by inhibiting the progression of HIV infection, some local journalists touted it as *the* cure for Aids, and responded to the announcement with what *Sunday Times* journalist Carol Paton (1999:www.suntimes.co.za) afterwards described as "reckless triumphalism". The press's initial coverage of the 'discovery' was totally unquestioning. They either used "most of their front page" (Sidley, 1997:www.bmj.com) for colour illustrations of the virus and the new drug Virodene P085, or carried AIDS sufferers' sad stories. Only later did journalists begin to ask questions about peer review, study design, controls, the credentials of the researchers and why they chose to make their announcement to the cabinet first.

Their blind acceptance of the anecdotal findings offered by the developers contributed to the confusion and subsequent disappointment of AIDS sufferers, and demonstrated journalists' inadequate knowledge of statistics and their inability to evaluate studies and trials.

Because the thesis was written with the general reporter in mind, very little attention is given to the numbers of business reporting. Although the contents of this thesis will be of equal value to magazine, radio and television journalists, the focus is on their counterparts at South Africa's daily and weekly newspapers. Most of the examples used to demonstrate both excellent and poor use of numbers were obtained from South African newspapers.

The aims of this thesis are threefold: to record the concern among journalists, mathematicians, statisticians about the numerical incompetence of journalists; to emphasise the need for improved numeracy, and to elaborate on the most basic skills needed by all journalists. Having dealt with the aforementioned in the literature study (chapter 4), the rest of the thesis's focus will be on the numerical skills journalists need, namely the ability to calculate percentages and percentage change and use them in a way that makes sense (chapter 5), sufficient numerical skills to deal with very large and small numbers (chapter 6); conversions (chapter 7); to report numbers accurately and in context, as well as to be able to spot implausible numbers and discrepancies involving numbers (chapter 8); to evaluate the numbers produced by studies and surveys (chapters 9 and 10), and deal with the numbers of risk (chapter 11).

In order to orientate readers, the concept of numeracy will be put in historical and educational perspective, and some common defintions of it will be given.

2. *Background and perspective*

The curse of innumeracy is not exclusive to the profession of journalism: it plagues thousands of people from all walks of life, and is a source of grave concern, as writer-mathematician, John Allen Paulos (1988:134), notes in *Innumeracy*:

> I am distressed by a society which depends so completely on mathematics and science and yet seems so indifferent to the innumeracy and scientific illiteracy of so many of its citizens.

A.K. Dewdney (1993:v,1), associate professor in the department of computer science at the University of West Ontario shares his anxiety:

> Innumeracy is now widely accepted as the mathematical parallel of illiteracy. Innumeracy, the inability or unwillingness to understand basic mathematical ideas involving numbers or logic as they apply in everyday life imposes a grave handicap on its victims ... those who abuse mathematics also abuse us. We become prey to commercial chicanery, financial foolery, medical quackery and numerical terrorism from pressure groups, all because we are unable (or unwilling) to think clearly for a few moments.

In October 2000 a Madam & Eve cartoon appeared in the *Mail & Guardian* (Francis, Dugmore & Rico:38) depicting the madam, the maid and the grandmother desperately hiding behind the sofa when young Thandi begs for someone to help her with her maths homework.

Very funny; though in the light of the concern expressed about South Africans' scientific illiteracy by the national Minister of Education and his special advisor on science and technology (Asmal, 1999: education.pwv.gov.za/Media; Kahn, 2000:19), this cartoon is an accurate version of what goes on in the average South African home. South Africans' fear of mathematics and numbers goes beyond age, race and social class. It affects every generation, and is every bit as serious as portrayed.

Innumeracy is just one element of a broader scientific illiteracy that threatens to relegate whole countries to onlooker status in the world arena of science and technology. It has far-reaching consequences, as professor of mathematics at St Olaf College, Northfield, Michigan, Lynn Arthur Steen's (1997: www.collegeboard.org) warning attests:

> As information becomes ever more quantitative and as society relies increasingly on computers and the data they produce, an innumerate citizen today is as vulnerable as the illiterate peasant of Gutenberg's time.

Locally, Steen's anguish is shared by Michael Kahn, Professor of Science Education at the University of Cape Town and advisor on science and technology to the Minister of Education. In the *Sunday Times* of 5 March 2000 Kahn (2000:19) writes: "... without some understanding of science and technology, citizens cannot fully participate in many decisions that affect their lives", and hinted at national disaster: "...without broader participation in science and technology practice ... we may condemn ourselves to be spectators outside the knowledge societies of the new millennium".

Although mathematics as a system of axioms, hypotheses and deductions has a long history, and numerical skills were in demand since the time of the barter economies, numeracy was for the first time named as such and formally acknowledged as one of the skills of an informed citizenry by the third American president, Thomas Jefferson, at the beginning of the 19th century (Steen, 1997, www.collegeboard.org).

Since then the demands of everyday life on people's mathematical abilities have risen as fast as concern about their innumeracy, especially in education circles, and reports about the state of math education in schools abound. *Mathematics Counts*, the report of the Cockroft Committee of Enquiry into the teaching of mathematics in (British) schools – described by Steen (1990: www.stolaf.edu) as "one of the most influential and well-researched analyses of numeracy" – was published in 1982.

Cockroft committee members interviewed hundreds of adults to determine just how they used mathematics on the job and in everyday life. The report revealed "intense apprehension in the face of even simple mathematical problems", and illustrated how many people manage to organise their lives so that they "successfully evade" the mathematics that confronts them. (Steen, 1990:www.stolaf.edu)

Outside the education system, the publication of Paulos's *Innumeracy* in the United States in 1988 brought the word innumeracy into common use. For Paulos, the public's "inability to deal with big numbers or to estimate the likelihood of coincidences ... leads to massive public confusion about issues such as political polling, medical consent and safety regulations" (Steen, 1997: www.collegeboard.org). *Innumeracy* was followed by Laura Buxton's *Math Panic* (1991) and Sheila Tobias's *Overcoming Math Anxiety* (1993), both books aimed at helping especially adults overcome their fear of mathematics.

These books put the importance of numeracy firmly on the American education agenda, and although South African educators have been slower to add their voices to those concerned about the level of scientific and numerical competence among their fellow citizens, it has been recorded.

At the launch of the University of Cape Town's B.Sc (Education) degree programme in 1999 Prof Kader Asmal (1999:www.education.pwv.gov.za/Media), Minister of Education, remarked that the standard of teaching and learning in the "crucial subjects of mathematics and science" was of "particular concern":

> Mathematical illiteracy is rife in our society ... the number of young people who study mathematics with any degree of understanding and proficiency has declined when it should be increasing rapidly.

The struggle for a more numerate public continues; "yet despite increasing civic, educational and economic incentives for quantitative literacy, evidence of innumeracy is not hard to find" (Steen, 1997: www.collegeboard.org).

In South Africa, some steps have been taken to change this. Besides the University of Cape Town's (UCT) degree course in science, mathematics and technology education which is aimed at alleviating the shortage of science and maths teachers (*Monday Paper*, 1999:1), the university's Department of Mathematics and Applied Mathematics has also launched a course in "effective numeracy" and opened a numeracy centre in 1997. The purpose of the UCT numeracy course is to offer skills that would make students in the faculties of Arts, Social Science and Humanities functionally numerate (Brink, 1999). Students are taught to handle ratios and percentages, deal with compound interest and money matters, interpret and manipulate data, understand and present charts and graphs, work with spreadsheets and explain what a standard deviation is (*Monday Paper*, 1997:www.uct.ac.za).

Concern about the numerical incompetence of journalists and efforts to rectify it started to gain momentum at the end of the 1980s with the publication of journalist Victor Cohn's *News & Numbers: A guide to reporting statistical claims and controversies in health and other fields*. It was followed by John Allen Paulos's *A Mathematician reads the newspaper* in 1996.

Some efforts have since gone into improving the numerical skills of journalists, mostly in the United States. They will be discussed in the literature study (chapter 4). And although very little has been written or done about the inadequate numerical skills that South African journalists display, those that are concerned about it, are few and seem to be voices crying out in the desert.

Stellenbosch University's journalism department has identified the need for scientific literacy and instituted a science and technology component to its honours course in 1994. At *Science & Society '98*, the second national conference on the public understanding of science and technology in Southern Africa, that was held in Pretoria, one of the speakers (Booyens, 1998) identified numeracy as an indispensable skill for journalists; and in November 2000 the Institute for the Advancement of Journalism in Parktown, Johannesburg offered a numeracy course – "Don't get lost in the numbers" – facilitated by Herb Frazier, visiting fellow of the Knight Foundation at Rhodes University.

3. Numeracy defined

What is called numeracy in South Africa, Britain and Australia, is known as quantitative literacy in the United States (Brink, 1999; Booysen, 1998; Steen, 1990:www.stolaf.edu).

Emeritus professor of journalism at the University of Georgia, George Hough (1995:386), expresses his concern about the phenomenon as a "lack of numbers sense", while the Poynter Institute's Deborah Potter (www.journalism.org/Poynterrpt.htm) talks about journalists' "numerical competence" or lack thereof. The national Minister of Education, Prof Kader Asmal (1999: education.pwv.gov.za/Media), and his science and technology advisor, Prof Michael Kahn (2000:19), prefer the term mathematical literacy.

For the purpose of this thesis the terms numeracy, innumeracy and numerical competence will be used.

Sources that were consulted yielded diverse definitions of numeracy. However, the authors all emphasise that numeracy is not the mastery of pure algebra, calculus and geometry; but a life skill involving common sense and a broad understanding of things numerical. According to them numeracy is:

> • The type of math skills needed to function in everyday life, in the home, workplace, and community. (Withnall in Kerka, 1995:www.ed.gov/databases/ERIC_Digests).
>
> • Those mathematical skills that enable an individual to cope with the practical demands of everyday life. (Cockroft in Steen, Daedalus, 1990: www.stolaf.edu).
>
> • Real world problem solving – the use of mathematics in every day life, on the job, and as an intelligent citizen. (Henry Pollak, applied mathematician, Steen, 1997: www.collegeboard.org).
>
> • Understanding the role of numbers in the world. It provides the ability to see below the surface and to demand enough information to get at the real issues. (Ted Porter, historian, Steen, 1997: www.collegeboard.org)

Chris Brink (*Monday Paper*, 1998: www.uct.ac.za) goes one step further by listing individual skills:

> By numeracy we do not just mean an understanding of numbers ... we mean understanding and skills that should form an integral part of numerical concepts and techniques used in daily

> life ... basic statistical concepts, interpreting charts and graphs, the manipulation of data, and spreadsheeting skills.

Equally to the point, and of particular relevance to this thesis and for journalists, is the far-reaching definition that *New York Times* science journalist and maths graduate, Gina Kolata (Steen, 1997:www.collegeboard.org), developed:

> Beyond arithmetic and geometry, quantitative literacy also requires logic, data analysis and probability... It enables individuals to analyse evidence, to read graphs, to understand logical arguments, to detect logical fallacies, to understand evidence, and to evaluate risks. Quantitative literacy means knowing how to reason and how to think.

4. Literature study

Literature about numeracy in the media or press does not mirror the infinite nature of numbers, nor does this thesis profess to review all the literature ever produced on the subject. It is at best a modest introduction, hopefully the basis for more in-depth research.

In their search for journalistic competence some journalists and media institutions have responded to the "overwhelming tendency to reduce complex information to a few numbers ... in health care, in social policy, in political analysis, in education" (Steen, 1997: www.collegeboard.org) in various ways. In more than one instance, numerical competence has been identified as *sine qua non* for journalists; two examples of which will be mentioned here.

In 1997 the Committee of Concerned Journalists, a consortium of hundreds of American reporters, editors, producers, publishers, media owners and academics concerned about the future of their profession, launched an enquiry into journalism. A series of forums was held around the United States to hear presentations from journalists about the state of the news media. When 'competency in the newsroom' was discussed at the Poynter Institute in Florida, "numerical competence" was named as one of the ten skills required of a competent journalist.

In his 1999 M.Phil. thesis part time science and technology journalism lecturer at Stellenbosch University, Bun Booyens (1999:24) listed numeracy as one of the "indispensable" skills for science reporters. According to him a numerate journalist has:

- Sufficient background knowledge to ask intelligent questions [about numbers] and understand the answers.
- Sufficient numeracy to do the basic calculations that will render their reporting factually correct.
- Advanced editing skills to make the numbers in stories more understandable and interesting for readers.

The majority of general textbooks for journalists do not deal with the issue of numbers in reporting at all. But for short, broad-based chapters by Victor Cohn and Jim Detjen, the other contributors to the official guide of America's National Association of Science Writers, *A Field Guide for Science Writers,* are rather uncommunicative about the subject. George

Hough's chapter titled "Numbers in the News" in *News Writing* may be short, but covers most of what the majority of general reporters need.

The only publication from the ranks of journalists that deals specifically with numbers in the news is Victor Cohn's *News & Numbers: a guide to reporting statistical claims and controversies*, a comprehensive guide for any journalist required to evaluate and write about scientific studies or surveys.

More has been written by those *reading* the newspapers, like John Allen Paulos (*A Mathematician reads the newspaper*, *Innumeracy, Once upon a number, Beyond numeracy*) and AK Dewdney (*200% of Nothing*), respectively a mathematician and a computer expert. And although some of the examples in Darrell Huff's 1954 classic, *How to lie with statistics,* are beginning to show their age, the underlying principles are as valid as ever.

Locally, one of the trailblazers, and probably the person most vocal in voicing his concern about journalists' innumeracy, is assistant editor of *Die Burger* and part-time science and technology journalism lecturer at Stellenbosch University, Bun Booyens.

As the Internet is used increasingly for research and information dissemination, it was searched and produced some useful sources. Paul Cox's (1998: www.mathmistakes.com) *Glossary of Mathematical Mistakes* on the World Wide Web is a collection of the math mistakes most frequently made, most of which were culled from the writings of Paulos and Dewdney. The site provides a variety of examples of each mistake from newspapers, as submitted by readers.

Journalists who struggle to master statistics will find help at www.learner.org/statistics/ The site contains, amongst others things, links to the Gallup Organisation and the Roper Centre for Public Opinion Research. Another valuable find was Robert Niles's statistical web page (www.robertniles.com), containing "statistics every writer should know". He uses clear language and practical examples to explain the different kinds of averages, standard deviation and margin of error.

There are three things common to all the literature studied: concern for journalists' lack of numerical skills; motivation for improving their numerical competency and the identification of the skills these authors think journalists need in order to do their work. The rest of this chapter will be dedicated to a discussion of this concern, the need for numeracy and the skills that journalists need, as found in the literature studied.

4.1 Concern

To say that numerate journalists, journalism lecturers and mathematicians are concerned about the lack of numeracy among journalists is an understatement. They are horrified by the depth of innumeracy in the media.

It seems as if the problem commences even before journalists check in for service in the media. When Booyens (1998:4) began lecturing science journalism to honours students in 1997, he thought he could cover basic numerical skills – calculating percentages, ratios, areas, volumes and doing basic conversions – in three or four sessions. "It bogged us down for much of the first term," he reports.

In an article to be published in volume 54(2) of the *Transactions of the Royal Society of South Africa* the University of Cape Town's Professor of Mathematics, Chris Brink (1999:5) writes about a similar experience. According to him the problem of teaching numeracy to arts and social science students (the academic fields from which most journalists are drawn) was "compounded" by the fact that they had "entirely underestimated the depth of maths deprivation these students suffered from, and the lack of confidence they had in dealing with anything numerical".

Deborah Potter (1997:www.journalism.org/Poynterrpt.htm) of the Poynter Institute argues that "the numerical world remains an area of serious weakness for journalists", while Doron Levin (1997:www.journalism.org/Poynterrpt.htm), a business writer at the *Detroit Free Press,* describes the amount of numeric incompetence in newsrooms as "horrifying". In a paper delivered at the Second National Conference on the Public Understanding of Science and Technology in Southern Africa, held in 1998 in Pretoria, Booyens (1998:4) said he was "taken aback" by journalists' inability to do even the most basic calculations.

These sentiments are shared – in rather blunt fashion – by Hough (1995:377) who believes that "too many people today, including journalists, are innumerate – they lack an understanding of what numbers mean".

Booyens thinks the problem of inadequate numeracy among journalists is probably symptomatic of a broader phenomenon: what Brink (Booyens, 1999:19) described as "a staggering lack of real-life numeracy", especially among arts and social sciences students at

South Africa's tertiary institutions. In the media it is manifested as miscalculations and a failure to question numbers, probably due to a lack of self-confidence.

In their use (and misuse) of numbers, journalists "perform" the whole repertoire: from avoiding numbers to using any old number, and everything in between, namely not putting the numbers they use in context, or not giving more background information.

In *A mathematician reads the newspaper* Paulos (1996:81) notes:

> It is easier and more natural to react emotionally than it is to deal dispassionately with statistics or, for that matter, with fractions, percentages and decimals. The media frequently solve this problem by leaving numbers out of stories and hiding behind such evasive words as "many" or "uncommon", which are almost completely devoid of meaning.

As a judge in the Environmental News section of the 2000 Sanlam Awards for the Community Press, Booyens (2000:10) was distressed at how often the words "many", "few", "big" or "small" were used in entries, and remarked:

> Not only does it render the reporting vague, it comes down to comment: the journalist makes a judgement instead of reporting.

At the other extreme, Potter (1998: www.journalism.org) says the problem is not so much that journalists *avoid* numbers; rather that too often they are "suckers for numbers".

> To them, a number looks solid, factual, more trustworthy than a fallible human source. And being numerically incompetent, they can't find the flaws in statistics and calculations. They can't tell the difference between a meaningless number and a significant one. The result is stories that are misleading and confusing at best, and at worst flat out wrong.

Booyens (1998:4) also accuses journalists of seeming "almost keen" to take any figure at face value, because it either provides them with a handy "hook" for a story, or because they don't have the confidence to ask probing questions about it.

Another area of concern is journalists' insufficient knowledge of statistics, and according to former science writer and editor of the *Washington Post* and author of *News & Numbers*, Victor Cohn (1989:back cover) writes that journalists often report poorly because they fail to understand statistics, or to take them into account, or because they "get bamboozled by phoney or unreliable numbers".

Booyens's (1998:4) teaching experience has revealed that many journalists and journalism students have "no grasp" of even the most basic statistical concepts, something that is often the source of misunderstanding between scientists and journalists. "A scientist describing a finding as *significant* refers to its statistical significance; a journalist will think the result is significant for the population out there."

His and others' opinion about the need for statistics is shared by Sharon Friedman (2000:2), professor at the science and environmental writing program of the Department of Journalism and Communication at Lehigh University, Bethlehem, Pennsylvania:

> Many journalists have problems with interpreting the statistics. They also don't understand all of the statistical tests presented and whether they were appropriately applied.

Although a staple of all the media, studies and surveys are also the most misunderstood sources of news. Jim Hartz and Rick Chappell's 1997 study revealed that:

> Few [journalists] understand the scientific method, the dictates of peer review, the reasons for the caveats and linguistic precision scientists employ when speaking of their work.

In addition, "public pressure and hasty journalism often launch a treatment that is unproved, particularly when the demand is great and the statistical background hazy" (Huff, 1991: 41), and it is because journalists don't ask enough questions, Cohn (1989:5-6) writes, that they often report as truths studies that suggest only evidence that something might be the case and often omit essential perspective, context or background.

4.2 Why numeracy?

[We] all require sound information to make choices in potentially life-threatening situations.

- Michael Kahn (2000:19)

The populace needs as much information as possible to act wisely and intelligently, whether it is about high technology or garbage collection.

- Jim Hartz and Rick Chappell (1997:117)

Reasons for mastering numerical skills and statistics are many and varied, with most tying in closely with journalists' duty to inform. In fact, writes Michael Weigold (1998:www.science.nasa.gov/scicomm) in the review of science communications literature that he did for *Research/Roadmap for the Communication of Science and Technology in the*

21st Century: "effective [science] reporting fulfills the media's *obligation* to provide knowledge of fast-breaking events, poorly understood natural phenomena and exciting developments from the world of science"; while Paulos (1996:3) believes it is the responsibility of newspapers to "knowledgeably reflect … the increasing mathematical complexity of our society in its many quantitative, probabilistic and dynamic facets".

In her book, *Selling Science: How the press covers science and technolog*, New York University Professor of Law Dorothy Nelkin (1995:2) adds another dimension to journalists' responsibility to inform:

> For most people, the reality of science is what they read in the press. They understand science less through direct experience or past education than through the filter of journalistic language and imagery. The media are their only contact with what is going on in rapidly changing scientific and technical fields, as well as a major source of information about the implications of these changes for their lives.

Numbers convey information. They have authority (Hough, 1995:366) and journalists are the messengers, the interpreters. They need to inform and educate. What they write often forms the foundation on which readers build their decision-making. By using numbers correctly, their reporting can be more specific; their stories can take on new dimensions. Numerate journalists can help their readers to judge scientific studies and surveys, and through their correct use of risk numbers, can help their readers to assess the personal risk.

Hough (1995:366) believes "the use of numbers enables a news writer to be specific, to give details and convey information in a precise form and to be absolutely clear in meaning".

In *A mathematician reads the newspaper*, Paulos does lambaste journalists for their careless use of numbers; but also gives reasons for the importance of numeracy. Paulos (1996:4) writes that 'number stories' "complement, deepen and regularly undermine … 'people stories'":

> Probability considerations can enhance articles on crime, health risks, or racial and ethnic bias. Logic and self-reference may help to clarify the hazards of celebrity, media spin control, and reportorial involvement in the news…

Although numbers can help the public to put news or events in perspective, Paulos (1996:38) notices that news stories are often bereft of the numbers that would enable a reader to put them in perspective, and cites the example of the oft-quoted statistic that 600 million African-American deaths are attributable to slavery that frequently goes unchallenged, because few people connects it to the fact that only between eight and 15 million slaves were brought to the New World (Paulos, 1996:39).

Paulos's (1996:138) experience has also taught him that it is difficult to evaluate risk without numbers:

> Failure to put statistics, even accurate ones, into context makes it almost impossible to evaluate personal risk with a clear eye.

Lehigh University, Pennsylvania's Prof Sharon Friedman (1996: www.fplc.edu/Risk), fully agrees:

> Environmental controversies are full of numbers that often confuse the media and the public. Particularly in complex risk issues involving such concerns as Alar[1], dioxin[2], radioactive wastes or air or water pollution, conveying numbers to and interpreting numbers for the public is important so that people can better understand the controversy and how it affects them. Risk numbers and effective explanations of them help show the public how a controversy is shaped by science, economics and politics

Lastly, says Paulos (1998:14), numbers – specifically statistics – lend credibility to stories:

> Although many stories need no numbers, some accounts without supporting statistics run the risk of being dismissed as anecdotal. Conversely, while some figures are almost self-explanatory, statistics without any context always run the risk of being arid, irrelevant, even meaningless.

Numeracy can help journalists to be more effective and to keep up with the demands of their profession and the times, as Deborah Potter (1997:www.journalism.org/Poynterrpt.htm) of Poynter believes:

> Journalists with numerical competence are more important than ever in today's highly technical world. They are the writers and editors who can assess and explain scientific, medical, technological and economic developments. They are the journalists who can find stories in databases by crunching numbers themselves, instead of waiting for someone with a vested interest to do it for them...

Potter (1997:www.journalism.org) minces no words when she describes the fate awaiting journalists who lack these skills:

> Journalists who fail to master math are missing one of the key building blocks of excellence. They lack a basic skill needed to decipher much of the information in the world around them, such as crime statistics, pollution standards, real estate taxes, and unemployment figures.

[1] A growth-regulating chemical sprayed on apples

Writing about numerical competence for a report of the Committee of Concerned Journalists, the Poynter Institute's Deborah Potter (www.poynter.org/research) suggests that:

> Competent journalists are both capable and careful with numbers. They're quick to spot an implausible number, and they have a basic working knowledge of arithmetic and statistics so they can confirm their suspicions. They know how to calculate percentages, ratios, rates of change and other relationships between numbers that tell far better stories than raw data can. They can translate numbers into terms that readers and viewers can understand.

In Paulos's (1996:81,82) "ideal world" reporters would have the "rudimentary numeracy to be able to translate from rates to absolute numbers and back, or to convert from one unit to another (from length to volume, for example) or to use percentages with accuracy and clarity". To that Booyens (1999:22) adds the ability to handle very large and very small numbers, as well as times and distances.

The real world is one still divided between those countries that use the metric system and those that have not converted to it, and journalists need to be extremely careful when using numbers found in literature from the latter. On the topic of conversions, Booyens (1999:21) and Jim Detjen (Blum and Knudson:177) also suggest that journalists find ways to make the complex understandable, i.e. to convert or translate difficult concepts to terms their readers can understand or relate to.

Brink (1999) wrote "employees can reasonably expect ... to read and understand reports containing tables, data, graphs and statistics; to be able to deal with ratios and percentages; to comprehend financial concepts such as compound interest, mortgages, inflation and annuities".

Most of the sources make a strong case for journalists to learn to evaluate studies, surveys and polls: to ask the right questions to distinguish between solid and incomplete research findings. Booyens (1998:4) calls for "greater methodological sophistication" among journalists so that they can better evaluate studies and surveys. Hough (1995:377) believes it is "necessary ... that today's journalists understand the nature of objective, scientifically devised polls and surveys and how they differ from a casual inquiry of a few people – the man-in-the-street story."

As Cohn (1989:4) states, it is the duty of reporters "not merely to repeat such numbers ... also to interpret them to deliver the best picture of reality". Instead of blindly accepting the findings of studies and reporting them, journalists should learn to ask questions to help them read a scientific report or listen to the conflicting claims of politicians, environmentalists, physicians, scientists … and weigh and explain them (Cohn, 1989:v).

Numeracy also requires "logic, data analysis and probability … that enables individuals to analyse evidence, to read graphs, to understand logical arguments, to detect logical fallacies, to understand evidence, and to evaluate risks", Gina Kolata (Steen, 1997:www.collegeboard.org) wrote in *Why numbers count. Quantitative Literacy for Tomorrow's America.*

No one can evaluate a study or survey properly without knowledge of basic statistical concepts, says Cohn (1989:back cover):

> We can do better by learning some basic principles – the laws of uncertainty, probability and chance, power and numbers, variability and bias – in order to learn the probable truth of the things we are told, to weigh and to question claims, to read and to judge the contentions of scientists, doctors, environmentalists, politicians and economists ... how to understand and analyse and explain and do a better job of telling our audiences the truth, given reporting's tight constraints.

Potter (1998:www.poynter.org/research) believes competent journalists also "know the difference between the median and the mean. … They always check the margin of error before deciding if a poll is worth reporting, and always explain what that margin means in the stories they write".

There is another dimension to numeracy, one that is more difficult to define than rates and percentages, but a skill without which journalists will never overcome innumeracy. Common sense and informal logic, Paulos (1998:13-14) believes, are "preconditions for numeracy".

Numeracy as a real life skill demands a sense and an awareness of the world we live in; in that sense numeracy becomes a "tool for baloney detection" (Sagan, 1997:189-206) and represents the common sense to do a "reality check" on the numbers that are used (Brink, 1999). It means that journalists would also have:

> ... the basic factual knowledge and the appropriate definitions essential to making reasonable estimates: the population of the metropolitan region, the United States and the world; certain geographical distances and socio-economic measures; some feel for common magnitudes, business figures of significance and so on (Paulos, 1996:81-82).

In conclusion, journalists need to learn to stand back from their work and take Dewdney's (1993:121) advice to heart:

Reporters face two pressures when they prepare a story for publication. It must be short and it must be exciting. The first pressure may cause them to omit crucial data from their report, leaving the remaining numbers to carry a burden they will not support. The second pressure causes them to make too much of the numbers they have. In either case, we do not expect reporters to be mathematical geniuses. But we do expect them to sidestep their mind-numbing fear of mathematics long enough to ask, "Does this make sense? What would I conclude from this numbers?

5. *Percentages*

When [Thoko] Didiza took office last year, she pledged that 15 million hectares of farmland, about 30% of agricultural land, would be transferred to black South Africans within five years. But, as she told Agriculture South Africa earlier this month, only 0,81% of farmland has been redistributed under the government's land reform programme.

- Barry Streek (2000:16)

In contrast South Africa is estimated to produce 74% of the world's platinum this year, and production is likely to rise by about 7% a year for the next three years. Over the past five years the growth in South Africa's platinum group exports has risen by 39% a year.

- Belinda Beresford (2000:6)

It is often easier to understand the relationship between numbers when one is expressed as a percentage of the other. Although they use this aid on a regular basis – and employ percentage changes to illustrate changes in values over time (as illustrated above) – the inability to calculate percentage changes correctly and use percentages in a meaningful manner seems to be a major chink in the armour of many a journalist.

In fact, this inability is of grave concern for *Detroit Free Press* business writer Doron Levin (1998:www.journalism.org). At a conference in Florida, USA, where numeracy was identified as one of the ten key competencies for journalists Levin said he'd bet his paycheck against that of anybody present if they could "go to any newsroom and get more than 50 percent of the editors and reporters who could figure out a simple percentage increase". Besides being unable to calculate percentages Booyens (1999:20) finds that journalists often use percentages in a way that does not make sense or add to their readers' understanding.

Huff (1991:100-105), Hough (1995:383), Paulos (1988:122) and Booyens (1999:20-21) have all written about the most common mistakes involving percentages, i.e. confusion between percentage and percentage point; missing raw figures; miscalculations involving percentage decreases and prices and levels rising and falling in succession; not stating percentages in terms that readers can understand and the reporting of 'pro' and 'anti' percentages. These mistakes will be dealt with in this chapter. Ways to present percentages in a more understandable way will also be discussed.

Confusion between percentage and percentage point

A "fertile field for being fooled" lies in the confusion between percentage and percentage points, Huff (1991:104) writes in *How to lie with statistics*, while Booyens (1999:20) finds that journalists often treat the words as synonyms, writing that an increase from 30% to 33% is a 3%-increase, while it represents an increase of three percentage points.

This confusion is rife. Not even the national Minister of Education, Prof Kader Asmal[3] (2000:18) – or his speechwriter – seems to be immune to it. In his comment on the 2000 matric results, Asmal writes in the *Cape Argus* of 30 December:

> A year ago I set a challenge for our educators and learners: let us raise the pass rate from 48,9% by five percentage points ... It is a pleasure to note that the examination pass rate has increased by more than the 5%, and has reached 57,9%. This represents an increase of 9%.

Journalists would do better learning from the recently appointed editor of the *Mail & Guardian*, Howard Barrell (2000:3), in his report on the findings of a public opininon poll about President Thabo Mbeki's standing among South Africans. Barrell writes:

> A poll by Research Surveys Omnicheck in metropolitan areas in August found that 46% of black women said Mbeki was "doing a good job" – a decline of 10 percentage points from the 56% measured in July, and a fall of 23 percentage points from the 69% measured as recently as February 2000.

Missing raw figures

A percentage on its own seldom gives enough information, e.g. a 100% increase in foot and mouth cases can mean that last year one cow contracted the disease and this year two. This exerpt from Belinda Beresford's (2000:6) report about platinum in the *Mail & Guardian* illustrate both the ubiquity of percentage use and how meaningless a percentage without raw figures can be:

> In contrast South Africa is estimated to produce 74% of the world's platinum this year, and production is likely to rise by about 7% a year for the next three years. Over the past five years the growth in South Africa's platinum group exports has risen by 39% a year.

[3] It is necessary – and interesting – to note that the Johannesburg daily *Beeld* published Asmal's article on the same day, but with the correct use of percentages and percentage points. Whether Asmal's original copy was correct and the *Cape Argus* wrong or Asmal's copy contained errors that the sub editors at *Beeld* picked up, it does not bode well for numeracy in South Africa.

Nowhere does she give an indication of the total world platinum production, so for all we know, South Africa's share of the market might be 22 kg or 22 million tonnes.

Also, when anyone claims that his product or invention would save the consumer 65% on energy or fuel, Dewdney (1993:3) suggests the first question should be "savings compared to what"? This mistake is a favourite ploy of those with something to promote, such as the manufacturers of Flora pro.activ, a low fat spread "which actually lowers cholestrol". In their advertisement (*Fairlady*, 2000:125) a woman says: "I was totally blown away. My bad cholesterol dropped by 18%". An 18% reduction in cholesterol compared to a diet consisting of peanut butter, fatty mutton and litres of full cream milk, or what?

Hough (1995:383) writes:

> There has to be something solid behind the percentage. Unless percentages are tied directly to some concrete figure, they may be misleading. Always relate percentages to the numbers they represent.

Disregard of raw numbers seems to mar the quality of reporting in publications ranging from *Die Burger* to *The Economist.* In December a reporter at *Die Burger* (Louw, 2000:7) must have put visitors to Cape Town thinking about the high prices they were paying for crayfish when he reported that since 1996 crayfish numbers have increased by about 600%. Unfortunately, he did not supply any numbers that readers could use to assess the significance of this "mysterious crayfish population boom".

In another case Kate Mallinson (1999:122) writes in a supplement of *The Economist* that, "The statisticians are not too upbeat about Britain either, where there will be some 6 000 new cases of TB in 1999. There has been a 100% increase in reported cases in London alone during the past decade."

Tuberculosis is a fatal, yet curable disease. For Mallinson's claim to have any impact she should have included a base number; i.e. the number of people with the disease at the beginning of the decade. Other obvious questions that spring to mind are: What proportion of the 6 000 British cases occur in London? Is there really cause for concern, given the fact that it might be a small portion of the 7 million people living in London and the fact that the disease is curable? It would also have improved readers' understanding if the 6 000 cases were put into the context of the whole UK population of about 59,5 million people; in other words, in 1999 1 in 10 000 people living in Britain had TB.

Both the reports discussed above would have been far more meaningful had their authors included raw numbers, i.e. mentioned that the crayfish population had increased from 6 000 to 42 000 – a 600% increase – and that there had been a 100% increase in TB cases in London, from 200 to 400.

Something else that journalists should bear in mind is that any percentage figure based on a small number of cases is likely to be misleading. According to Cohn (1989:24) a report on a new treatment for a poultry disease reportedly announced that "33,3% were cured, 33,3% died, and the other one got away". In order to avoid such ludicrous and misleading statistics, it is better practice to give the figures.

Miscalculations involving percentage decreases

Journalists often get it wrong when they calculate percentage decreases. Something can't decrease by more than 100 percent, because that would mean there was less than nothing left. If journalists were required to remember just one equation it should be the one for calculating percentage changes. This formula is the same, whether you're dealing with prices, the stock market or the water levels of dams:

$$\frac{\text{New value - old value}}{\text{Old value}} \times \frac{100}{1}$$

Both Huff (1991:101) and Dewdney (1993:4) believe that journalists would make fewer mistakes if they'd just think about the meaning of what they've written. Huff (1991:101) uses the following examples to explain what some percentage changes used by journalists actually mean:

> When the president of a flower growers' association said ... flowers are 100% cheaper than four months ago, he did not mean florists were now giving them away...
> In her History of the Standard Oil Company, Ida M Tarbell went even further. She said that price cutting in the southwest ... ranged from 14 tot 220%. That would call for seller paying buyer a considerable sum to haul the oily stuff away.

In his book *200% of Nothing* Dewdney (1993:4) does not take the percentages that light bulb manufacturers offer in advertisements at face value either, when they claim that by installing some metal halide bulb consumers can save an amazing "200 percent on energy". He explains:

> To save a mere 100 percent on energy, after all, means to save all of it. A light bulb that saved 100 percent on energy would burn brightly without absorbing the slightest amount of power, a physical impossibility. Were the metal halide bulb to save 200 percent on energy, not only would it consume no energy, but it would actually produce an excess of 100 percent of energy!

So when Andrew Worsdale (2000:4) wrote in the *Mail & Guardian* about a company that announced the sale of some of its non-core assets after it reported a 135% fall in headline earnings, he either made a calculation error or wanted to write that the company made a huge loss. In effect, the reported fall in earnings might mean that shareholders will have to pay the company.

Prices and levels rising and falling in succession

Although percentage changes are useful to help people understand changes in a value over time (Niles, 1997:www.robertniles.com) journalists frequently make mistakes when they write about percentage changes in prices or dam levels when they rise and fall successively, because of what Huff (1991:100) calls a "confusion of base". He points out that one often sees advertisements urging shoppers to "buy your Christmas presents now and save 100%".

> This sounds like an offer worthy of old Santa himself, but it turns out to be merely a confusion of base. The reduction is only fifty percent. The saving is one hundred percent of the reduced or new price.

In *Innumeracy* Paulos (1988:122) explains it as follows:

> Despite a good deal of opinion to the contrary, an item whose price has been increased by 50% and then reduced by 50% has had a net reduction in price of 25%. A dress whose price has been 'slashed' 40% and then another 40% has been reduced in price by 64%, not 80%.

While the latter phrasing is less misleading, Paulos (1988:122) writes it is also less impressive, which explains why it isn't used.

Stating percentages in terms that readers can understand

Although a percentage is often a good way to express the relationship between numbers, some percentages do not make sense unless they are "translated" into terms that readers will understand better.

In *News & Numbers* Cohn (1989:95) supplies the following example:

> Certainly ... reporters should remember to convert some barren cancer rates or percentages into numbers. If "only" 5% of all new cancer cases are related to industrial exposure, this still becomes what has been called a major public health problem resulting in 20 000 excess cancer deaths each year.

In a report about the extent of world poverty the *Cape Argus* (2000:8) reports that the world population is 6,055 billion and growing at an annual rate of 1,3%:

> This translates into an addition of 76 million people, the number of inhabitants of Vietnam or the Philippines. It also means a net increase of 145 people per minute...

Journalists could improve their numbers sense by doing similar conversions to improve their own understanding; because they often state that something affects "only 1%" of the world population, forgetting that this translates into 60 million people – almost the whole population of the United Kingdom.

Reporting 'pro' and 'anti' percentages

In addition to their value as a widely understood method of expressing the relationship between numbers, percentages have also become a tool to be manipulated by opposing groups. This fact is well illustrated by Cohn (1997:108) in *A Field Guide for Science Writers*:

> During a 1990 debate over the Clean Air Act, one issue was whether or not to require automakers to remove 98 percent of tailpipe emissions, compared with a previous 96 percent. The auto industry called it an expensive and meaningless 2-percent improvement. Environmentalists said it would result in a 50-percent decrease in automobile pollution.

Cohn advises journalists to seek all the figures, not just the assertions someone tries to spoon-feed them.

5.1 Conclusion

Despite being a common feature of news writing, the use of percentages is a source of misleading reporting – even if most of it is unintentional. Many journalists cannot calculate percentages and percentage changes, a problem that leads to wrong interpretations, and the inability to grasp the meaning of what they've written. Journalists often do not regard percentages with sufficient criticism and frequently fail to provide the raw numbers that would add context to their figures.

6. *Large and small, near and far*

For all their superior qualities human beings are rather deficient in some areas, as zoologist Richard Dawkins (1991:2) remarks in *The Blind Watchmaker:*

> Our brains were designed to understand hunting and gathering, mating and child-rearing: a world of medium-sized objects moving in three dimensions at moderate speeds. We are ill-equipped to comprehend the very small and the very large; things whose duration is measured in picoseconds or giga-years; particles that don't have position; forces and fields that we cannot see or touch, which we know of only because they affect things that we can see or touch.

Just because an understanding of "the very small and the very large" doesn't come easy, it does not mean we can ignore them. Sometimes these numbers and objects *are* the news, but because they are so large, so unrelated to the experience of the average person, they can mean little or nothing to the users of news media. As Hough (1995:384) writes:

> Figures like the size of the national debt, the chance that there is life somewhere else in the universe, the distance to the nearest galaxy – large numbers not directly related to everyday experience – are unreal.

Therein lies a challenge for journalists: to explain these infinite times, distances and quantities in a language that the ordinary reader can understand, and to quantify their effect. It is equally difficult to understand the goings-on in the world of the minuscule, the infinitesimal; therefore journalists should be able to put a number and explanation to the risk that lurks at the microscopic level of our genes; or the danger in the air we breathe. Journalists need to understand these very large and small numbers themselves before they would be able to explain them to their readers or listeners.

Unfortunately, there seems to be no shortcut to arriving at an appreciation for large and small numbers. According to British molecular biologist and Nobel Prize winner Francis Crick (Comley et al, 1984:392) it is a long and difficult process:

> By themselves, large numbers mean very little to us. There is only one way to overcome this handicap, so natural to our human condition. We must calculate and recalculate, even though only approximately, to check and recheck our initial impressions until slowly, with time and constant application, the real world, the world of the immensely small and the immensely great, becomes as familiar to us as the simple cradle of our common earthly experience.

6.1 Large numbers

Without some appreciation of common large numbers, Paulos (1988:2) says it is "impossible to react with the proper scepticism to terrifying reports that more than a million American kids are kidnapped each year, or with the proper sobriety to a warhead carrying a megaton of explosive power – the equivalent of a million tons of TNT".

It might help if journalists were familiar with some of the big numbers of our planet, for example the world population has passed the six billion[4] mark, the South African population is about 40 million, and that of China – the country often cited by business people and journalists as an "untapped market" – about 1,2 billion. Other big numbers are *Los Angeles Times* columnist KC Cole's (1996) observations that:

> ...the American budget is over a trillion dollars; the Milky Way galaxy contains 200 billion stars; chemical reactions take place in femtoseconds (quadrillionths of a second); life has evolved over a period of 4 billion years.

Before using trillions and billions to describe budgets and distances, journalists should know that "compared to a trillion, a billion is peanuts ... that's because a trillion is a thousand times a billion" (Cole, 1996); or that the power of large numbers is often illustrated by a line drawn with a mark showing zero at one end and another marking a trillion at the other. A billion falls very near the line that marks zero (Dewdney, 1993:14).

In an essay 'Times and distances, large and small' Crick (Comsley et al, 1984:386-393) offers various analogies that could help to make the astronomical enormity of the universe comprehensible to journalists and their audiences. He quotes astronomers Robert Jastrow and Malcolm Thompson (Comsley et al, 1984:389):

> Let the sun be the size of an orange; on that scale the earth is a grain of sand circling in orbit around the sun at a distance of thirty feet; Jupiter, eleven times larger than the earth, is a cherry pit revolving at a distance of 200 feet or one city block from the sun. The galaxy on this scale is 100 billion oranges, each orange separated from its neighbours by an average distance of 1 000 miles.

Yet, analogies like Jastrow and Thompson's will only be effective in feature articles where space or time is not at such a premium as in the hard news sections of newspapers or news

[4] A billion as used here, is 1 000 000 000; and a trillion is 1 000 000 000 000. In South Africa 1 000 000 000 is called a milliard.

broadcasts on the radio or television, and journalists will have to think of other ways to explain these very large numbers.

They can learn a great deal from the writings of other experienced journalists and scientists and how they deal with enormous entities. Some of the best-known "interpretations" of large numbers are on the cosmic level. When Freeman Dyson (2000:35), author and physicist best known for his speculative work on the possibility of extraterrestrial civilisations, writes in *Time* magazine's *Visions 21* Science and Space supplement that the difference between travelling to the nearest star and travelling around our own solar system is about the same as the difference between swimming across the Atlantic and swimming across the Potomac, his readers immediately get the picture. In the same feature he put a vast distance in perspective by expressing it in terms of the time it would take to cover:

> To scoot around the solar system and return within a few years, you need a spacecraft that will cruise at 160 km a second. At that speed you will get to Mars in ten days, to Pluto in 16 months ... A trip to the stars within a human lifetime requires a spacecraft that cruises at more than 16 000 km a second and accelerates to this speed within ten years.

Joel Achenbach (2000:26) offers a similar comparison in *National Geographic:*

> Our solar system's closest neighbor, Proxima Centauri, is 25 trillion miles away, a trip light makes in 4,2 years; Voyager would take 70 000 years.

Back on earth and writing for the *Cape Times*, Dale Granger (1999:5) explains the enormity of an Indian military transporter in terms of a distance most South Africans know very well:

> In just 20 minutes, soaring to cruising altitude, the IL 76 military transporter will burn enough fuel to power the average car to Johannesburg and back 25 times. And once she's completed a long-range flight, she'll have used enough fuel to take you to Gauteng and back 225 times.

In his feature for the *Observer Sport Magazine* Tim Adams (2000:55) employs an everyday example when explaining the kind of pressure on freediver Trevor Hutton's lungs as he descends into the ocean at Limassol, Cyprus, for an attempt at the world freediving record:

> The current record stands at 72 metres, and the weight of water at that depth is easily enough to crush, say, a Coke can or the average lung.

Another way to portray large numbers is to describe their effect on our lives or the environment. For about 24 hours after the discovery of asteroid 1997 FX11 by astronomer Jim Scotti in December 1997 some astronomers believed that it would hit the earth. In his report for *Time* Leon Jaroff (1999:77) did not stop at telling his readers that an asteroid the size of XF11 colliding with earth at more than 60 000 km/h would explode with the energy of

300 000 megatons, or nearly 20 million times the force of the bomb that levelled Hiroshima. He also described in detail the disastrous consequences of such a collision.

> If it hit the ocean ... it would cause a tsunami (commonly called a tidal wave) hundreds of metres high, flooding the coastlines of surrounding continents. Where cities stood, there would be only mudflats. A land hit ... would blast out a crater of at least 50 km across and throw up a blanket of dust and vapour that would blot out the sun for weeks, if not months.

6.2 Small numbers

Understanding the big numbers is only half the battle, because Dewdney (1993:14) believes we are "equally numb to small numbers, like millionths and billionths".

According to Dewdney (1993:14) John Sununu, former White House chief of staff in the Bush administration, and supposedly known for his critical attitudes on the subject of innumeracy in Congress, once said that policy makers "all too often" do not have an intuitive sense of the difference between a million and a billion, and quoted Sununu as saying "It is not a trivial change of one letter to write a regulation in terms of parts per billion instead of parts per million."

It helps if journalists assist readers in comparing small numbers such as one part per million to everyday things. In this regard journalists can learn from Jim Detjen (Blum&Knudson:177), Knight Fellow in Environmental Journalism at Michigan State University:

> One part per million is about one minute in about two years. One part per billion is one second in 32 years. One part per trillion is one second in 32 000 years ... One part per trillion is one grain of salt in an Olympic-size swimming pool.

For more help with understanding very small objects and numbers, and in order to get a grip on the futuristic microscopic world of nanotechnologists (engineers and chemists working at the level of a billionth of a metre, or a millionth of a millimetre), it would be worth any journalist's while to read 'Small is beautiful', an article by *The Guardian*'s Tim Radford (1999:www.mg.co.za). Radford writes about railways the size of a human hair and submarines that navigate arteries, and quotes a Japanese nanotechnologist about the efficiency of adenosine triphosphate molecules, the sub-microscopic "engines" that power human body cells:

> If the motor was as big as a person ... it would be able to spin a telephone pole about two kilometres long at about one revolution per second.

Any analogy or comparison must make sense, though. Sometimes journalists try too hard to make a concept understandable and end up offering their readers meaningless comparisons like "the world produces 250 million megabytes of data for every person on earth – enough data to fill computer floppy disks stacked to the moon eight times" (2000:News24.co.za).

6.3 Conclusion

Cambridge biologist and author Richard Dawkins (1991:2) writes that human beings are ill-equipped to comprehend "the very small and very large; things whose duration is measured in picoseconds or giga-years".

Because these numbers and quantities are so unrelated to the experience of the average person, they mean little or nothing to readers if they are left unexplained. This limitation also makes it difficult to react with sufficient awe or scepticism to very large or small numbers being offered in newspaper and broadcast reports. As it is the obligation of journalists to inform their readers, viewers or listeners, an appreciation of very large and very small numbers and the ability to interpret them for their readers should be a part of every journalist's numeracy kit.

However, there is no shortcut to attaining this skill. It calls for a working knowledge of the common magnitudes of our world – the size of the budget, the age of the earth, the distance to the nearest star or the sun, the size of a nanometre. Francis Crick's (Comley et al, 1984:392) advice to journalists is to "calculate and recalculate ... to check and recheck" their initial impressions, until slowly, with time and constant application, the real world, the world of the immensely small and the immensely great, becomes as familiar as their earthly experience.

7. Conversions

The problem here was not the error, it was the failure of NASA's systems engineering, and the checks and balances in our processes to detect the error. That's why we lost the spacecraft. The peer review preliminary findings indicate that one team used English units (e.g., inches, feet and pounds) while the other used metric units for a key spacecraft operation. This information was critical to the maneuvers required to place the spacecraft in the proper Mars orbit.

- Douglas Isbell, Mary Hardin and Joan Underwood (1999:mars.jpl.nasa.gov)

The Americans have massively expensive Mars orbiters which crash because someone forgets to convert newtons into foot-pounds per square inch.

- Pam Sykes (2000:8)

While disaster never strikes on such a grand scale and not even a computer crashes when journalists forget to convert from one unit of measure to another, their failure to do so amounts to careless and inaccurate reporting.

South Africa converted to the metric system in the 1960s, but some American states and Britain still use the imperial system. This duality makes the ability to do simple conversions between the metric and imperial systems crucial for journalists.

Journalists who use information from countries that have not converted to the metric system should be able to convert feet and yards, miles, gallons, pounds, degrees Fahrenheit and acres to the metric system's metres, kilometres, litres, kilogrammes, degrees Celsius and hectares. In this regard *The Economist's How to measure, convert, calculate and define practically anything*, published by John Wiley & Sons, is an invaluable guide.

Booyens (1999:22) writes that they should be especially careful not to accept that the "degrees" used in American literature is degrees Celsius; or that "tonnes" refers to metric tonnes.

Another common conversion error by journalists (Booyens, 1999:22) is to think because five miles is equal to eight kilometres, five square miles should be equal to eight square kilometres. Through multiplication and the addition of another dimension, the magnitude in kilometres becomes more than double the number in miles.

Examples of the conversions most journalists will have to deal with on a regular basis are given at the end of the chapter.

Of further concern to Booyens (1999:22) is that sub editors often fail to notice these conversion errors because they don't have the original numbers in front of them. Such errors often end up uncorrected in the electronic libraries of newspapers, from where they are perpetuated in follow-up stories.

Few people are able to visualise the size of a hectare – or 20 000 hectares for that matter. Booyens (2000:10) suggests that, when reporting fire damage, measures of area would make more sense if they were converted to more understandable units. In *Sanlamgram* (2000:10) he writes:

> Just how big is the 40 000 hectares that burnt down? 400 square kilometres gives the reader a much clearer picture. Better yet, call it 20km by 20km if these were the proportions.

Even though South Africa uses the metric system, some nautical units of measure are still in use. Because the majority of South Africans have grown up and still live inland, they may not be familiar with terms like "knots" and "nautical miles".

When seafaring folk or naval officials report that a sardine trawler sank "two nautical miles" off the coast, it is the journalist's duty to explain to landlubbers that the ship went down 3,7 km from the coast. Likewise, when the *Mail & Guardian*'s John Sweeney (2000:19) wrote about a new wave of pirates plundering the world's cargo lanes "using speed boats capable of 30 knots to overtake ships going half as fast", the least he could have done was to slip in that these boats can travel at speeds of about 55 km per hour.

7.1 Conclusion

In a world where different units can be and are used to measure the same thing, it is important that journalists convert the numbers in their stories to the ones their readers or listeners understand best.

South Africa converted to the metric system about thirty years ago, but we are still exposed to the imperial system through literature from countries that have not made the switch. Journalists often neglect to convert numbers from the imperial system, and base conclusions on wrong numbers. Not only should journalists be able to convert imperial units of measure to metric units, they should also be able to convert difficult numerical concepts to terms that their readers, listeners or viewers can understand.

There are a number of conversions journalists should be familiar with. They are given in the table below.

Table 1. General conversions

Miles to kilometres: 1 kilometre = 5/8 mile

Kilometres to miles: 1 mile = 8/5 kilometre

Inch to centimetre = 1 inch is 5/2 centimetres

1 hectare = 10 000 square metres; or 100 metres by 100 metres

100 hectares = 1 square kilometre

1 square mile = 640 acres = 258,999 hectares

1 acre = 0,405 hectare

8 square kilometres = 3 square miles (rough)

1 nautical mile (n mile) = 1 852 metres

1 international knot (kn) = 1 international nautical mile per hour

1 knot = 1,852 km per hour

Fahrenheit to Celsius: C = 5/9F - 32

Celsius to Fahrenheit: F = 9/5C + 32

The unit "degree Celsius" is equal to the unit "kelvin". The zero of the Celsius scale is the temperature of the ice point, which is 273,15 K (0.01 below the triple point of water); i.e., degrees Celsius (C) = K-273.15

1 US gallon = 3,75 litres

6 US gallons = 5 UK gallons

1 gallon = 3,785 litres

1 hectolitre = 100 litres

1 kilolitre = 1 000 litre = 1 cubic metre

a 42 gallon barrel is used for crude oil or petroleum products for statistical purposes

1 pound = 0,454 kilogram (rough)

1 kilogram = 2,2 pounds

1 stone = 14 pounds

1 metre per second (m/s) = 3,6 kilometres per hour (km/h)

1 kilometre per second = 3 600 kilometres per hour

The speed of light is defined as 2,997 924 58 x 10(8) m/s

The speed of sound (in air at sea level and at 0C) is defined as 331,5 metres per second.

Geological eras

Origin of the universe = estimated at 20 000 to 10 000 million years ago

Origin of the sun = 5 000 million years ago

Origin of the earth = 4 600 million years ago

Source: *The Economist Desk Companion: How to measure, convert calculate and define practically anything. John Wiley & Sons. 1998.*

8. Numbers, context and accuracy count

News writers are taught early in their careers to be accurate with names addresses and other everyday facts. Not enough news writers have been cautioned to be careful about the use of numbers. Too frequently news stories make authoritative-sounding statements and cite as evidence numbers carelessly gathered or loosely presented. Too often, these statements are misleading or inaccurate.

- George Hough (1995:378)

When the percentages have been calculated and put into context; times and distances – big and small – explained; and all the imperial units of measure converted to the metric units used here, journalists need to take a thorough look at the other numbers they've used, and contemplate those they've left out. Do the numbers in the story improve readers' understanding of the issue covered? Do they enhance or deepen the story, or do they mislead or confuse readers? Would their absence make any difference, or better still, improve the story?

In addition to errors involving percentages, big and small numbers and conversions, journalists often err by omitting numbers that their readers need to make sense of the report or for informed decision-making. Their figures sometimes don't add up, they often neglect or forget to put their numbers in context and they frequently report numbers that are far removed from reality.

This chapter deals with different forms of numerical misuse or meaningless use of numbers, those nagging "little" numerical errors that are all too common in news reports. They probably result from journalists' inadequate numerical skills and inaccuracy due to time constraints and poor sub-editing. Numbers count and so do context and accuracy. Journalists should pay attention to the following instances of number abuse for which the remedy is better and more accurate sub editing and an improved "math intuition" to tell when the numbers just don't add up.

Sub editing sense

Reporting in South African newspapers sometimes reveals errors that should have been spotted by numerate and vigilant sub editors. They include an obvious sub-editorial oversight in a report in *The Sowetan* (Bhungani, 2000:4) stating that:

> The Gauteng health department ... acknowledged that the long waiting list at certain hospitals for patients wishing to have an abortion done could have contributed to them seeking help elsewhere ... Ms Jo-Anne Collinge, spokeswoman for the department, said for women who were three months pregnant there were no problems as these were usually performed by trained midwives ... Collinge said the problem arose where the women were between 10 and 20 months pregnant...

An equally glaring mistake was published in the *Cape Argus* (2000:8):

> Alfonso Sandoval, the UN Population Fund representative in Mexico, said that as of mid-2000, the earth's population was 6 055 billion people and growing at an annual rate of 1,3%.

The only way that these types of mistakes can be eliminated is for journalists and their sub editors to pay more attention to the numbers in stories and make doubly sure that the numbers they use are true and make sense. It would also be worth their while to heed Hough's (1995:381) advice:

> Careful reporters and news writers should view numbers with caution. Add up columns of figures. Refigure percentages. Verify numbers wherever possible.

Give the numbers

Although numbers should never be used just because they seem to lend authority to the story, the opposite also holds true. For Cohn (Blum & Knudson:107) many news stories "simply fail to include some numbers that any of us would want for intelligent decision making".

His advice in *News & Numbers* (1989:144) is short and to the point:

> If the numbers are the story, give them.

At the end of each year South African journalists routinely write about the shortage of donor blood at blood banks. But a 1999 report in *Die Burger* (1999:8) is completely bereft of numbers, and does not answer questions like: How many units are needed? How many hospitals have run out of blood? How low are stocks?

A *Cape Times* (Gosling, 2000:1) report on levels of pollution at beaches and tidal pools on the Cape Peninsula's Atlantic coast teems with appeasing words such as "exceeding limits, but inside EU limits" and "better than those of Belgium, the UK, Finland and Sweden"; but fails to give the measured faecal pollution count, or inform readers whether it is safe to swim in water with that count.

Observational selection

Another way in which journalists often abuse numbers is what Carl Sagan (1997:201) calls "observational selection"; the enumeration of favourable circumstances, or as the philosopher Francis Bacon described it, "counting the hits and forgetting the misses".

A classic example of observational selection and unbalanced reporting was a front page story in *Die Burger* (Hoffman, 2000:1) reporting the R80 million won by people at slot machines during the first 18 days of the Caledon Casino's opening, but ignoring the money lost during that time and the hardship it could bring to the losers.

Reporting rates

Journalists often confuse rates with mere numbers, as Cohn (Blum and Knudson, 1997:108) explains:

> In the reporting of risk, there is wide lack of understanding of the difference between a plain number and a rate. A rate has to mean so many per so many per unit of time. A *Washington Post* headline once read, "Airline accident rate is highest in 13 years". The story, like many others misusing the word rate, reported no rate at all, merely death and crash totals.

The reporting of changes in population growth rates is often a fertile field for confusion of rates and numbers. The introduction of a January 2000 *Cape Times* (2000: *IOLonline.com*) report stating that "SA's population growth rate is expected to drop 71% in the next 10 years as a result of the AIDS epidemic, a survey released by the SA Institute of Race Relations revealed yesterday," was interpreted as follows by the numerically incompetent sub editor:

> AIDS will cut population by 71% over 10 years – study.

Exaggeration

This "common misuse of numbers" (Hough, page 378) is often found where journalists have to report conflicting estimates of numbers of people attending an event such as a protest march or a political rally. Especially locally – where these estimates have in the past sparked political disputes – a cautious reporter would balance figures from different sources and write that estimates of the size of a crowd ranged from this figure to that.

In *News Writing* Hough (1995:380) tells how the *Boston Globe* handled the problem of different estimates of the size of a crowd:

> After an anti-nuclear rally in front of the Capitol in Washington, D.C., newspaper readers were given varying estimates of the size of the crowd. Among the numbers cited were 60 000, 65 000, 70 000 and 100 000. The *Boston Globe* reported the source of various estimates: the organisers of the protest estimated the crowd at 125 000; the police estimated the crowd at 65 000; and reporters found a middle ground, 100 000. Again, perhaps none of these figures was accurate, but *Globe* readers were given some basis for understanding the impact of the rally.

Do a reality check

Both Brink (1999) and Booyens (2000) have complained that the students they teach, "rarely thought to do a simple reality check on the outcome of their calculations". Thus Brink found "incongruities such as one rand being worth thousands of dollars, a Boeing flying at 27 km/h and VAT on a new car being a few cents".

It is not only students who fail to do reality checks, much to the frustration of newspaper readers. In a story about a street cleaning plan for the Cape Town City Improvement District *Die Burger* (2000:3) reported that the street area concerned covered 186 000 km^2: an area far bigger than the whole of the Western Cape Province – or an imaginary square with Cape Town, Garies, Beaufort West and Knysna as its corners.

Discrepancies

Although innumeracy is also rife among newspaper readers, it does not take much more than common sense to spot most of the discrepancies and miscalculations often found in newspapers. Once again, Hough (1995:381) offers good advice:

> If you are reporting that at a city council meeting, the council voted 7 to 1 to approve a motion, you could be in trouble. Your readers know that there are nine members on the council. Seven votes for and one against add up to eight. Where was the ninth member of the council? Absent? Abstaining? You have to account for the ninth member.

It is possible that the blame for this should not be put squarely at the door of reporters, since it might be another sign of sloppy sub editing. Be that as it may, discrepancies like the one on *Die Burger*'s front page (Essop, 2000:1) where it was stated in one paragraph that 400 people died every year on railway tracks between Khayalitsha and Cape Town, while the next paragraph quoted a Metrorail representative as saying that 140 people died every year on railway tracks in the Cape metropolitan area, does not contribute to readers' understanding.

Reporting averages

An average is a good way to get a typical number, but it has limitations. Although journalists hardly ever have trouble calculating averages correctly, there is reason for concern about their presentation and interpretation of it.

Journalists often forget (or don't know) that most averages obscure huge extremes. Take for instance South Africa's "overall" population density of 33,1 people per square kilometre. What journalists often leave out, but Anton Harber and Barbara Ludman (1995:361) point out in *A-Z of South African Politics*, is that the country's population is very unevenly spread. It ranges from the vast, yet sparsely populated, plains of the Northern Cape province (2,1 people per square kilometre) to the highly industrialised Gauteng province with the smallest surface area and a population density of 354,9 people per square kilometre.

Booyens (1999:29) writes journalists "love the compactness of averages" and use them without breaking them down into the different groups that represent that average. Crime statistics are often presented in this way, resulting in stereotypes of Cape Town being the crime capital of South Africa and a woman getting raped every 26 seconds, as well as ludicrous inferences by politicians (*Mail & Guardian*, 2000:16) and pressure groups.

Incomprehensible numbers

Journalists like to write pollution stories, be it about a sewage spill into a river, or oil refineries spewing a cocktail of toxic chemicals into the atmosphere. But such stories often do not contain any numbers, and when they do, readers can't use them to estimate risk.

Unfortunately, this is an area where South African journalists frequently fail their readers. They just write that "very high concentrations of 16 very dangerous chemicals" were reported to pollute the air around Sasolburg (Kirk, 2000:5), or that "the levels of carbon disulfide in the Cape air were found to be seven times higher than in Sasolburg, where pollution levels were exceptionally high" (Kirk,2000:3). Although the chemicals are named and their effect on human health chronicled, the reports never mention at which levels these afflictions are caused.

When writing about the water quality of a popular Hermanus bathing spot, the Onrus lagoon, a reader and prospective bather can deduce nothing from the routine *Hermanus Times* (2000:3) report stating that "*E.coli* counts in the lagoon are as high as 2 400". Is this high? Will a swimmer suffer only mild diarrhoea, or will he die?

When writing about environmental risk, journalists should always heed the advice of Jim Detjen (Cohn, 1989:124):

> Don't forget people. Write about things in a way your readers can relate to. Don't say rain has a pH of 3; say it has become as acidic as vinegar. Don't just say so many parts per million of sulphur dioxide are going into the air; explain how these levels can trigger asthmatic attacks among the sick and elderly.

Penalties

Sentences passed by magistrates are often criticised by the public for their leniency, because "the newspaper said" the penalty for perlemoen poaching or false bomb scares is three years in prison or a R12 000 fine, and so-and-so got off with six months in prison or a R1 500 fine. It would be more accurate and fair to report not only the maximum penalty possible, but also the minimum.

Benchmark figures

Journalists should not only report the numbers; they should also help their readers to put them into perspective. In *A mathematician reads the newspaper* Paulos (1995:40) writes that most reports can benefit from the "occasional inclusion" of appropriate benchmark estimates:

> If the subject is the national economy, then mentioning the fact that the annual GNP is approximately $6 trillion serves to orient the reader. Knowing that the budget is about $1.5 trillion ... can be immeasurably helpful. Furthermore, these numbers should, if possible, be compared with quantities that are more viscerally appreciated.

A *Cape Times* (2000:2) report stating that "Moscow is half poor", because "more than one in two of the inhabitants live below the poverty line" helps readers by also reporting that the minimum subsistence level in Russia is 980 rubles ($34). Unfortunately it does not report how far above the the poverty line the other half lives.

At the height of the December 2000 holiday season the *Cape Argus* (Bamford, 2000:3) published a report about breathalyser tests on bathers to ensure that they were sober enough to ride the waves. The reporter wrote that a holidaymaker "looked alarmed" when the breathalyzer showed his blood alcohol content as 0,61 mg per 100 ml of blood, and immediately explained that the legal limit is 0,05 mg per 100ml.

Newspaper reports often state that about a third of the world's population lives in poverty. But how do they define poverty? The teacher who struggles to survive on R5 000 per month, paying rent of R2 000, a student loan of R1 000 and R700 on a car? The shack dweller with three children who works as a cleaner for R80 per week? The street child living off alms from passers-by?

In a December 2000 report about poverty *SakeBurger*'s Jaco Leuvennink (2000:S2) writes that the struggle against poverty sometimes seems to be a lost cause, and that the commitment of world leaders to cut by half world poverty and hunger by 2015 is a good idea, but one that is not practicable and viable. Before giving a motivation for his pessimism he explains that the measure for "absolute poverty" is having to survive on $1 or less per day.

Meaningless comparisons

"The comparison of unlike things," Hough (1995:382) writes, "leaves gaps in information that can confuse readers".

Comparing "unlike things", especially statistics, is according to Booyens (1999:30) a serious problem among South African journalists. He writes that statistics often "get a life of their own" after conclusions get separated from the underlying numbers.

During the 1980s it was the vogue among journalists to compare acid rain levels on South Africa's eastern Highveld with levels in the former East Germany. In effect, Booyens (1999:30) writes, acid rain in South Africa's most polluted region was compared to the average for the whole of East Germany. "It would have been more accurate to compare South Africa's most polluted region with a similar area in East Germany."

According to Booyens environment reporters make the same mistake when they compare the proportion of South Africa that is allocated to conservation areas with those of other countries, writing that conservation areas occupy "only 6%" of South African land, against 20% in Zaire or Angola.

> What journalists tend to forget is that the animal species found here, are well represented in South Africa's 6%. In addition, these numbers give no indication of the quality of management. As a matter of fact, most of the parks in Africa exist on paper only.

Minimising and maximising

Depending on what one wants to achieve when discussing diseases, accidents, or other misfortunes and their consequences, one can state some risks as a rate of incidence or the absolute number of incidences. Paulos (1996: 79) illustrates this point in *A mathematician reads the newspaper* writes:

> If one wishes to emphasise the severity of a problem one will usually talk about the number of people afflicted nationally. If one wants to downplay the problem, one will probably speak about the incidence rate. Hence if 1 out of 100 000 people suffers from some malady, there will be 25 000 cases nationwide. The latter figure seems more alarming and will be stressed by maximisers.

To clarify matters for their readers, journalists should give both numbers. Cohn (Blum & Knudson:108) warns:

> Watch risk numbers. To influence us, someone can choose an annual death total or deaths per thousand or million, or per thousand persons exposed, or deaths per ton of some substance, or per ton released in the air, or per facility. There are lots of choices to make something seem better or worse.

Radio records

Another way of presenting numbers in a way that sounds impressive, but is nothing extraordinary, is favoured by radio announcers, but also used by newspaper journalists, is what can be called record reporting. Or "firsters" as Darrell Huff (1991:119) calls them:

> Almost anybody can claim to be first in something if he is not too particular what it is. This is the kind of reaching for a superlative that leads the weather reporter on the radio to label a quite normal day 'the hottest since 1967'.

In their quest to emphasise the significance of an event or news item, radio announcers might say that last December's road accident rate was the highest in two years. Or, as was reported in the *Cape Times* (2000:5) on 29 December, under the headline 'Scots suffer coldest winter in five years': "Scotland is in the grip of its coldest winter for five years with lows of -14 degrees Celsius on Wednesday." In the same story a weather forecaster is reported to have said it was the first time there had been so much snow in the centre of London for four or five years. One of the more ludicrous examples of a radio record occurred in November 2000, when a newsreader went so far as to announce that the rand had reached its eighth lowest level against the dollar since the beginning of that month.

Extrapolations

To extrapolate is to reach a conclusion by speculating or guessing at the consequences of known facts, Hough (1995:382) writes in the section on misuse of numbers in *News Writing*. His conclusion is that extrapolating is "much like conducting a survey or a poll. It is educated guessing, and if the guessing is a little too free, the results may be highly inaccurate."

The findings of polls and studies often provide fertile bases from which extrapolations grow. For example, the results of studies with urban 15-year-olds as subjects are often used to draw conclusions about the whole population, and before taking the easy option of extrapolation; journalists should heed Hough's (1995:383) advice:

> Comparison of a heterogeneous adult population with a homogeneous non-adult population could lead to serious error. Be wary of such extrapolations.

South African journalists should be especially careful when reporting AIDS numbers – the majority of which are at best speculations – and almost without exception extrapolations. Because AIDS is still not a notifiable disease, and because of the fear of stigmatisation, it is difficult to get access to accurate numbers.

Reporting earthquakes

Another all too common error found in newspapers concerns the numbers used to describe the magnitude of earthquakes; the most familiar one being the Richter scale.

When the *Mail & Guardian* (2000:2) reported that "the earth moved ... in massive earthquakes at four sites: Ankara, Turkey, with a quake measuring 5,9 on the Richter scale, followed by 32 aftershocks; Kyushu in western Japan (4,9); northern Myanmar (6,5); and Bengkulu on Sumatra island, Indonesia, whose main quake registered 7,3, with an aftershock almost as strong, at 6,3," it erred in its interpretation of the scale used to measure the magnitude of earthquakes.

The New Oxford Dictionary of English's (Pearsall, 1998:1595) definition, in typical English fashion, understates the case somewhat, by stating the Richter scale as "a numerical scale for expressing the magnitude of an earthquake on the basis of seismograph oscillations. The more destructive earthquakes typically have magnitudes between about 5.5 and 8.9. It is a logarithmic scale and a difference of one represents an approximate thirtyfold difference in magnitude."

Dewdney's (1993:16) explanation is a better representation of reality:

> The force 7.1 quake that shook the San Francisco Bay area in 1989 was a midget compared to the quake that hit in 1906. Estimated to have greater than force 8, the latter had ten times the seismographic motion – which works out to 31 times the power.

8.1 Conclusion

As a group journalists take pride in their commitment to facts and accuracy. Unfortunately, the high standards applied to facts and names aren't always applied to numbers. A numerate reader's confidence in a publication will be undermined by consistent numerical discrepancies and errors, and journalists therefore have a duty to pay more attention to how they use numbers in reporting.

Some journalists seem to believe any number will do. Associate editor of *Reason* magazine, Brian Doherty, (*CATO Policy Report*, 1995:www.cato.org) writes in his article 'Counting the errors of modern journalism' – "newspapers do like to throw in a number now and then to add verisimilitude to the tales they tell".

In reporting, context counts, and Hough's (1995:378) advice to journalists is:

> To mean anything, numbers must be presented in the right form, they must be explained and they must be put into context. That is they must be placed in an understandable and accurate relationship with other things ... Numbers not properly explained or not in proper context not only fail to inform, they mislead.

9. Evaluating surveys and studies

Pretoria scientists claim AIDS breakthrough (*Mail & Guardian, 1*997:www.mg.co.za)
Locals love water campaign - survey (*Hermanus Times*, 1997:21)
Mbeki's popularity plummets (Barrell, 2000:3)
Presidency on a knife-edge (Sayagues, 2000:5)

Whether it is a new cure for Aids, the attitude of Hermanus residents towards their town's water conservation programme, the State President's standing in the eyes of South Africans, or Zimbabweans' opinion about the future of President Robert Mugabe; journalists always seem to find space to report the findings of studies and surveys.

With little thought for the source and validity of studies or surveys, journalists often consider these findings important hard news, publish them in screaming headlines that proclaim the last word on such-and-such, then excuse themselves from blame for the consequences of their reporting by slipping "– survey found" into headlines, or by ending introductory paragraphs with "a study found" or "scientists say".

Not that there is anything wrong with reporting the findings of studies and surveys. On the contrary, in his study on science communication for the (American) National Science Writers' Association, Michael Weigold (1998:www:science.nasa.gov/scicomm) has found that newspapers are often the public's only source of science information. In addition, people will – be it for purposes of public persuasion or mere curiosity – always be interested in other people's drinking and sex habits or their opinion of the president or new legislation.

Even though they perform an important public service by reporting them, journalists should not treat studies or surveys as the last word on any subject nor take the numbers they offer as gospel. Rather, they should regard them with a healthy dose of scepticism. Hough (1995:377-378) believes reporters should understand the nature of objective, scientifically devised polls and surveys and how they differ from a casual inquiry of a few people; the man-in-the-street story. Besides being able to handle the numbers correctly, he says journalists should be able to establish their accuracy and credibility.

In the light of the 1997/98 Virodene saga and some journalists' "unquestioning" reporting (Sidley, 1998:www.bmj.com; Paton, 1999:www.suntimes.co.za) of it, Booyens (1998:4) agrees that there is a need for greater methodological sophistication among South African journalists so that they can better distinguish between solid and incomplete research findings.

Once they have established the credibility of a survey or study, Cohn (1989:4) says reporters should not merely repeat such numbers, but also interpret them "to deliver the best picture of reality".

That, indeed, is no mean task, given the uncertain nature of science and the fact that "many studies are inconclusive and virtually no single study proves anything" (Cohn, 1989:10). According to Dr Arnold Relman (Cohn, 1989:9), editor of the *New England Journal of Medicine*, the first step towards understanding the world of science is for the reporter to realise and "help the public to understand ... that we are almost always dealing with an element of uncertainty".

Fortunately, when dealing with such scientific uncertainties, there are ways of reporting them in an honest, but still interesting, manner. Cohn (1989:12) encourages journalists to "borrow" from science by trying to judge all possible claims of fact by the same methods and rules of evidence that scientists use to derive guidance in unsettled issues.

Internet journalist Robert Niles (www.robertniles.com) writes that nobody would buy a car or a house without asking some questions about it first, and suggests that journalists should not go buying into someone else's data without asking questions either. But with no tyres to kick or freshly painted walls to inspect for damp, what questions can reporters ask "to make ... news solid, to report the more valid claims and ignore the weak and phoney?" (Cohn, 1989:48).

The rest of this chapter deals with the questions journalists can ask to judge studies and polls, to distinguish between solid evidence and half-baked anecdotes, to identify weaknesses in studies; in short, to separate the trash from the truth.

9.1 Scientific studies, tests and cures

The researchers have not submitted their work for peer review (either by publishing, announcing their findings at the recent AIDS conference in the United States, or presenting it to experts in the field of HIV research). They have also not released the details of the compound called Virodene, which makes it difficult to assess the validity of their conclusions.

- *Lesley Cowling (1997:www.mg.co.za)*

We don't know enough to comment properly, because we were informed by the media. It would be usual if there was a breakthrough of a medical kind to first inform the scientific community, which would need to hear it and evaluate it.

- Prof JP van Niekerk, dean of UCT Medical School (Cowling, 1997:www.mg.co.za)

When scientists and researchers want to shift the frontiers of knowledge, they have a number of tools at their disposal. Most widely used are observation, experimentation and measurement via clinical tests and epidemiological studies.

But these methods of obtaining new information often vary in quality, making it necessary for journalists to view all study results and/or conclusions with a healthy dose of scepticism. Cohn (1989:v) writes that there are questions that journalists can ask in order to help them "read a scientific report or listen to the conflicting claims of politicians, environmentalists, physicians, scientists, or almost anyone and weigh and explain them".

When she heard about the Virodene claims, Dr Ute Jentsch (Cowling, 1997:www.mg.co.za) of the South African Medical Research Institute said all new treatments had to be approached with a degree of scepticism until controlled clinical tests had been executed. And because "lots of people claim breakthroughs, which come to nothing" (Jentsch in Cowling, 1997:www.mg.co.za), the first questions journalists should ask when they are being confronted with claims about discoveries, cures or findings are:

> How do you know? Are you just telling us something you "know" or have "observed" or "found to be true"? Or have you done or found any studies or experiments? (Cohn in Blum & Knudson, 1998:103).

Once they've established the origin of claims by researchers or scientists, Cohn (Blum & Knudson, 1998:103) recommends that journalists ask the following questions:

- What are your data? Your numbers? How or where did you get them?
- How sure can you be about them? Are there any possible flaws or problems in your conclusions? Salespeople are sure. Honest investigators admit uncertainties.
- How valid? In science, this means are your numbers and conclusions accurate?
- How reliable? That is, how reproducible are your results? Have they been fairly consistent from study to study?
- What is your degree of certainty or uncertainty by accepted tests?
- Who disagrees with you, and why?

From the literature that was studied for this thesis, it is clear that journalists should ask questions about peer review, study design and the statistical methods applied to analyse the data that was obtained. If the basic questions listed above do not put a journalist's questioning mind at rest, there are yet more questions that they can ask, as recorded in detail by Victor Cohn (1989) in *News & Numbers: A Guide to Reporting Statistical Claims and Controversies in Health and Other Fields*. A comprehensive guide to evaluating studies, surveys and the statistics gathered and kept by government departments, it can be also be studied for more specific questions to get to the bottom of the claims made by researchers.

In the face of fierce competition and the race to be first to tell the story, journalists often offer "facts" where a study merely suggested that there was evidence that such might be the case or omit the fact that a scientist calls a result preliminary. To avoid this, journalists should ask:

- Are you presenting preliminary data or something fairly conclusive? Are you presenting a conclusion or a hypothesis for further study? (Cohn, 1989:50)

Study design is one of the decisive factors in any honest scientific study. As all kinds of studies have their uses and limits and because there is not one kind of study that can be used for testing all hypotheses, journalists will have to ask:

- What kind of study was it? Was there a systematic research plan or design? What was the study design or method: observational, experimental, case-control, prospective, retrospective, or what? Do you think it was the right kind of study to get the answer to this question or problem? (Cohn, 1989:49, 50).

Because the general rule regarding sample size is 'the bigger the better', Cohn (1989:50) advises journalists to grill researchers on sample size by asking:

- How many subjects, patients, cases, or people are you talking about? Are these numbers large enough, statistically rigorous enough, to get the answers you want? Were there an adequate number of patients to show a difference between treatments?

"Usually, writes Detjen (Blum & Knudson, 1997:177), "the statistical validity increases with large scientific studies". But even if larger numbers are always more likely to pass statistical muster, there are exceptions to this rule, i.e. small numbers can sometimes carry weight: One new case of smallpox would be a shocker in a world in which smallpox has supposedly been eliminated. In another example, the world was first alerted to what would become the AIDS epidemic via a report that five young men had been treated for *Pneumocystis carinii* pneumonia at three Los Angeles hospitals (Cohn, 1989:50).

Also on the subject of samples and to stress the importance of random selection, it is recommended that journalists establish how the sample subjects were selected by asking: Who were your subjects? How were they selected? What were your criteria for admission to the study? Were rigorous laboratory tests used to define the patients, or were clinical diagnoses used? Was the assignment of subjects to treatment or other intervention randomised? If subjects weren't randomised, why not?

Because the comparison of non-comparable groups is according to Dr Thomas Vogt (Cohn, 1989:51) "probably ... the single most common error in the medical and popular literature on health and disease", journalists should ask:

- Was there a control or comparison group? (If not, the study will always be weaker.) Who or what were your controls or bases for comparison?

Journalists should leave no stone unturned to ensure that they get all the information and should also ask:

- Does the investigator frankly document or discuss the possible biases and flaws in the study?

"A good scientific paper should do so," says Cohn (1989:59). Does the investigator admit that the conclusion may be tentative or equivocal? Do the authors use qualifying phrases? If such phrases are important, journalists are bound to include them in any responsible story.

Journalists should also find out whether it was a blind study, and in the case of a study comparing drugs or other forms of treatment with a placebo or dummy treatment, did all involved know or were they blinded. Because of ethical problems when patients are not told what drugs they are taking and what the side effects might be, not every study can be blind, but according to Cohn (1989:52), "a blinded study will always carry more conviction".

Researchers cope with uncertainty by calculating the probability that the results of their studies might have occurred by chance. Here knowledge of the statistical concepts like probability, power, bias and confounders and variability that will be discussed in more detail in the next chapter, will come in handy. To ensure that the analysis of data is solid, journalists can ask:

- Could your results have occurred just by chance? Have any statistical tests been applied to test this?
- Did you collaborate with a statistician in both your design and your analysis?

Since many of the most important new findings about ozone depletion, global warming, the loss of biodiversity and other environmental issues are published in scientific journals, former environmental reporter for the *Philadelphia Inquirer* Jim Detjen (Blum & Knudson, 1997:177) says journalists must learn how to read research papers and ask questions to determine the value of the research. They should ask:

• Has it been published in a peer-reviewed journal?

One of the biggest concerns about the Virodene issue was the lack of peer review, i.e. the fact that the research team took their research to a Cabinet meeting and that the scientific community heard about it through the media.

According to Niles (www.robertniles.com) peer review means that professionals have looked at the study before it was published and concluded that the study's authors by and large followed the rules of good scientific research and did not torture the data to make the numbers conform to their conclusions. "Always ask if research was formally peer reviewed," he recommends, "if it was, you know that the data you'll be looking at is at least minimally reliable. If it wasn't, ask why."

Detjen (Blum & Knudson, 1997:177) says peer review helps to screen out incomplete or flawed research, and journalists should be suspicious of non-reviewed studies that are being announced at a press conference.

• Where did the data come from, i.e. who paid for the research?

Detjen (Blum & Knudson, 1997:177) says he's more sceptical if the study has been paid for by an environmental or industry group and rather than by a federal research agency such as the National Science Foundation or the National Institutes of Health.

Niles (www.robertniles.com) warns, though: "Just because a report comes from a group with a vested interest in its results doesn't guarantee the report is a sham. But you should always be extra sceptical when looking at research generated by people with a political agenda."

9.2 Opinion polls and surveys

At the end of last week it looked as if everything was beginning to unravel for Gore. His September poll lead had vanished and Bush seemed to be pulling ahead in the final stretch. Now it has changed again. In the latest national tracking polls he has recovered a wafer thin lead: 46% to 45% in Gallup, 45% to 42% in *Zogby*, and dead level on 46% in the *Washington Post*. All are within the statistical margin of error.

- Martin Kettle (2000:17)

In November 2000 we witnessed one of the closest presidential elections in the history of the United States of America. The paragraph quoted above is but a small sample of what the media dished up about the "nip-and-tuck White House race" (Kettle, 2000:17) or the fact that the polls "still indicate a photo-finish" (Kettle, 2000:17).

Back on African soil, things weren't very different. President Thabo Mbeki's statements about AIDS and President Robert Mugabe's handling of the land occupation issue in Zimbabwe resulted in numerous surveys to gauge the standing of these two southern African leaders in the eyes of the public.

According to former Iowa State University statisticians George W Snedecor and William G Cochrane (1992:5) opinion polls can provide estimates of public feeling towards recent events, types of human behaviour and new proposals and laws, and are of considerable interest to social scientists and representatives of government as well as to the general public.

Yet, a survey can be anything, from journalists of the Durban newspaper, *The Mercury*, finding in "a door-to door survey that levels of childhood leukaemia in the [South Durban] area were 24 times the national average" (Kirk, 2000:5) to well-designed randomised sample surveys done by professional and reputable research companies with questions worded in such a way as to leave no room for bias. Journalists should be careful not to assign them equal weight.

A survey that is fair and free from any bias does not come cheap, writes AK Dewdney (1993:38) in *200% of Nothing*:

> To obtain an accurate picture of public opinion, you must take a large enough sample to rule out statistical fluctuations, you must gather the sample carefully, and you must ask the right questions. Experience has shown pollsters that missing just one of these criteria invites disaster.

And yet, major sources of news that they promise to be, in an article for the *Chicago Policy Review* Norman Bateman (1996:www.harrisschool.uchicago.edu) reminds journalists that "it is still important to remember that polls are subject to a 'margin of error' and are not substitutes for real elections".

As with studies, tests and trials, there are questions that journalists can ask to verify the validity of public surveys. Hough (1995:379), as well as assistant professor of Journalism at the University of Wisconsin-Madison, Paul Voakes (2000), and co-founders of the Associated Press/NBC News Poll, Sheldon R. Gawiser and G. Evans Witt (1997:www.publicagenda.org), recommend different questions that journalists can ask pollsters before writing stories about polls and surveys:

• Method: how was the poll conducted? What was the sample? Was this a probability (random) sample? Or just a convenient sample? Or worse yet, a self-selected sample, like a call-in poll?

> Bateman (1996:www.harrisschool.uchicago.edu) says some journalists seem to think self-selected polls have the same validity as scientifically based polls, and according to him reporters often fail to distinguish between the two types.

• Who sponsored the survey and why was it done?

> "You must know who paid for the survey," write Gawiser and Evans Witt (1997:www.publicagenda.org), "because that tells you – and your audience – who thought these topics were important enough to spend money finding out what people think." According to them polls usually are not conducted for the good of the world. "They are conducted for a reason – either to gain helpful information or to advance a particular cause."

The important issue for journalists is whether the motive for doing the poll creates such serious doubts about the validity of the poll results that they should not be published.

• Who was interviewed? How were the persons selected for interviews, i.e. what was the sample design? How many persons were interviewed?

What broad group of people is being described? These questions should be asked to determine whether it was a stratified, random sample. In a random sample every member of the population has an equal chance of being selected. The bigger the sample, the more confidence one can have in it, or put another way, the more people interviewed for a scientific poll, the smaller the error due to the size of the sample.

Like Mercedes Sayagues (2000:5), when she wrote for the *Mail & Guardian* on a Probe Market Research poll in Zimbabwe, journalists should find out, and report that:

> The survey interviewed a national random sample of 2 000 voters in rural and urban areas, a large sample for a population of 11 million.

• How accurate are the results? or What is the sampling error for the poll results?

For example, Voakes (2000) writes: "If there is a 3% margin of error, and the results are 51% for one candidate (or preference) and 49% for the other, neither can claim to be ahead: The ranges of 48-54 and 46-52 overlap. The smaller the sample size, the greater the margin of error." (Margin of error will be explained in the next chapter.)

• How were the interviews conducted?

On a personal basis, by phone, or questionnaires? Telephone interviews are the method of choice for conducting public polls these days. According to an article in the STATS (Statistical Assessment Service) newsletter (2000:www.stats.org) mail surveys are generally cheaper than telephone surveys, can produce results uninfluenced by different interviewers and offer an increased sense of privacy. Among the drawbacks are low response rates and self-selected (i.e. non-random) responses. Personal interviews are expensive, time-consuming and subject to a lot of interviewer bias.

• When were the interviews conducted? When was the poll done?

According to Gawiser and Evans Witt (1997:www.publicagenda.org) journalists should ask these questions because events like rousing speeches, stock market crashes or environmental disasters, can have a dramatic impact on what people think, i.e. poll results. In addition, poll results that are several weeks or months old may be valid as history, but are not always newsworthy.

• What were the actual questions asked?

"The questions asked in polls are crucial," Cohn (1989:138) writes. "They can be loaded to get a desired result. Or they can be innocently yet badly worded – hence enters bias – to get misleading answers."

In a STATS (Statistical Assessment Service) newsletter article about polls, predictions and the press the writer concludes that, "...questionnaire design is the art the pollster practices alongside the science of sampling. A technically perfect sample will give meaningless results if asked meaningless or misdirected questions."

• Is it clear when the results relate only to a part of the full sample? Are the results based on the answers of all the people interviewed?

If only female eligible voters were asked a question on voting intention, the report should mention this fact, and not make inferences about the whole population based on the responses of one group. In a report for the *Cape Times* reporter Eric Ntabazalila (1997:www.iol.co.za) writes:

> A total of 1 000 women – black and white – were interviewed last month in the survey. It was conducted in all the major metropolitan areas in South Africa.

Last October the Mail & Guardian's Howard Barrell (2000:3) broke down the response to questions about President Thabo Mbeki's performance as follows:

> A poll by Research Surveys Omnicheck in metropolitan areas in August found that 46% of black women said Mbeki was "doing a good job" – a decline of 10 percentage points from the 56% measured in July and a fall of 23 percentage points from the 69% measured as recently as February 2000. Among white males, the proportions fell from 24% to 13% over the same period, and among white females from 24% to 11%.

• What other polls have been done on this topic? Do they say the same thing? If they are different, why are they different?

Gawiser and Evans Witt's (1997:www.publicagenda.org) advice is as follows: "If the polls differ, first check the timing of when the interviewing was done. The different poll results may demonstrate a swing in public opinion. If the polls were done about the same time, and no other factor seems to explain the disagreement, go to each poll sponsor and ask for an explanation of the differences. Conflicting polls often make good stories."

Once the truth is separated from the trash, Cohn (1989:138) hopes to see more candid reporting of polling results, as illustrated by the following story in the New York Times on a New York City poll of 900 adults conducted in January 1987:

> In theory, in 19 cases out of 20, the results based on such samples will differ by no more than 3 percentage points in either direction from that which would have been obtained by interviewing all adult New Yorkers. For smaller groups, the potential error is greater. For all whites, plus or minus 4 percentage points. For all blacks, it is plus or minus 7 points.
> In addition to sampling error, the practical difficulties of conducting any survey of public opinion may introduce other sources of error into the poll.

9.3 Conclusion

Just about everything that journalists report involves numbers and if they're going to use them, advises *Newsweek*'s economics columnist, Robert Samuelson (Cohn, 1989:132), they'd "better know where it comes from, how reliable it is and whether it means what it seems to mean".

No public opinion polls or scientific and sociological studies can be finalised and published without some number crunching, and in order to make their reporting accurate journalists should get to know more about the "mechanics" of surveys and scientific studies, tests and trials and always view their findings and/or conclusions with a good deal of caution and scepticism.

In order to establish the credibility of numbers and evaluate the methods by which they were obtained, *Chicago Tribune* science writer Ronald Kotulak (Blum & Knudson, 1998:144) says journalists should use their "most important tool", namely the ability to ask questions.

These questions, as recommended by experienced journalists, can help them "read a scientific report or listen to the conflicting claims of politicians, environmentalists, physicians, scientists, or almost anyone and weigh and explain them" (Cohn, 1989:v).

10. Statistical concepts

The basic ideas in statistics assist us in thinking clearly about the problem, provide some guidance to the conditions that must be satisfied if sound inferences are to be made, and enable us to detect many inferences that have no good logical foundation.

- George W Snedecor and William G Cochrane (1992:3)

The secret language of statistics, so appealing in a fact-minded culture, is employed to sensationalise, inflate, confuse, and oversimplify. Statistical methods and statistical terms are necessary in reporting the mass data of social and economic trends, business conditions, opinion polls, the census. But without writers who use the words with honesty and understanding and readers who know what they mean, the result can only be semantic nonsense.

- Darrell Huff (1991:10)

We are continuously exposed to statements that draw general conclusions; for instance that a third of the world's population live in dire poverty; that the use of cellphones might cause cancer; and that tomatoes can prevent some forms of cancer. But how can we test the truth of such sweeping statements?

Snedecor and Cochrane (1992:3) write that quantitative research is largely concerned with gathering and summarising observations or measurements made by planned experiments, by questionnaire surveys, by the records of a sample of cases of a particular kind, or by combing past published work on some problem. "From these summaries, the investigator draws conclusions hoped to have broad validity."

Having done the research, researchers use statistics to turn masses of data into conclusions, findings, and hopefully, useful information. Not all experimenters have it as easy as the inventor of the light bulb, Thomas Alpha Edison, because it does not take statistics to see that a light has come on, and for many, statistics is the only way of determining the cause certain events.

Yet, for an instrument of analysis that is so widely used, it is ironic that so many people regard statistics with such contempt. While we often hear people dismissing statistics by quoting

Benjamin Disraeli (or Mark Twain) that there are "three kinds of lies: lies, damned lies, and statistics", few people can ever refrain from using them.

As was stated in the previous chapter, because science is a "continuing story" and nature is complex, some uncertainty will almost always prevail. Statistics is a tool for collecting, analysing and drawing conclusions from data. Journalists who know which numbers to look for and which questions to ask will be able to verify results and findings offered by researchers in journals or reports. Cohn (Blum & Knudson, 1997:103) writes:

> We can then go a long way toward distinguishing the probable facts from the probable trash, a long way toward judging claims and statistics that are thrown at us, by learning ... basic concepts that apply to all science, all studies, and virtually all knowledge of society and the universe. Remembering these can teach us to ask 'how do you know?' with a considerable degree of sophistication.

As in the case of evaluating studies, tests and surveys, Cohn (1989:14) believes journalists can learn to ask more pointed questions if they understand some basic concepts and other facts about scientific studies. Having asked all the questions about peer review, study design and subjects, journalists should know statistical concepts such as probability, power, bias and variability that researchers and statisticians use to analyse the data that was produced by experiments and studies.

However, research reports rarely contain a chapter titled 'Statistical Analysis' where all the statistical information pertaining to that study is recorded. Most reporters can't be scientific referees, but when they read an article it is recommended that they look for a credit or footnote indicating collaboration with a statistician, and a paragraph describing the method of statistical analysis and its outcomes, such as a *P* value or confidence level, the power to detect treatment effects. "Muddle around in the footnotes and appendices," Professor Emeritus of Mathematical Statistics at Harvard University, Frederick Mosteller (Cohn, 1989:62), advises:

The rest of this chapter will be devoted to explaining a number of statistical concepts that journalists should know in order to evaluate the results and/or conclusions of studies.

Probability

Scientists cope with uncertainty by measuring probability. Journalists are advised by Cohn (1989:14) to take note of this uncertainty and learn how researchers deal with it:

> Since all experimental results and all events can be influenced by chance and almost nothing is 100 percent certain in science and medicine and life, probabilities sensibly describe what has happened and should happen in the future under similar conditions.

Probability is expressed as the *P* value, and is a value that researchers calculate and employ to eliminate chance, or a way of reporting how likely it is that a test figure represents a real result rather than something produced by chance (Huff, 1991:42). A *P* value of 5% or 0,05 means that the probability that the results are due to chance is 5% or less.

When a researcher sets out to do an investigation, he first forms a hypothesis. Then he tries to disprove it by what is called the null hypothesis, i.e. that there is no effect, that nothing will happen. To back the original hypothesis, the results must reject the null hypothesis, and the *P* value must by 0,05 or less.

A low *P* value – usually a value of 0,05 or less – is called statistically significant. But statistical significance does not mean medical or practical significance; as Richard F Harris (Blum & Knudson, 1997:171) explains in *A Field Guide for Science Writers*:

> All too often, people see that a study is statistically significant and conclude that the effect must be real. But all statistical significance means is that if a study were repeated 100 times, it would come out the same way on 90 or 95 of those occasions. Mathematical significance says nothing about whether the study was designed well to begin with.

Another common way of reporting probability (and uncertainty) is the margin of error, or the confidence interval. The margin of error is the range within which the truth probably lies. For example: in a scientifically designed experiment to determine the effect of substance X on the weight of chickens, a weight increase of 8% was attained. Given a *P* value of 0,05 and a 3% confidence interval, the weight change will fall within a 5% to 11% range in 95% of the repetitions.

In the case of polling results, Voakes (2000) explains it as follows:

> If there is a 3% margin of error, and the results are 51% for one candidate (or preference) and 49% for the other, neither can claim to be ahead: The ranges of 48-54 and 46-52 overlap.

The margin of error is a function of sample size, i.e. the smaller the sample size, the greater the margin of error. Cohn (1989:16) says "The more people who are questioned in a political poll or the larger the number of subjects in a medical study, the greater the chance of a high confidence level and a narrow, and therefore more reassuring, confidence interval".

However, once a study is shown to be statistically significant, it does not mean there is a cause and effect. Correlation or association is not causation (Cohn, 1989:17); i.e. if there is a positive correlation between eating red meat and heart disease, it does not necessarily mean that red meat causes heart disease. It could be caused by the drinking habits or sedentary lifestyle of red meat eaters.

In this regard Paulos (1996:137) encourages journalists to make a habit of questioning correlation when reading about "links" between this practice and that condition. Huff (1991:84) warns that an association between two factors is not proof that one has caused the other, and recommends that any statement of relationship needs to be put through a sharp inspection.

Power

Statistically, power means the probability of finding something if it's there, for example, an increase in leukaemia in children living near oil refineries or power lines. For example: Given that there is a true effect, say a difference between two medical treatments or an increase in cancer caused by a toxin in a group of workers, how likely are we to find it?

Power depends on sample size, i.e. the larger the sample - assuming there were no fatal biases or other flaws – the more confidence a statistician would have in the result (Cohn, 1989:21). Or to put it another way, the greater the number of cases or subjects studied the greater a conclusion's power and probable truth.

Power also depends on study design, more specifically, the accuracy of measurement. If a study has too little power, the researcher runs the risk of overlooking the effect he's trying to find. The effect or differences may be there, but the test that was used to look for them might not have been sensitive enough to find them. (Cohn, 1989:23).

According to Charles Krebs and Len Thomas (1997:126), respectively of the Department of Zoology and the Centre for Applied Conservation Biology at the University of British Columbia, power analysis is a "critical component of designing experiments and testing results", in the sense that it can distinguish between a test that is not statistically significant because there is no effect and one that shows no significance because the study design makes it unlikely that a biologically real effect would be detected.

It has become more common for investigators or researchers to publish power statements, and Cohn (1989:22) suggests that journalists "scan an article's fine print or footnotes" to find a power statement. It is not necessary for journalists to know how power is calculated, just that it is a parameter by which the validity of a study can be judged. As a general rule of thumb, power should be at least 0.80 to detect a reasonable departure from the null hypothesis.

On the other hand, notes University of Wisconsin Schools of Nursing and Medicine researcher Clay Helberg (1995:www.esecpc.com/~helberg/pitfalls/) in a paper presented at the Third International Applied Statistics in Industry Conference in Dallas:

> ...with excessive power, you may be finding microscopic effects with no real practical value.

Bias and confounders

Bias enters the statistical equation when the results or relationships that were obtained could be explained by other factors. Cohn (1989: 73) defines bias as the influence of irrelevant or even spurious factors or associations – commonly called confounding variables – on a result or conclusion.

Common examples of bias are: failing to take account of age, gender, occupation, nationality, race, income, health, or smoking and drinking habits. Journalists can check for bias by asking: Are there any other possible explanations?

Variability

Sampling would not be a problem were it not for ever-present variation, Snedecor and Cochrane (1992:5) write in *Statistical Methods*:

> If all individuals in a population were alike, a sample of one would give complete information about the population. But variability is a basic feature of the populations to which statistical methods are applied; successive samples from the same population give different results.

Variability (or variation) is the fluctuation of results from measurement to measurement, and compels journalists to look at the distribution of the data as well. In *A Mathematician reads the Newspaper*, Paulos (1996:110) writes:

> If the sample is large, we can have more confidence that its characteristics are close to those of the population as a whole. If the distribution of the population is not too dispersed or varied, we can again have more confidence that the sample's characteristics are representative.

Because it is impractical to work with a collection of 5 000 measurements, researchers and statisticians calculate single values to summarise and classify the data. Of these measures, averages are the most commonly used. There are three kinds of averages: the mean, median and mode.

When most of us speak of an average, we mean the mean or the arithmetic average, i.e. the sum of all the values divided by the number of values.

The mean is a good way to get a typical number, but it has limitations. Most averages obscure huge extremes. For example, a study that reports an average increase of 500 kg per hectare in wheat yield due to the application of a new fertiliser, might not reveal that the yields on the different study plots ranged from decreases to increases of about one tonne per hectare.

Other ways of expressing a collection of numbers or results are the mode (the halfway point in a collection of data) and the median (the most common value). But they also don't tell the full story, and it would be far better to look at the distribution of the data. To present the distribution of data, statisticians calculate the standard deviation, a value that takes account of all values in a distribution to indicate how widely spread or dispersed they are. A small standard deviation indicates a set of data that is tightly bunched together, while a large standard deviation means that the data is spread.

The standard deviation can help journalists to evaluate the worth of all the studies that land on their desks in the form of press releases, writes Niles (1998:www.robertniles.com):

> A large standard deviation in a study that claims to show a relationship between eating Twinkies and killing politicians, for example, might tip you off that the study's claims aren't all that trustworthy.

10.1 Conclusion

Statistics as a tool for data analysis is defined in may ways: as the science and art of gathering, analysing and interpreting data; a means of deciding whether an effect is real; a way of extracting information from a mass of raw data; a set of mathematical processes derived from probability theory.

No matter which definition is used, journalists would go a long way towards more accurate and informative reporting if they could attain a working knowledge of basic statistical concepts like probability, power and numbers, bias and confounders and variability.

Such knowledge will help them understand the scientific method better, as well as teach them the right questions to ask.

11. Reporting the numbers of risk

Environmental controversies are full of numbers that often confuse the media and the public. Particularly in complex risk issues involving such concerns as Alar, dioxin, radioactive wastes or air or water pollution, conveying numbers to and interpreting numbers for the public is important so that people can better understand the controversy and how it affects them. Risk numbers and effective explanations of them help show the public how a controversy is shaped by science, economics and politics.

- Sharon M Friedman (1996:www.fplc.edu/Risk/).

The past century was characterised by rapid developments in science and technology, as well as almost exponential population growth. These developments, together with exploitative mining and farming practices, climate changes and other forms of human intervention, have led to the deterioration of the environment, often disturbing natural balances and increasing environmental risk. Over the years people have become more aware of environmental risk and less tolerant of pollution and contamination.

The last two decades especially, had their fair share of environmental risk controversies in the form of leaking nuclear power stations and oil tankers, asbestos mines with inadequate measures to ensure employees' health and oil refineries with poor pollution records.

Between industrialists on the one side and the public and environmentalists on the other, are governments and the media. And although commentators from both within and outside the news industry are unanimous about the media's role and responsibility to convey these risks to the public and to explain how they might affect them, journalists are often accused of not reporting risk in a neutral, non-sensational - or even accurate - way. Mathematician AK Dewdney (1993:109), the author of *200% of Nothing*, writes:

> The media, more than any other group, consistently overestimates certain risks. This is probably because bigger risks sound more dramatic than smaller ones. Overestimation sells newspapers and television programmes.

From the ranks of journalists, Cohn (1989:98) acknowledges that:

> ... the media are typically accused of overstating, needlessly alarming, emphasising the worst possible case, reporting half-baked and unsupported conclusions, or falsely reassuring.

Although the subject of risk reporting contains enough material for another thesis, the fact that no environmental risk issue can be fully uncovered without numbers warrants the inclusion of the numerical aspect of risk reporting in this thesis.

Research by Prof Sharon Friedman (1996:www.fplc.edu/Risk), chair of the Department of Journalism and Communication at Lehigh University, Pennsylvania, has shown that the media "do not play the environmental risk numbers game very well", partially because the issues and the numbers themselves are complex and hard to explain.

11.1 Conveying and interpreting risk numbers

In risk reporting numbers can be expressed as actual numbers such as 2,7 milligrams per litre, or 1 in 5 000, or implied numbers such as very high or negligible risk. Journalists' most common mistake involving risk numbers is avoiding them completely. When they do give numbers, they seldom give background information about the complexity of risk assessment and often don't differentiate between different risks. The rest of this chapter will deal with these common mistakes surrounding the use of risk numbers.

For more information about risk reporting journalists can visit Sharon Friedman's 'Selected Publication Index' found at www.lehigh.edu/~smf6/pubs/ Also well worth perusing, is a variety of risk articles published in *RISK*, the official journal of the (American) Risk Assessment and Policy Association, as found at www.fplc.edu/RISK/rskarts.htm

No numbers

Because they seem simpler, Friedman (1996:www.fplc.edu/Risk) has found that implied numbers are used much more frequently in the mass media than actual numbers. Her review of the coverage of the Chernobyl accident by the American media found that journalists relied on implied numbers such as "high" or "low", "safe" or "dangerous".

> But what "safe" actually meant was unclear, since these media outlets rarely explained what normal or background radiation levels were. (Friedman, 1996:www.fplc.edu/Risk)

Some South African journalists fail their readers in the same way, as illustrated by the following examples. During the second half of 2000, the *Mail & Guardian* published regular reports about oil refineries as possible sources of lethal chemicals found in air samples taken from Cape Town, Durban and Sasolburg. Under the headline 'Clouds of death over Sasolburg' it reported that:

> The tests have found very high concentrations of 16 very dangerous chemicals in the air. Seven of these chemicals are known causes of cancer. Some have been found to be eight times higher than the maximum levels allowed in the United States. (Kirk, 2000:5)

Besides mentioning that "large concentrations of carbon tetrachloride (a chemical that attacks the kidneys and livers of humans) were also found"; "toluene, one of the more dangerous chemicals in existence, was also present"; and that "carbon-disulfide, a chemical that causes severe chest pain, is also in the air in quantity", no other attempts were made to quantify the risk.

Readers of the *Mail & Guardian* living in Table View, Cape Town, had an equally difficult task estimating the risk to their health after reading in Paul Kirk's (2000:3) report that:

> The government has threatened to shut down the Caltex refinery in Cape Town after air sampling revealed the air in the city's Table View area is among the most heavily polluted ...The levels of carbon disulfide in the Cape air were found to be seven times higher than in Sasolburg, where pollution levels are exceptionally high ... Toluene was found in twice the concentration as the Durban sample ... Tetrachloroethane was found in the Cape Town air sample – and nowhere else. This chemical causes massive liver damage. Also found exclusively in Cape Town was 2-Hexanone – this chemical causes irreplaceable damage to the central nervous system.

In *News & Numbers* Cohn (1989:122) advises journalists to:

> Put numbers on risks if at all possible, rather than just saying the risk is small or greater or greater than. Is the risk 1 in 100 or 1 000 or 1 000 000 or what? And per what unit of time? A day, a month, a year or a lifetime?

Numbers without explanations

Even when they do give the numbers – especially contamination counts – journalists often don't explain them in terms that the public would understand. In order to avoid misleading people and to have any function in risk reporting, numbers – actual or implied - need to be accompanied by explanations and background information.

Possible faults in the design of a sewerage system in the Greater Hermanus area often cause raw sewage to spill into the Onrus lagoon, a favourite bathing area. Although the local newspaper frequently warns residents about the pollution by giving *E. coli* counts, its reporters never explain what these counts mean, how exposure to water containing such levels of the bacterium can affect people, or how they are calculated. Without some knowledge of safety benchmarks, no member of the public will be able to assess the risk of swimming in the Onrus lagoon if the only information available is the following:

> According to a spokesman for the municipality, Mr Shaun Page, the results – which were sent to different laboratories – revealed *E. coli* counts of below 130 ... Page gave the assurance to readers that the *E.coli* which registered a count of more than 5 000 recently have been broken up by ultraviolet light... (*Hermanus Times*, 2000:1) ... The Onrus River lagoon is seriously polluted and should be closed to bathers. This is the view of a spokesperson of the Onrus Lagoon Trust, Mr Casper Geldenhuys ... Geldenhuys said that Onrus residents have a constitutional right to clean water, but that *E. coli* counts in the lagoon are as high as 2 400 (*Hermanus Times*, 2000:3)

Besides serving as a good example of how journalists should report contamination numbers and spillages of toxic substances, a story in *The Economist* (2000:33) about the leakage of 100 000 tonnes of cyanide-laden sludge from a mine in Baia Mare, Romania, into the Danube river helps its readers to get a better understanding of the seriousness of the problem. The magazine reported in the following way:

> With concentrations of 2.7 milligrams of cyanide per litre of water recorded several hundred kilometres from the source, 130 times the safe limit, the water is now lethal. Cyanide, however, decomposes quickly, so should not remain long upstream. It also dilutes easily, so its impact downstream in the Danube has been much less severe. But toxic heavy metals have leaked out too, and these will stay for perhaps five years in the mud of the Tisza's riverbed. Unlike cyanide, these do not kill animals or fish instantly; but, when concentrated, they can cause long term ill health and cancers.

Maximising and minimising risk numbers

There are many ways to express or present risk numbers. In fact, this characteristic of risk numbers is often abused by politicians, industrialists and environmentalists alike to further their cause. To influence people, someone can choose an annual death total or deaths per thousand or million, or per thousand persons exposed, or deaths per ton of some substance, or per ton released in the air, or per hospital or clinic. There is no shortage of ways to make something seem better or worse.

Mathematician John Allen Paulos (1996:142) whose lifetime of reading newspapers has taught him that it doesn't take much to come up with a frightening headline, writes in *A mathematician reads the newspaper* (Paulos, 1996:79):

> A related equivocation arises when one is discussing diseases, accidents, or other misfortunes and their consequences. If one wishes to emphasise the severity of a problem one will usually talk about the number of people afflicted nationally. If one wants to downplay the problem, one will probably speak about the incidence rate. Hence if 1 out of 100 000 people suffers from some malady, there will be 2 500 cases nationwide. The latter figure seems more alarming and will be stressed by maximisers.

Failure to put risk statistics in context

When reporting health statistics, journalists often give the bare risk numbers, without qualifying them. This failure to put statistics into context makes it difficult for the public to evaluate personal risk. To illustrate, Paulos (1996:138) uses as an example the claim that 1 in 8 women will develop breast cancer:

> This figure is correct, but it is misleading for several reasons. First, it is a lifetime incidence risk, not a mortality risk, which is 1 in 28. Second, the incidence rate for breast cancer, like that for most cancers, rises with age; the risk of a woman's having developed breast cancer by the age of fifty is 1 in 50, but by the age of eighty-five it is 1 in 9.

When doing radiation stories, journalists should also be aware of different kinds of radiation and exposure. Cohn (1989:112) recommends questions that journalists can ask to help them tell the difference:

> In reporting on radiation – from a Three Mile Island or Chernobyl – reporters often fail to differentiate between actual human exposure – that is, how much of the radioactivity has reached or can be expected to affect people – and radioactive fallout in the air, water, soil, crops, and milk. Ask: *What are the fallout levels in the air, water and soil? How much has reached or may reach food supplies? How much is a lethal dose?* From the standpoint of cancer? Of future birth defects? Of early death?

Risk comparisons

Risk comparisons are another tool in the hands of those who want to influence people. Tobacco companies would compare the risk of dying from smoking-related diseases with the much higher risk of dying in a road accident. Although there's nothing sinister about using risk comparisons, Cohn (1989:123) alerts journalists to the fact that these risk numbers are usually average numbers and therefore not to be accepted as the last word on the subject. He cites the example of the risk of being killed by a bee sting - 1 in 5 500 000:

> ...theoretically anyone could be stung by a bee, even in Times Square – but if you're a farmer or beekeeper or gardener, your chances go up. The average isn't average for everybody.

And before choosing to compare the relatively high risk of dying in a car accident to the lower risk of getting cancer from polluted air, Cohn (1989:123) warns journalists to distinguish between risks that people choose to accept and those imposed on them.

Comparative risk assessment has become a widely used practice, and science and environmental writers can learn a lot from 'Comparing risks thoughtfully', an article by the Director: Health Standards Programmes of the United States Occupational Safety and Health Administration, Dr Adam Finkel (1998:www.fplc.edu/RISK). Examples of some of the ridiculous risk comparisons employed by both the opponents and proponents of strict environmental, health and safety regulations discussed in the article, are the following:

> Working at an oil refinery is safer than hang-gliding
> More people died in the San Francisco earthquake than died at Three Mile Island

11. 2 Uncertainty of risk assessment

Even if they will admit to inadequate reporting of risk numbers, some journalists might complain that their reporting is being hampered by the complexity of risk assessment and scientific uncertainty.

According to Cohn (1989:99) journalists have to learn to function in situations where uncertainty reigns, data are incomplete, inadequate or non-existent; they are told different things by different people; where distinguished scientists make opposing – even warring – assertions, such as 'the hazard is horrendous' and 'the hazard is minimal or nonexistent', and the public distinguishes (often unknowingly) between risk imposed upon them and their own decisions.

Friedman (1996:www.fplc.edu/Risk) agrees that the risk assessment process is complicated and confusing, making it "hard for reporters to understand and even harder for them to explain", particularly since they must simplify this information for readers and viewers. By listing some of the mistakes made by journalists when reporting risk, she indirectly makes recommendations for accurate risk reporting:

> Reporters frequently do not reflect the uncertainty that haunts the assessment process. They do not tell the public that risk assessors must make assumptions and extrapolations, and that policy decisions affect whether a risk assessor uses an estimate that is conservative or moderate. They do not let readers or viewers know that risk estimates will vary depending on which computer model is used, and they rarely discuss the scientific disagreement over the threshold theory and whether it was or was not applied in a particular risk assessment ... As a result, they frequently report only a bare risk estimate without any of the caveats that need to be applied. By not reporting the uncertainties, assumptions, extrapolations and policy decisions, they make it difficult for the public to understand why experts reach different estimates about the same risk.

11.3 Conclusion

All members of the public face environmental risks every day, every time they breathe, swim, choose not to wash the apple they're about to eat, or live their lives in an industrialised country. Sometimes they knowingly increase their risk by not wearing a seat belt or by smoking. Still, they need good information and numbers about risk to make decisions.

Inadequate or misleading media coverage can contribute to people's fear of environmental risks, as posed by air and water pollution, radiation, genetically modified foods and pesticides. People have a right to know the degree of environmental risk facing them. Where possible the risk should be quantified and qualified in terms of explanations, caveats and background information. Although journalistic constraints will make this difficult, reporters must strive to tell the public about the uncertainties, assumptions, extrapolations and policy decisions, and why experts reach different estimates about the same risk.

12. Summary

Numbers count. The ability to use them competently, even more. In fact, numeracy has been described as the new literacy of our age by professor of mathematics at St Olaf College, Michigan, Lynn Arthur Steen, who also warns that an innumerate citizen today is as vulnerable as the illiterate peasant of Gutenberg's time.

This thesis was written from the premise that the public requires as much accurate information as possible to make choices and decisions, and in many instances depend on the various news media to supply that information. Effective reporting fulfills the media's obligation to provide news of events, natural phenomena and new developments, and journalists have a responsibility to reflect and explain the complexity of a world that is increasingly defined by numbers.

There is considerable concern about journalists' lack of numerical skills; inasmuch that experienced journalists, academics in the communications field, mathematicians and statisticians are either "taken aback" by the inability of journalists to do even the most basic calculations or "horrified" by the "amount of numeric incompetence" in newsrooms. Their concern flows from the fact that most news stories can be enhanced, improved or rendered more specific by the use of numbers, that numbers can give readers perspective or help them to evaluate personal risk.

Furthermore, numerical competence can give journalists an edge over their innumerate counterparts; either by saving them the time of "getting up to speed" when doing stories or helping them to spot the controversies and stories often "hidden" in statistics and databases.

Journalists who fail to master numerical skills lack a basic ability needed to decipher much of the information in the world around them, such as crime statistics, pollution standards, price changes, municipal rates, and risk numbers. Without these skills, journalists are bound to fall short in their quest for accuracy.

The biggest part of this thesis is dedicated to the number mistakes that journalists make, as illustrated by examples found in (mostly South African) weekly and daily newspapers, as well as the numerical skills any general reporter needs. Recommendations for improved and meaningful use of numbers are given. They are listed below:

- The most common number mistakes involving percentages, i.e. confusion between percentage and percentage point; missing raw figures; miscalculations involving percentage decreases and prices and levels rising and falling in succession; the reporting of 'pro' and 'anti' percentages and the failure to state percentages in terms that readers can understand.
- Journalists often struggle to understand very large and small numbers and are thus unable to 'translate' them into terms that their readers can understand. In this chapter different ways to explain large and small numbers are being discussed.
- In a world that is divided between countries that have converted to the metric system and those who has not, it is important that journalists know how to convert from the imperial units of measure to the metric units. Similarly, journalists will add to their readers' comprehension if they'd convert nautical terms such as nautical miles or knots to the more commonly understood kilometres or kilometres per hour.
- A whole chapter is devoted to Darrell Huff's "little figures that are not there", the seemingly minor errors and omissions often found in newspapers. Chapter 8 deals with the use of numbers to improve stories, the importance of accurate number use and putting the numbers that are used in context. Specific examples are:
    - sub editing errors overlooking discrepancies and miscalculations that mar readers' understanding and harm the credibility and reputation of the newspaper;
    - stories bereft of the numbers that could lead to better understanding,
    - the phenomenon of 'observational selection' whereby journalists enumerate favourable circumstances and ignore their negative side,
    - the confusion of rates and plain numbers;
    - exaggeration and extrapolation;
    - journalists' failure to do a reality check, an oversight that may result in reports containing "outrageous incongruities" such as one rand being worth thousands of dollars and VAT on a new car being a few cents;
    - inadequate reporting of averages;
    - the use of incomprehensible numbers, especially when writing about pollution;
    - the omission of benchmark figures that could help readers to put the numbers in the story in context;

- A further, less concrete, dimension to numeracy, but one that demands common sense and informal logic, and without which journalists will never fully overcome innumeracy, is the skill that embraces a sense and an awareness of the numbers of the world we live in, it serves as a tool for "baloney detection", and provides the common sense and real-world number knowledge to do a "reality or plausibility check" on the numbers that are used. Numerate journalists are quick to spot an implausible number, and they have the common sense and a sufficient knowledge of simple calculations and common magnitudes so they can confirm their suspicions.
- In the light of the enthusiasm and frequency with which journalists write about the findings of scientific studies and surveys, part of the thesis was set aside to discuss strategies to help journalists evaluate scientific studies and surveys. As a journalist's most important tool is the ability to ask questions, this chapter followed a practical approach, recommending questions that journalists can ask to assess the validity of the conclusions offered and claims made by researchers, as well as to establish the credibility of numbers and evaluate the methods by which they were obtained. These questions, together with knowledge about some basic statistical concepts such as probability, power, bias and variability can help journalists read a scientific report or listen to the conflicting claims of politicians, environmentalists, physicians, scientists, or almost anyone and weigh and explain them.
- The last chapter is devoted to environmental risk and the mistakes – namely the absence of risk numbers, numbers without explanations, minimising and maximising risk numbers, the failure to put risk numbers in context and risk comparisons – most frequently made when reporting the numbers of risk.

This thesis focuses on the basic numerical skills needed by all journalists, and as such forms the basis for further studies on the subject of numeracy for journalists that could include the specific numerical skills needed by business, medical, environmental and sports reporters, as well as the use of graphs, illustrations and tables to present numbers.

All the evidence assembled in this thesis serve to emphasise the importance of numeracy for journalists, as well as the potential of numbers to enhance the value and accuracy of their reporting and the possibility of giving readers, listeners and viewers some concrete and precise information upon which to base their choices and decisions.

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