

The Horror of Number: Can Humans Learn to Count?

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Human beings pride themselves on their mathematical prowess, but as Jeremy Grantham (2011) has grimly observed, while communication skills have been a matter of life and death for humans, mathematics so far has not (he invites us to imagine the murderous mayhem that would ensue if our undeniably admirable driving skills were on a par with our average mathematical capacities). The problem of mathematical incapacity is hugely increased by the institutionalised antagonism to mathematical and quantitative thinking in the humanities. Literary studies, my own home discipline, has contributed powerfully to the formation of the phobic, and potentially catastrophic, view that the vocation of the humanities is to defend or redeem us from quantity and calculation. Large quantities of time and money are consumed in sustaining this ideological rather than accidental innumeracy. In what follows, I aim to explore the ways in which literature, and the humanities more generally, might in fact provide resources for the development, in place of the allergic recoil from an allegedly 'inhuman' world of number, of an imaginative numerosity.

For the time being, however, there is in the arts and humanities an exceptionless consensus about the encroaching horror of the domain of number. Indeed, this for many is what defines the arts and humanities. This consensus fails or refuses to take account of number's plurality. The effort to discredit calculus takes the form, not of the noncalculative, but of the substitution of a crude calculation for a subtle one. What calls itself, or themselves, 'the arts and humanities' secure their sense of their distinctive identity through a kind of reciprocal recoil. First of all, the many different kinds of mathematical reasoning and application are rounded up crudely and carelessly into one thing, since anything that can be said to count as calculative thought will have precisely the same inevitably cramping and withering effects on collective life and the individual spirit. The number of the Beast known as Number is not 666 but 1. Then, having limned the countenance of the foul fiend Number, the arts and humanities define and defend themselves as the merciful guardians of everything that Number crunches underfoot. The arts thus borrow their identity from this repugning of their falsely singularised antagonist. They are held together as one by their recoil from the one of Number that is their declared and determining other.

But the number of Number is not 1. This is suggested clearly enough in the history of the word 'mathematics', the plurality of which is retained by its abbreviation to 'maths' in British English, as opposed to 'math' in American English, in parallel with the plural 'sweets' for which Americans have only the singular 'candy'. The bulging definition offered by the OED indicates the inclusiveness of the mass noun 'mathematics':

Originally: (a collective term for) geometry, arithmetic, and certain physical sciences involving geometrical reasoning, such as astronomy and optics; spec. the disciplines of the quadrivium collectively. In later use: the science of space, number, quantity, and arrangement, whose methods involve logical reasoning

and usually the use of symbolic notation, and which includes geometry, arithmetic, algebra, and analysis; mathematical operations or calculations.

There are, of course, many forms of mathematics. The two major academic reviewing databases have generated a Mathematics Subject Classification and ask those submitting work to journals to identify their work in terms of its alphanumeric subject codes. ‘Number theory’ forms a very small part of this array, under large general headings like general foundations, algebra, analysis (the study of rates of change and quantity), geometry and topology. These are only the divisions of what is known as pure mathematics. There is then the open and constantly expanding field of applications, in mechanics, statistics, optics, astronomy, biology, systems theory and many other areas. It would be very hard to say what there is that runs through the whole of mathematics that makes it essentially ‘mathematical’. The concern with numbers or even quantities certainly would not cover it. This means that mathematics has the quality (of not having a single defining quality) that Wittgenstein famously ascribed to language and explicated with the parallel example of the game in *Philosophical Investigations* 65-71. In trying to explain how it is that we can have a conception of ‘language’ without being able to identify any single essential feature that runs through all the forms that language takes, Wittgenstein in fact offers a parallel to the metaphor of games in the idea of numbers:

[T]he kinds of number form a family in the same way. Why do we call something a “number”? Well, perhaps because it has a – direct – relationship with several things that have hitherto been called number; and this can be said to give it an indirect relationship to other things we call the same name. And we extend our concept of number as in spinning a thread we twist fibre on fibre. And the strength of the thread does not reside in the fact that some one fibre runs through its whole length, but in the overlapping of many fibres. (Wittgenstein 1986, 67)

Wittgenstein seems to return repeatedly in *Philosophical Investigations* to the parallels between word and number, as well as the intersections between them.

There is good reason to suspect that language and number are indissolubly related. Palaeontologists have for some time suspected that numerical and other kinds of symbolism were closely related in the beginnings of writing culture. Frederick L. Coolidge and Karenleigh A. Overmann have recently argued that human numerosity, the innate capacity that humans share with certain birds, primates and mammals of being able to recognise quantity and magnitude without the need for intervening symbolic representation, may have had a large role to play in the development of symbolic thinking:

number concepts may be formed by the innate processes of numerosity from the sense perception of objects. As embodied concepts, numbers may have then been expressed through fingers and then external devices and only later in writing and speech, respectively. The physical expression of concepts may have created a shared conceptual space in which concepts were used, imitated, taught and learned, and communicated as icons, indexes, and symbols in writing and speech. Embodied numerosity, then, may have been integral to the process whereby symbolic thinking emerged in *Homo sapiens*. (Coolidge and Overmann 2012, 208)

Numbers may have been the earliest symbolic figures to have been written, in the form of quantities representing the contents of sealed clay balls, like piggy banks (Schmandt-Besserat 1980). A nomadic people has little need for records, or for records more extensive than a collective memory can store or recall. Nomadic peoples adjust their levels of resource by moving between areas of varying abundance. Like most species in the animal and vegetable world, nomadic people do not perform reckonings, because their modes of life are a form of reckoning with their environment. Their economies, as studies of indigenous peoples, in North America, Canada, Amazonia and Australia, have demonstrated, often maintain exquisitely subtle and delicate ecologies with their environments. But when a sedentary people develops the arts of agriculture in a region whose continuing fertility makes nomadic roaming unnecessary, the combined opportunity and need represented by grain surpluses and rapidly increasing populations require one to take stock, and to maintain accounts. So in one sense the paranoid view of the Romantic capitalists is right – number begins in accountancy and economic exchange.

But this is only a small part of what number gives – by which verb one always means demands and allows. Occupying certain kinds of space, like the fertile crescent in the Middle East, means that humans can substitute a kind of temporal mobility, conceived as movement forward to the future, for spatial mobility. And it is mathematics that makes those temporalities habitable. Number invents time. It is hard not to feel that the distinctive topography of the region between the Tigris and the Euphrates had some potentiating role in all this. The complex looping of the river systems means that water is never more than a few miles away, meaning that crops and pasture can be maintained constantly. (Mazur 2014, 10-11). But these loopings also seem to be a figuring of a kind of topological intelligence. Knowing that one may have to travel ten miles by water to get to a spot that is only a couple of hundred yards away in line of sight helps to institute complex thought about the equivalences of time, space and labour. The landscape itself becomes at once a rebus and an abacus.

All this implies that symbolic representation, and especially written representation, may have been closely involved with forms of accountancy; the projection, preservation and conservation of resources. Walter Ong sees in the development of writing a move from the events of utterance to the material objects of language, allowing for a conception of language as made of separable things – things like words and letters, for example, which literally take on material form in the development of moveable type, but in writing have already been semi-hardened into symbolic types. Numbers are perhaps closer to the things of the world than words; since numbers are tied to numerable objects or articles, they bring with them an articulated view of the world. According to Stanislas Dehaene, '[n]umber emerges naturally the most abstract representation of the permanence of objects in space' (Dehaene 1999, 190). In the mathematical notation used for calculation, numbers are close to the condition of manipulable things, that can be moved around the space of the page as the *calculi*, or pebbles of a counting frame may be deployed. A numeral is consequently a word that seems to be close to the condition of a thing, a sort of counter.

The question of whether number and language are compounded or merely coexistent is controversial. Stephen Pinker argues that mathematical cognition and language are separate functions. Being able to manipulate large numbers requires the ability to

count, and counting is a specific mental procedure that, though it is effected in language, is not an essential part of it.

Counting is an algorithm, like long division or the use of logarithmic tables—in this case an algorithm for assessing the exact numerosity of a set of objects. It consists of reciting a memorized stretch of blank verse (“one, two, three, four, five,..”) while uniquely pairing each foot in the poem with an object in the spotlight of attention, without skipping an object or landing on one twice. Then, when no object remains unnoticed, you announce the last foot you arrived at in the poem as the numerosity of the set. This is just one of many possible algorithms for ascertaining numerosity. In some societies, people pair up the objects with parts of their body, and I know several computer programmers who count like this: “Zero, one, two, three, four. There are five.” Now, the counting algorithm we teach preschoolers, like the more complex mental arithmetic we teach school-age children, co-opts words in the language. But it is not part of the language, like subject-verb agreement, nor does it come for free with the language. So in the case of the number sense, the proper comparison—similar cultures, different languages—*refutes* Linguistic Determinism rather than supporting it. The prerequisite for exact number concepts beyond “two” is a counting algorithm, not a language with number words. (Pinker 2008, 141)

But this is a view of language as having an essential core with inessential extra components, like counting. But if language does not merely accidentally but essentially include all the many things that one can do with language, then one might arrive at a different view of the ways in which language can work.

Numbers and words have moved away from each other, as both have developed autonomous systems for the representation of mathematical and semantic-symbolic operations. Well into the nineteenth century, however, scientists still relied on verbal exposition of their results and arguments, to a much greater degree than today. The end of the nineteenth century seems to mark the point at which the capacity to translate between mathematical and verbal representations was increasingly lost, and especially in the science of physics, which led the way in becoming the first truly mathematized science, but has been followed by biology. Increasingly the insights and arguments of these areas of scientific enquiry seem to be symbol-dependent, meaning that those insights can only really be expressed in terms of mathematical languages.

I think that the estimation of quantity is never absent from the understanding and experience of art and literature, and that this should not provoke horror, dismay or denunciation. But it ought to be possible to go further than this, to ask whether there might be distinctive features of the kinds of practices known as aesthetic, or artistic or cultural, as they are being developed today, that might in fact be assisting us in the development of our ‘numerosity’, or quantical imaginations.

It is possible today to see words moving towards the thing-like condition of numbers. Hugh Kenner’s *The Stoic Comedians* finds in the work of Flaubert, Joyce and Beckett the evidence of a specifically typographic writing that is mathematical in two senses. First of all, it has, like mathematics, liberated itself from the occasion of utterance: ‘The language of printed words has become, like the language of mathematics, voiceless’ (Kenner 1962, xv). The second feature of this kind of writing is that it

consists of finite quantities, closed sets of information, from which the text selects, rather than seeming to emerge out of nothing in an unbroken, sourceless stream. Kenner calls this 'stoic' because, as he explains in the marvellously level words of his book,

The Stoic is one who considers, with neither panic nor indifference, that the field of possibilities available to him is large perhaps, or small perhaps, but closed. Whether because of the invariable habits of the gods, the invariable properties of matter, or the invariable limits within which logic and mathematics deploy their forms, he can hope for nothing that adequate method could not foresee. He need not despair, but the most fortunate resolution of any predicament will draw its elements still from a known set, and so will ideally occasion him no surprise. The analogies that underlie his thinking are physical, not biological: things are chosen, shuffled, combined; all motion rearranges a limited supply of energy. He has been typically, at typical moments in history, an ethical theorist weighing duty against preference without extravagant expectations, a hero aware that in defying the gods he yet fulfills their will, a gambler calculating odds, a proponent of the Second Law of Thermodynamics, and in our time a novelist filling four hundred empty pages with combinations of twenty-six different letters. (Kenner 1962, xiii)

The quality of print is 'its reduction of language to a finite number of interchangeable and permutable parts' (Kenner 1962, 36). Of Joyce's *Ulysses* we read that

whatever line we follow into the past of this book, it will meet some other line equally traceable, and return upon itself; we receive, that is, once again the impression of a finite set of materials, finite in reality as they must be finite in the book, of which the book is the adequate exemplar. Our ultimate sense of the book, or one mode of our ultimate sense of it, is this: that it is the minute and reliable and exhaustive inventory of all the facts that it incorporates, or even implies. (Kenner 1962, 66)

'Incorporates, or even implies': this is a telling phrase, that itself implies the most important thing about contemporary numerosity. For it is precisely through the apparent reduction of the text to a sequence of separable, substitutable and permutable units that the expansion of the text beyond its given finite condition can occur. Derrida's word for the way in which Joyce's writing seems always already to have anticipated things of which it cannot have awareness is *hypermnesia*. Once a text is constructed as a kind of *combinatoire*, a machine for computing and producing variations on its elements, it becomes an open field of potentials. Thus, the innumerable comes via the enumerable. Thus, the innumerable comes via the enumerable, and only via the enumerable. To enumerate is always both to reduce and to expand, even, to expatiate. There is good reason to suspect that the vast proliferation of life on this planet is made possible by the evolution of a coding system based upon the permutation of four components, adenine (A), guanine (G), cysteine (C) and thymine (T) (and good reasons why there should be four such elements).

This brings about a new relation between the actual and the possible. There are actual things which exist, and possible things which do not. Artefacts like literary texts have previously been actualisations from fields of possibility, on the model of the selection of utterances that makes up a *parole* from the complete set of such

utterances that is known as the *langue*. A medium or a genre seems to hold out a set of possibilities, both in terms of plot and form, from which an individual work seems to make a selection. The creation of a work is an increase in predictability, the carving out from an open and equiprobable field of an island of predictability and limited self-similarity. The force and significance of this order comes in large part from the way it stands out as actual against a background of the merely possible. More and more, however, such artefacts are taking the form of, or being understood as, the actualisation *of* rather than *from* fields of possibility. In the past, works such as texts and utterances were made to stand out against the background of what they were not. We are entering an era in which such works are capable of being what they are not.

Hugh Kenner was formed by the remarkable upsurge in interest in media theory that took place at the University of Toronto, through the work of Eric Havelock, Marshall McLuhan and Northrop Frye. It may seem odd to count Frye in this company, but his interest in the substitutable structures and patterns of literary forms seems to have been nourished by the concern with the modular, with the elements that are combined to make up literary genres. Kenner's particular brilliance was in the tracing of the implications of the typographic sensibility. The most important principles of the typographic sensibility are discontinuity and finitude. The principles are related, because finitude requires numerable elements, and numerability requires separability of those elements one from another. This is why the typographic sensibility is so focussed upon spatial relations. Typography depends upon juxtapositions in the space of the page, and what Stephen Dedalus calls the *nebeneinander* rather than the *nacheinander*. The looped, continuous, cursive flow of the line of handwriting, mimicking the flow of speech, or the movement of the plough across the field or *pagus*, gives way in typography to individual blocks of type, that cannot overlap or join with each other. As it is spatialised, the page is hardened and finitised, such that it became possible for literary bibliographers to follow the fortunes of an individual piece of distinctively damaged type, as it was used and reused on different pages.

In a certain sense, one may say that the invention of writing is not just cognate with numbering – it is itself a form of number thought. This is because writing involves the intersection of the spatial with the serial. Spoken language, we may say, has strong seriality with weak or limited retrievability. What matters in spoken language is the forward push rather than the topological ability for ideas to be copresent, or to form links other than the local links provided by the series. When a stream of utterance is rendered as a written sentence, the elements of the sequence are not just serial, they are numerable. And being numerable means the cooperation of the ordinal and the cardinal. That is, one may put things in order, but one may also jump from one cardinal value to another without needing to count through all the intermediate stages. This is because any counting system has discontinuous steps (the tens, hundreds, the multiples of the times-table) which can be used as grappling points or bookmarks. One can move continuously or discontinuously through an ordered space. One can turn to the final page and find out whodunnit because the final page is already available. Because the pages exist in a numerable order – whether or not the pages are actually numbered – they can be reordered. So, to use the terms proposed by Michel Serres, the hard enables, and becomes, the soft. Fixing things in place makes fluidity possible.

The ability of writing to form a navigable space is of course dependent upon particular ways in which the articulated units of the writing are processed. Any of these units may be numbered; volumes, chapters, paragraphs, notes, lines. In fact, numerical sequencing does not even require numbers, since the alphabetical sequence also allows for the ordering of elements, and therefore the possibility of reordering. This means that a book is always a kind of computational process: a set of data which is available for different kinds of configuration. The phrase 'text-processing' suggests that the text and its processing are separable, but perhaps they are not. Perhaps every text is, in Andrew Piper's phrase, already a 'textual instrument', even though we may 'continue to struggle with the idea of writing as instrument and not as testament' (Piper 147) Writing is not just a particular kind of operation performed upon speech; any piece of writing is a kind of machinery for processing itself. This means that the machinery of reading produces itself, for example as different kinds of implied machine. It was I.A. Richards who opened the preface to the 1926 edition of *Principles of Literary Criticism* with the words 'A book is a machine to think with, but it need not, therefore, usurp the functions either of the bellows or the locomotive. This book might better be compared to a loom on which it is supposed to re-weave some unravelled parts of our civilization' (Richards 2001, vii). Because the writing is the machine, its object, and its product – because writing is the machinery that knits these three together – the machine is an infinitely variable one.

The earliest and most obvious kind of advantage conferred by writing, which was then massively amplified by printing, was the possibility of repetition and standardisation. It is this same principle that made the assault on modern mechanistic civilization in the name of reading so imperative for the movement that formed the academic study of literature. The very words used to denounce this civilisation were derived from printing technology – cliché, stereotype. Yet, as William Burroughs was to discover with his tape cut-ups, the existence of a programme allows for its rewriting, and gives that rewriting a kind of traction that it would not otherwise have. Without repetition, no variation. Without redundancy, there is no possibility of information.

The essential principle here is compressibility. An ordered array of elements is one that is mathematically describable in terms of its degree of economy. The most economical system would be one in which there is maximum redundancy and no variation at all – and therefore no information. The least economical system is one which it is not possible to summarise or compress at all, because there are no patterns of recurrence or self-similarity. This is in fact a mathematical specification of chaos, as absolute unpredictability. The only way to describe such a system would be simply to reproduce it – indeed, not even that, since such a system would not even have the minimal self-similarity required for it to be able to begin or end, so there would be nothing to reproduce.

Compressing a system yields a gain in speed. To say that literary writing is highly formed is to say that it is compressible to a greater degree than nonliterary writing. One certainly loses a great deal of information in simply giving the technical specifications of a Shakespeare sonnet – the number of lines, the metre, the rhyme-scheme – but all of the information that the sonnet may deliver comes from the fact that it exhibits this form of compressibility.

One can think of compressibility as both an effect and an effector of speed. One may manipulate quantities without having to count through them by compressing them into blocks – groups of five and ten beads on an abacus, for example. A rhymed text, or an oral text subject to formulaic patterning, may easily be memorised, and random access memory is itself a kind of compression. Anything which allows a text to be ‘black-boxed’ or broken into summarisable modules, where it is not necessary to know in detail the exact contents of the module, exhibits compressibility. One may move quickly through such a system – jumping ahead to chapter four, for example .

Any kind of iterability, any way of seeing or saying ‘that again’, any recognisable or recurring feature in a system of relations, any way, in short of keeping count, or pleating the raw open succession of phenomena together, is a means of compression. This means that any formal feature of a work is a kind of compression. In fact, numerability itself is a form of black-boxing, a segmentation of a work that allows its structure to become apparent and tractable.

And the relation between compression and speed is reversible. That is, just as compression allows for speed, so speed can perform the effect of compression. There is no need for the kind of short-cut effected by models and embedded calculation models when one has technology that is capable of counting through the numbers.

Speed becomes particularly important when very large or very small scales are in question. For much of human history, mathematical calculation and measurements have involved approximation or rounding up. Increasingly, as Lewis Mumford observes, the application of mathematics is on very small and increasingly precise scales, to the right of the decimal point (Mumford 1934, 232). ‘Rationalisation’ still tends to imply a crude and reductive approximation that speeds things up by cutting corners, making complex and subtle variation simple and predictable. But ratio, measurement and computation are in the process of moving closer to the subtle variability of the organic, by getting down – and up – to the scales at which nature operates.

At these scales, segmentation amplifies variation rather than reducing it. Rationalisation at smaller scales, which implies and requires increases in computational speed, increases the sensitivity to fluctuation rather than damping it down or cancelling it out. Subtlety comes with the move away from the Pythagoreanism of whole numbers, and Mumford’s move to the right of the decimal point. The expressive performer, or the skilled athlete or artist, is one who is capable of calculating and working across thresholds that are very small, detecting and managing micro-variations. We amuse ourselves with the fact that no human family has ever consisted of 2.4 children, but to disallow such a concept in the representation and management of our social relations would lead inevitably to blunder and brutality. In order to manage a social collectivity sensitively and accountably, at a scale much larger than the individual, varying provision between localities with different population densities, for example, one needs to be able to operate with tenths and hundredths of an individual. Bergson decried the cinematographic apparatus and metaphor, but it was only the micro-segmentations of cinema that allowed us for the first time to understand the fluidity and complexity of organic movement. We live in an analogue world, but we are formed digitally by the combination of atoms, molecules and coded DNA, and can understand and modify our analogue existence much more effectively through digital analysis, once we have machines that allow us to analyse these digital relations very fast indeed.

This is because most of our perceptions and judgements are in fact roundings-up, crude or near-enough estimates. Digital analysis can get underneath or inside these perceptions.

When we speed-read, we summarise, the result being the reliance on models, or prefabricated blocks of thought. The result is intelligible but ‘lossy’, coherent but lacking in grain and subtlety. But when machines and other devices speed-read, they permit us to slow our reading, to zoom in down to the scale of the individual pixel or molecule, increasing subtlety and precision. In fact the most important thing about the speed offered by computing devices is the capacity to connect different scales, moving from the very large to the very small and the very small to the very large. This kind of rationalisation moves us away from exactitude and towards precision. This capacity, accorded by the digital principle of segmentation plus speed, may be characterised as the principle of articulation, a term which joins together the idea of that which is jointed or discontinuous, and that which joins together those joints to form continuities – hence the use of the word ‘articulate’ to signify both clarity and fluency. The notion of articulation joins joining and disjoining. These two sides are conjoined in the word as far back as it is possible to trace it – Latin *articulus* being cognate with Sanskrit *ṛtú* ‘fixed time, order, rule’, Avestan *ratu*, ‘section of time, period’ and Greek ἀρτύς ‘arrangement’, all deriving from Proto-Indo-European **h₂r-tú*, ‘juncture, ordering’. Until recently, numbers and words were on opposite sides of what the word articulation brings together: numbers belonged to and exemplified a discontinuous universe, of distinct, static and permutable segments, while words belonged to the order of the continuous, the fluid, the mobile and the infinitely variable. Now, number and word converge, in that they are both forms of articulation, that join joining and disjuncture.

Digital texts and the technologies used to read and navigate them now make the communication between these orders ever faster and more fluent. Michel Serres has described this kind of development in knowledge in terms of the distinction between declarative and procedural forms of knowledge. Declarative knowledge is customarily defined as knowledge *that* (knowledge that there are twelve inches in a foot, that Paris is the capital of France, etc.), while procedural knowledge is knowledge how to do something, such as ride a bicycle. Serres sets out the difference:

The declarative or conceptual invents ideas, defining them distinctly, follows the principle of reason in its fixed form, following out causes and effects in detail. The algorithmic or procedural constructs events and singularities step by step, entering into details, in a series of times and circumstances. The declarative demonstrates, abstractly. The procedural relates, individually (Serres 2007, 184)

The algorithmic mode is made possible primarily by computing and other automated procedures, which mean that that ‘the old image of light changes from clarity to speed’ (Serres 2007, 185). ‘To comprehend thousands of examples, we have less need of the concept... Inscribed in the machine, a thousand algorithmic procedures allow the construction and direct envisaging in rich detail of singularities which are no longer smoothed out’ (Serres 2007, 185)

Digital texts participate in this new economy of knowledge which allows the rapid interpenetration of model and instance, concept and circumstance, without the one being sacrificed to the other. N. Katherine Hayles and Jessica Pressman have

focussed attention powerfully on the new forms of 'born-digital' writing that change the ways in which we might conceive of a text and what it might mean to 'read' it. N. Katherine Hayles has highlighted pointed to the ways in which 'nonconscious cognition' is enacted through algorithmic processing, in medicine, economics, biology and other information systems. Cognition, she proposes, 'is much broader than human thinking and... other animals as well as technical devices cognize and interpret all the time... The search for meaning then becomes a pervasive activity among humans, animals, and technical devices, with many different kinds of agents contributing to a rich ecology of collaborating, reinforcing, contesting and conflicting interpretations' (Hayles 2014, 217)

This is changing the nature of what interpretation is. Interpretation no longer means the explication of what a text might seem to be saying, but is rather a working out of the kind of work that a text might perform in different circumstances. It is much more like the execution of a code, or the playing out of a game than the utterance of a meaning, or the performance of a ritual (Connor 2014). Faced with digitally conceived and executed texts, Jessica Pressman proposes that we subject them to the same kind of interpretative response as the texts produced under the historical and technological conditions of modernism. The most arresting part of her claim is that digital works require and respond to an application of the same kind of close reading as had previously been applied to more traditionally-produced works. Literary scholars, she writes

need to pay more attention to the literariness of electronic literature. I close read digital literature because the works deserve it... The works that sustain my study invite and reward close reading. They are rich and complex, filled with intertextual allusions and complicated poetics that reward careful reading and rereading. (Pressman 2014, 19)

Central to Pressman's conception of close reading are the notions of difficulty and critique, the idea that literary texts should embody some kind of refusal of or resistance to the very media which they occupy. This is to make internal to the works of digital modernism a conflict that had been characteristic of the defining relation between literary texts and the texts of the mass media as it had shaped the practice of close reading in the work of Richards and Leavis. Her analysis of *Dakota* by YHCHI (Young-Hae Chang Heavy Industries, the duo Young-hae Chang and Marc Voge) is central to her argument. The difficulty presented by the work is that it refuses to surrender itself to our attention. The text, describing a drunken car trip, flash on to the screen at just about the speed required to give the sense of a monologue being uttered, in a kind of hear-seeing. It is certainly true that the text puts quite a lot in the way of our comprehension, since we are unable to do what texts ordinarily allow and even require us to do, namely to move backwards and forwards. The text is not only opposed to the digital principle of interactivity, it is trying to eschew all the conditions of writing. While the text as it unrolls on the screen seems to allow us to do little more than snatch at comprehension, the reading offered by Pressman snatches from that very principle of uncapturable flight a principle of flight, catching from the text's surcease success.

Dakota promotes two seemingly opposed reading strategies: it prompts the reader to sit back and passively consume streams of flashing text but also incites the critical reader to reread the work, transcribe the words, and compare its content to Pound's modernist epic. *Dakota's* content calls for a

reading strategy of careful interpretative comparison while its formal presentation challenges such attempts. (Pressman 2014, 84)

But this reading of the text as an allegory of reading reduces it to a gesture (or doubles the self-reduction of which it already consists). This is the very opposite of the kind of uncompression which we might say is the aim of traditional practices of close reading, which is to unpick the codes that allow us simply to consume the text in the mode of recognition. Instead, the foregrounding of the difficulty of reading exacts the most powerful kind of compression of all, in compressing the text to a gesture, which is closely compacted with the critical reading that tells us what it is (a work that is literary as well as digital). It would be tempting to say that there is little that resembles close reading in this exercise, were it not for the fact that it presents, in a formalised and accelerated fashion, the very gesture which had already become characteristic of the ideology of close reading. When one knows that one is doing close reading, and recognises what one is doing as just the kind of approved and predictable practice that 'close reading' is taken to be, the effect is to increase redundancy and therefore speed up the recognition and absorption of the text rather than to slow it down.

It would be a mistake to see this as a 'critique', though it aims to diffuse some of the force of the idea that close reading itself is a critique. It is rather a demonstration of the economies of reading and the representation of reading in which the idea of close reading has come to operate, in a way that might have seemed predictable, and is perhaps necessary.

Of course we must expect writers and artists to explore the possibilities that digital media and algorithmic structures open up, and admire their inventions. But it would be a mistake to see too dramatic a break between texts that inhabit an earlier phase of writing and texts that exemplify the new digital or virtual condition. For, just as written and printed texts absorbed and transformed oral performances, while at the same time making the conditions of the oral clearly visible for the first time, so digital texts are in the process of absorbing and transforming the texts of the last 5000 years, by making visible their conditions of possible, and the conditions that they make possible. Indeed, what might be termed, following Jakobson, the move from the axis of selection to the axis of combination is something that belongs to the mathematical condition. By the axis of combination, Jakobson means the joining together of signs in temporal sequence. The axis of combination depends upon the conjunction 'and'. By the axis of selection he means those elements which a language seems to make available to us as alternatives at every point in an utterance; this axis depends upon the relations established by the word 'or'. In a metaphor, Jakobson proposes, the axis of selection appears to be rotated into the axis of combination; seeming to spell out sequentially the alternatives that might be regarded as stacked on top of each other, mapping equivalence on to sequence.

But perhaps we need another rotational dimension to image what digital work seems to add to text. Rotate a line through 90° and you obtain a two-dimensional chord. Rotate that chord through 90° outwards (or inwards), and you obtain a three-dimensional conic section. What name might we give this extra dimension? It might perhaps be the axis of *variation*, in which what are already chronotopes, or space-time aggregates, are themselves extended into a new 'direction', the direction of multiplication of form. Writers and artists from the late nineteenth century onwards became fascinated by the possibility of imagining a fourth dimension of space, and it

may be that the digital condition is an enactment of something like that possibility. For, once one sets out on the work of extending dimensions, the number of possible dimensions is itself extended beyond limit: any given number can become n , any number at all. Michael Serres has characterised the open field of thought that this promises, in the life of the fabular daughter he christens 'Thumbelina', for whom technologies that begin by abstracting things into number lead us out beyond the abstraction of our concepts:

And what are we to think of concepts, so difficult to form sometimes? Tell me what Beauty is. Thumbelina replies: a beautiful woman, a beautiful dance, a beautiful sunset... Stop! I asked you for a concept you give me a thousand examples! Will you never have done with your dolls and horses? ...

Just as the subject has changed, so has the object of cognition. We do not have any necessary need for the concept. Sometimes we need it, but not always. We can dally as long as we wish among fictions, instances and singularities—the things themselves. Practically and theoretically, this innovation restores dignity to the knowledges of description and the individual. As a result, knowledge gives dignity to the modalities of the possible and the contingent, to singularities. (Serres 2012, 45, 46; my translation)

The ability to calculate and reason with n -dimensional space cannot take place without the primary act of reducing the plenitude of space to number, to the three dimensions of left-right, forward-backward and up-down. In the Cartesian grid, these three dimensions will suffice to plot every single point of experienced space. But extrapolating the numerical operations required to construct our experience of three-dimensional space takes us without any kind of break into any number of dimensions beyond those which we seem equipped to imagine. Number outdoes imagination, but perhaps draws imagination in its wake.

One might see writing as the rotation of time-bound speech in the direction of space. The coming digital text, with print as its harbinger, is a rotation of the space-time aggregate of the text in the direction of number. In what direction is number to be rotated? We may say, in as many directions as there are numbers, since only the enumerable gives access to the innumerable.

How are we to see the entry of number and quantity into literature and art? Our tendency is to think of the series of integers as blank, invariant, unhistorical, and of 'mathematics' as a single, universal and unchanging code, such that anything that is translated into mathematical form loses its colour, quality and distinctness. But it may be that the gravitational pull between word and number will work in both directions. That is, not only will the word have been transformed by the entry into it of number, the order of number will also be diversified. Words are no longer the same now they have been fully quantised, but numbers are no longer the same either.

The world we are entering is one in which number and word are no longer antagonists, and in which what we think of as literary language shares more with the qualities of numbers than any other kind of language. The way in which many people in our modern world encounter number is in the mode of play – whether in sport, or in the forms of quantical speculation it spawns. The kinds of playfulness that characterise art and literature borrow from the energy of putting things into play. For the play with possibility, number is indispensable.

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