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The Neurobiology of Human Super-Communication: Insights for Medicine and Business

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Abstract

Background: Much adversity in our lives can be traced to a communication breakdown. To communicate well, it helps to understand how our brains and its communication hardware and software were assembled in the first place. With these insights, comes a better understanding not only how we can best communicate, but also why it is that way. We can be heard globally but fail to relate to someone beside us. **Current modes of human communication:** Electronic communication has had stupendous impacts, but cannot accomplish the fine-tuned, penta-sensory input and multimodal output communication abilities we developed over millions of years as primates. Even those developed before the age of mammals, such as scent and sound, continue to influence and modulate our more dominant vision sense. Hence, video-conferencing or skyping is unlikely to reliably relay critical pupillometrics, facial micro expressions, body postures, leg movements or scents. Although convenient to dispatch an email, twitter or facebook message at any time during a 24-hour period, the intended message or its impact may not be the optimal one. The remedy exists in knowing what communication tools should be used for what purpose. Much of our interaction involves important decisions, maneuvers, counseling and visionary ideas that are most effectively communicated with the 10 communication modalities we evolved with. **Deployment of our communication modalities:** An overview of the communication unit assembly process and prodigious communication abilities is presented and how to use these features to propel us back to our super communicator status amongst our workers, patients, peers and colleagues.

Keywords

Multimodal Communication, Non-Verbal Communication, Non-Linguistic

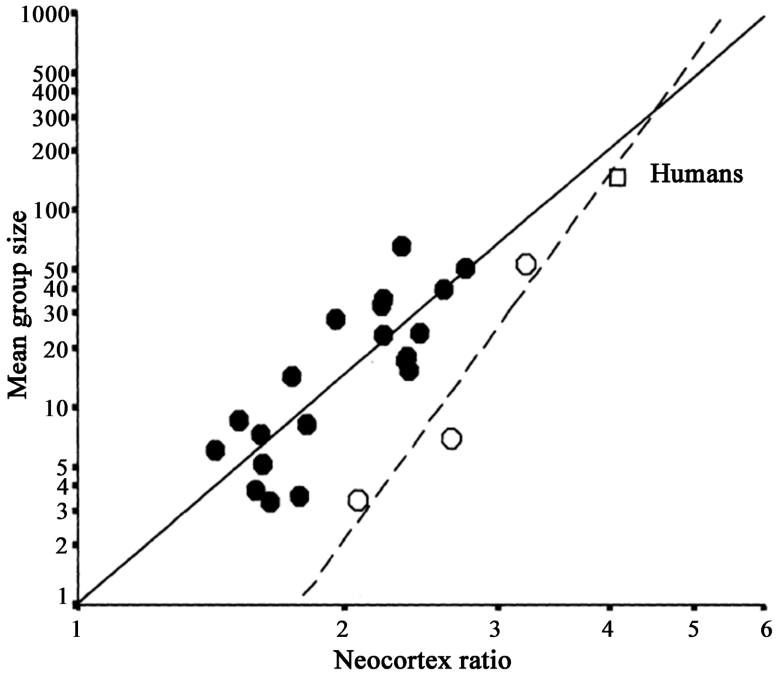
Communication, Super-Communication

1. Background

Human communication research portends that about one third of language communication is verbal and two thirds non-verbal [1] [2] [3] [4] [5]. How then can we become proficient communicators in an age of electronic communication. As always, it helps to look inside the box and take a peek inside at the equipment we use. Trees and plants have sophisticated cellular machinery, including the same DNA and neurotransmitters we use. However, they do not move, that requires a brain. Movement through the environment and its inherent encounters of both hazards and opportunities is a game changer, requiring enormous neural resources. The more rapidly an organism can assess the environment, the more effective its coping skills and survival are. Our communication heritage evolved to include a penta-sensory input system and a multimodal output communication proficiency. Our brains were honed, literally through fire (volcanism, plate tectonics) and ice (Milankovitch cycles triggered ice ages) culminating in our emergence on the relatively newly evolved African Savannah ~7 million years ago [6]. We survived by carving out a new niche of endurance running, power scavenging and high-quality diets alongside the apex super-predators (Dinofelis and others). Some portend that an even greater brain growth stimulus was the survival enhancing group effort and polyadic communication challenges of our conspecifics, the Social Brain Hypothesis [7] (**Figure 1**). Both correlated with a tripling in brain size, but the latter linked to a surge in connectivity. In today's world, this "make or break" arena takes the form of the business world, big corporates and stock market transactions. The evolutionary trajectory of the brain from early vertebrates to mammals and then humans, has changed from one of processing sensory stimuli, to one that selects an appropriate motor response, to one that carefully weighs its options, culminating in today's human brain being dubbed a "predication machine" [8].

Supercomputer vital statistics

Similar to computer systems, we have operating constraints both in terms of hardware and software governed by the laws of physics and with ours, also by biological systems. We have a 1.5 kg (3 pound) processing unit that is at near maximum working capacity, comprising of 100 billion neurons and 100,000 miles of cables (axons) [9]. The five human sensory systems together acquire ~11 million bits of information every second, whereas the conscious mind is only able to process 16 - 50 bits per second [10]. The overwhelming portion of incoming information is therefore processed subconsciously. Overall estimates are that conscious activity comprises of ~5% of all cognitive activity with 95% occurring non-consciously [11] [12] [13]. It is no surprise therefore that many survival aspects and important decisions occur without our conscious awareness. We jump



Legend: Black circles: monkeys, open circles: great apes, square: humans. Y axis: number of interacting individuals. X axis: neocortex ratio (neocortex volume divided by total brain volume). With permission: Dunbar RIM. The social brain: mind, language and society in evolutionary perspective. Annual Review of Anthropology 2003; 32: 163-181.

Figure 1. The Social Brain Hypothesis: increasing brain size with increasing group size.

before we think, thanks to evolutionary, fine-tuned survival features of rapid subconscious reflexes. That is our heritage. To benefit from our non-conscious processing capability, about each other, for optimum communication between us, we have to be in each other's company, that is, face to face!

The drive towards increasing complexity, intra-connectivity and inter-connectivity

Humans evolved to be "wired" to seek and enjoy the process of information acquisition, as this leads to improved survival [14]. The more you know, the better prepared you are for any eventuality. Reading, for example has hedonic value because of its tremendous information acquiring capacity [15]. Arbitrarily, taking up the story from the departure from the primate lineage ~7 million years ago, our brains swelled to about 3x the size of our chimp like ancestor, over the next few million years, ascribed to an increasing high quality, shellfish, meat and tuber diet [16]. Perhaps even more important, have been challenges of coping with increased social complexity [17]. Within this much larger brain, key intelligences for the environment (natural history), sociality, technical and early communication skills resided, but remained relatively isolated from each other [18]. These attributes were acquired in the Eastern and Southern African environments. Intra-connectivity of these intelligences followed, with the birth of enhanced working memory capacity. The surge in brain intra-connectivity may have been an isolated Southern African event, impelled by the severe climatic

conditions of Marine Isotope Stage 6, about 180,000 years ago, which forced dwindling humans to fortuitously imbibe a high sea food and tuber diet and spurred synaptic efficiency, thanks to the high DHA (docosahexanoic acid) fatty acid consumption [19] [20]. The intra-connectivity that followed has been dubbed the 'missing link' of cognitive evolution [21] and culminated in the complex social circuitry (**Figure 2**) we have today and the human connectome. All of the cerebral lobes are involved in communication, depicted in different colors in the figure to facilitate appreciation of their expansive locations.

Supercells

Other key features in our hardware include super cells. Von Economo neurons (VEN) and fork cells in the ventral anterior insula and anterior cingulate of the frontal lobes, so far have been found only in humans, great apes and social animals such as elephants and cetaceans [22] [23] (**Figure 3**). VEN are a feature of social animals and are postulated to have enabled rapid social communication. These long-range distance communicators are a key component of the social brain circuit for the rapid decision-making processes required by the very much more dynamic social environment compared to the relatively static physical environment that most other mammals contend with [24].

The emergence of emotional intelligence and super-cooperators

We are born imitators of each other. We nod, move and feel in synchrony with others, thanks to our mirror neuron system (MNS) circuitry. When viewing the facial expressions of others in pain, we feel that pain to some degree, emotionally. This allows empathic feelings and improved ability to take another's point of view. Both working memory and MNS levels have been accredited with 7 levels differentiating us from our nearest living relative [21] [25]. Emotional

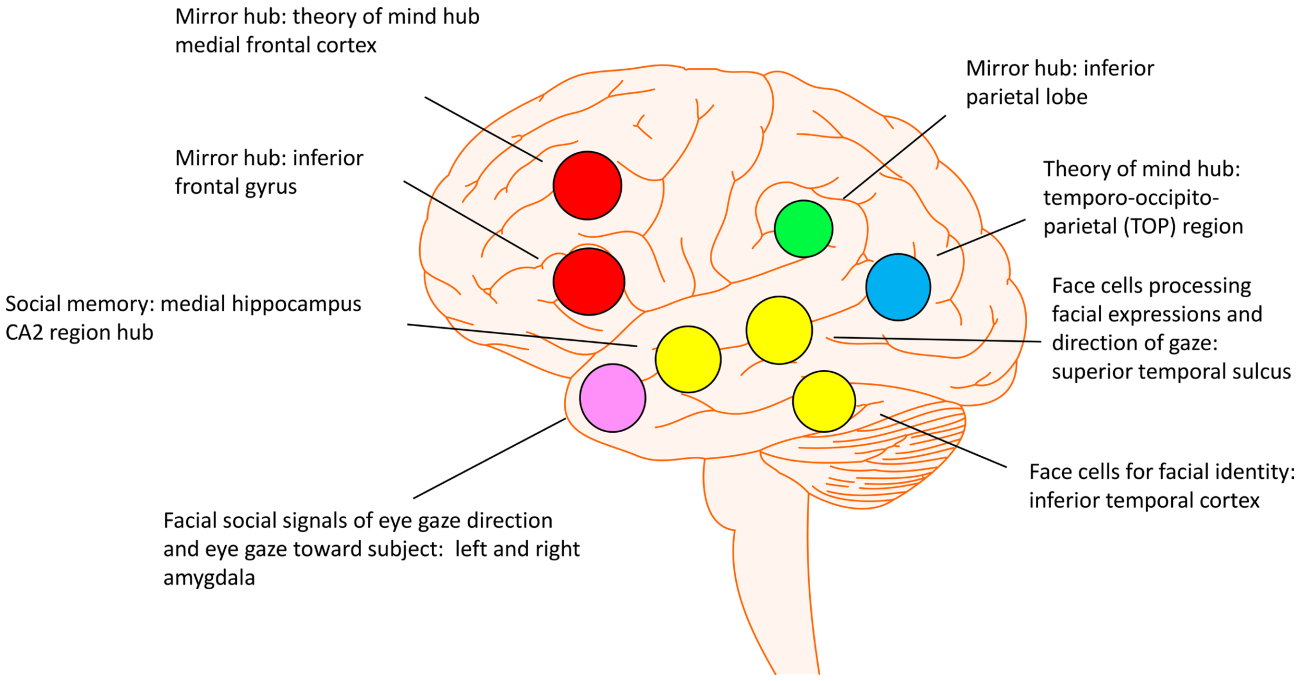
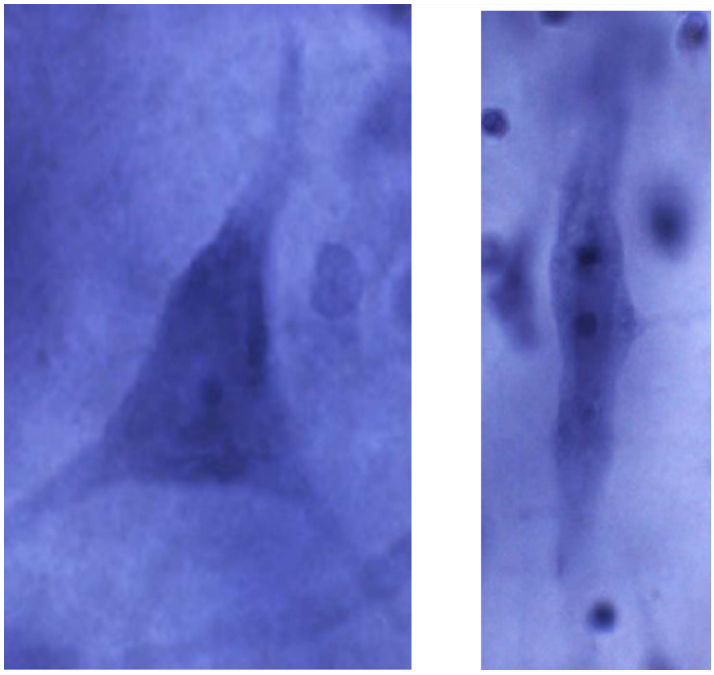


Figure 2. Schematic social brain circuit hubs.



With permission: Uppal N, Wicinski B, Joseph D, Buxbaum JD, Heinsen H, Schmitz C, Hof PR. Neuropathology of the Anterior Mid-cingulate Cortex in Young Children With Autism. J Neuropathol Exp Neurol 2014; 9: 891-902.

Figure 3. Neuron (left) and VEN spindle shaped cell (right).

intelligence evolved from social intelligence and a theory of mind based on the MNS to better understand and predict the actions and intentions of our conspecifics and so facilitating social bond formation [26].

Progressive intra-connectivity followed, through multimodal (acoustic, visual, olfactory) means. Dirt archeological evidence of these processes include the first symbols such as stone axes, dubbed the "Ferrari's of the stone age", that endured in our history for a staggering 1 million years [27]. Subsequent artefact discoveries included seashell art evidence, ochre painting (80 kya), the first musical instruments (ivory flutes) discovered in the Danube valley in the Swabian Alps and subsequently the impressive Franco-Cantabrian cave art ~40,000 years ago [28] [29] (**Figure 4**). In the latter phases of our cultural development, verbal language was presumed to have emerged around 40 - 50 kya and later written language ~5000 years ago [30]. Today we are in a super interconnectivity, global phase (electronic age, internet), presciently predicted over 60 years ago by Teilhard de Chardin that he termed the "noosphere" [31]. This is largely language and narrative based, devoid of the more ancient multimodal communication systems and their unique contributions.

The culmination of these processes endowed us with a sophisticated multimodal communication means, that we largely relinquished today and have reverted back to a paucimodal communication, analogous to the unimodal morse code type manner of communicating. Super-cooperation emerged amongst hominins as a by-product of direct and indirect reciprocity, network reciprocity

The artist had to retrieve images from long term memory and maintain it in working memory: Two Bison, Lascaux France. With permission: Fagan B. Cro-Magnon. Bloomsbury Press. 2010 New York. Martin Jenkinson/Alamy.

Figure 4. Using visual symbols to represent ideas.

and kin selection reciprocity. Some researchers, such as Nowak Maintain, that the preponderance of what humans have achieved is as result of this super-cooperation [32]. The right mix of friendship clusters and diverse contacts for exposure to novel ideas is critical for success. There were times when sociality circles were optimized in terms of the mix, ratio and clusters of people interacting, resulting in creative works. This was well demonstrated by the flourishing scientific, psychology and artistic events in Vienna at the end of the 19th century and the musical West Side Story in the early 20th century, as examples of an optimum mix of people, number and environmental interactions [33] [34] [35].

2. Current Modes of Human Communication

Human multimodal communication components

There are 5 senses (vision, hearing, touch, smell, taste) and 10 or more output channels (**Table 1**).

With all but three of these, language, musicality and visual arts, a physical face to face presence is required. These sensory and motor components of our discourse are tightly linked and play varying parts in our interpersonal and group discourse.

1) We have gaze signaling eyes

Humans and primates have emphasized the visual sense more than others primarily due to our arboreal evolution. More recently however, visual processing evolved to steer social interaction and monitoring of eye signs and gaze interpretation have become a foundation of the theory of mind analysis. This is linked to the mirror neuron system that allows predictions of the intentional states of conspecifics [36]. Gaze has thus evolved to become a key and critical social signaling mechanism. Humans are unique amongst primates in having evolved the "whites of the eyes" or the sclera which allows much more accurate appraisal of direction of gaze (**Figure 5**). This enhanced human gaze

Table 1. Communication output channels.

method	Communication
1	Eye gaze
2	Pupil alteration
3	Facial expression (>10,000)
4	Gesturing
5	Body posture (~250,000)
6	Musicality
7	Visual art
8	Prosody
9	Language
10	Olfaction

Kobayashi H, Kohshima S. Unique morphology of the human eye and its adaptive meaning: comparative studies on external morphology of the primate eye. Journal of Human Evolution 2001; 40: 419-435.

Figure 5. Human Eye Evolution: Human eye (left) and Chimpanzee eye (right).

signal enabled by white sclera was due to loss of scleral pigmentation of primates as well as widened and larger eyes. This improved communication amongst conspecifics translated into better cooperation and success in daily activities so critical for primate social interaction. The greater visibility of the eyeball trajectory allowed for 'gaze signaling eyes' of humans as opposed to the 'gaze camouflaging eyes' of the primate lineage [37]. Sideways glancing may signal both interest and suspicion. Increased blinking may reflect a stressful situation or indicate lying [38].

2) Pupil signals

Pleasant images correlate with pupillary dilation and constriction with unpleasant images, registered non-consciously [39]. The pupils are one of the most important and reliable human communication devices but are involuntary and work independently from the conscious control mechanisms. Pupil dilatation detection occurs automatically and is evolutionarily hardwired. Pupil size is affected by arousal and excitement which may cause a fourfold increase in size. Conversely anger causes pupillary contraction [40]. Both pupil size and eye gaze

were critical developments amongst primates in social communication with evidence that extant primates display pupil size mimicry similar to us. The protective and cooperative benefits of group-living are countered by the challenges of securing trust which amongst primates has been primarily achieved by eye signaling movements and pupillary size estimation, which confers insights as to the state of mind of others [41].

3) Facial expression

Estimates of our ability to feature over 10,000 facial expressions reveal the extent to which we rely on face to face encounters [42]. Facial micro-gestures lasting about 1/5 of a second, are subconscious and may indicate lying. A genuine smile too, is generated subconsciously, are automatic with the genuine smile coordinating movement of both the eyes and mouth whereas a forced smile causes upturned corners of the mouth only [43]. Smiling and its close cognitive activity, laughter is infective in a group and simulates cooperation, promotes concepts, teaching and nurtures friendship. Facial electromyographic studies have revealed that people tend to mimic facial expressions of those around them and that both positive as well as negative emotional reactions may occur unconsciously, implying that face-to-face communication may have important non-conscious input [44]. Furthermore, medical benefits include an augmentation of the immune system and inducing endorphin release that engenders a sense of well-being [45].

4) Gesturing

Gesturing predated language and is today used to emphasize spoken language and also used to free up working memory capacity for narrative language [46] [47]. To date, descriptions of up to 7 different hand to face gesture signs of lying have been described, including the mouth cover, nose rub, eye rub, neck scratch, collar pull, fingers in mouth and ear grab [2]. Gestural language is one of the three major language evolution theories and a form of gesture therapy is employed today in enhancing language in those rendered aphasic [48] [49].

5) Body language and posturing

Crossed arms may indicate reservation, hands on the hips and wide based stance a degree of aggressiveness and a head tilt or chin support may indicate evaluation processes. Crossed legs may indicate withdrawal from the interview and foot tapping the body language of impatience [50].

6) Musicality

After terrestrial based olfaction developed about 380 million years ago (mya), improved detection by auditory senses developed 300 mya enabling reception of higher frequency sounds [51]. Very much later in our evolutionary history, this was further elaborated by musical ability evolution (~1 mya) is therefore a much more ancient communication circuit than language, which is variously dated to about 30 - 50 thousand years ago (kya) [52]. Neuro-archeological research posits that 'music making's role emerged as a form of social bonding. One mechanism may be the role played by the neurochemical, oxytocin release from the basal forebrain that modulates synaptic connections of previously stored knowledge, facili-

tates new knowledge acquisition while interacting with others [53]. Music has the capability of invoking so called partial emotional states. Aside from the principal mammalian emotions of fear, rage sadness or happiness, less intense derivatives of these, such as apprehension, annoyance, pensiveness and feeling contented, may be induced by musicality [54]. Making music together is a form of cooperation at very little cost [55]. Music is the "biotechnology of group formation" [56].

7) Visual art

This predated language and the impressive Franco-Cantabrian cave art (~40 kya), regarded as equivalent resplendence to the Renaissance paintings with Henri Breuil designating the Spanish Altamira cave painting "the Paleolithic Sistine Chapel" [57]. These represent an imagistic form of communication, akin to imagenes used today in electronic communication. Cave art has been interpreted as conveying and reflecting on our most important challenges and concepts that humans of the day faced, including pondering the afterlife, cosmic contemplation and transcendental ruminations [58]. With fragmentation of the brain's circuitry such as occurs with dementia or traumatic brain injury, a return to visual art communication is sometimes more effective than language and the quality of art can be impressive [59]. The National Intrepid Center of Excellence research into art and mask painting for military related traumatic brain injury and post-traumatic stress disorder, is a good example and yields information not easily obtained through language; "When words are not enough" [60].

8) Prosody

The melodic intonation of speech sometimes mediates the major part of a message. With different accentuation, the sentence "I *really* had a great day today" could mean the exact opposite, that is, having had a terrible day instead of having experienced a wonderful day [61]. In some languages, such as the Mandarin Chinese, tonal language prosody is even more critical. The word "ma" may refer to mother, numbness, horse or curse, depending on the accentuation used [62].

9) Language and communication

Complex language involves tens of thousands of words in addition to complex sentence construction and the unique human capability of 5 or more levels of recursivity of expressive language output. Despite this, some researchers have suggested that the total impact of a message is 7% verbal (words only), 38% vocal (tone of voice, inflection and other sounds) and 55% non-verbal [63]. Others such as Birdwhistell have postulated the term 'kinesics' to refer to the non-verbal communication and have estimated that a face to face conversation is 35% verbal and 65% of communication is non-verbal [64]. Although language has unique powers of communication, especially with regard to its reading adaptation in conveying precise information, it remains an imperfect method of communication. A fleeting overview of terms such as; "what I meant to say", the frequent use of "I mean…", or "let me put it another way", or "let me rephrase", underscores the difficulty we frequently have at times, in transmitting our message in the narrative. However, narration may override all other forms of communication. Some people "have a way with words" or "are powerful speakers" and may

override the message of a less eloquent presentation. As a form of knowledge acquisition, it is probably unparalleled amongst the forms of communication. The overall acquisition of knowledge and information is a major driving force in human evolution. The urge to learn new information is associated with survival value and sexual selection advantages.

Reading is perceived as a form of pleasure by some individuals and hence is linked to the reward processing, hedonic circuitry of the brain [65]. There are grades of pleasure, including anticipation, liking (hedonic effect of a reward), wanting (conscious and non-conscious motivation) and learning (associations and future reward). Seeking out novelty information, often by electronic media, such as "surfing the web" is termed diversive curiosity. Epistemic (knowledge) curiosity is associated with more integrative knowledge storage already embedded or wired in the brain. An important consequence is that this mode of knowledge seeking, engages and activates more extensive brain circuitry than that triggered by a particular modal input such as vision or sound [66]. Reading is of course the most exacting and efficient manner of knowledge acquisition [15].

10) Olfaction

The olfactory sense is perhaps the least emphasized sensory organ. Yet, this is our most ancient organ and similar to sound, it is spatially unconstrained. Unlike vision which needs to be directed or "locked onto" a particular target, requiring attention, focus and concentration, the olfactory and auditory senses are always online. They do not require focus and are critical alerting responses for predation, environmental and social events. Much of this information is processed non-consciously or subliminally, but subliminal does not mean minimal information. On the contrary, olfaction, smells or aromas influence not only our minds, but interact and modulate our other senses. There is a cross modal interplay between our 5 senses, in that they influence each other. For example, cueing of an olfactory stimulus led to quicker sound localization in young adults [67]. The chemosensory organs of smell, taste and the trigeminal sensation display a convergence into central processing region in the brain that can lead to alteration or reduction in the other senses at the brain level [68]. Furthermore, brain areas mediating emotional responses were affected differently by pleasant and unpleasant odors demonstrating a physical link between odors and emotions [69]. Odors affect our emotions even whilst sleeping. For example, dream content can be manipulated to a more positive emotional content by pleasant odors, such as rose scent and a more unpleasant one by rotten eggs [70]. During sleep, if a fear inducing odor was given to rats, this adversely affected memory consolidation [71]. Humans therefore probably also communicate emotion through chemosensory signaling [72].

3. Deployment of our Communication Modalities

Communication failure causes

The approximate lexicon for words in a young adult is typically around 50,000

- 70,000 words [73]. Research by Ekman claims the potential number of different facial expressions number in the region of 10,000, whereas Mehrabian claims up to 250,000 and body postures and movements ~450,000 [5] [74]. Although one may question these numbers, even if only a fraction is correct, there is a vast panoply of facial expressions and body posturing, the sheer numbers which rival word vocabulary numerically.

Language is heavily dependent on one or more of our senses to illustrate a point. This is usually visual or the auditory domain; "Do you see what I mean?" and "I hear you". In the last few decades, we have in a sense regressed back to a more restricted paucimodal communication method. As with the invention of Morse code in 1836, long distance and remote communication represents a technological advance but a large part of a typically human message is not transmissible. The rich multimodal communication systems we evolved with and the predominant use of literary and narrative linguistic communication may lose a large part of the message.

Why did senses and signaling modes evolve in this manner? Probably, it was one of necessity. The social scene is very dynamic, as opposed to the more static environment [75]. We needed all the help we could get from our senses and motor abilities. Lack of sociality has considerable detrimental effects, not the least of which depression and anxiety are, both leading causes of morbidity in the modern world with neuropsychiatric disease in general the number one cause of morbidity in "Western" societies. Depression and anxiety are direct consequences of social exclusion from an evolutionary perspective. The leading medical illnesses afflicting societies globally (heart attack, stroke, cancer, viral illnesses) are others [76].

1) Attention is critical to language but is limited: What you cannot do

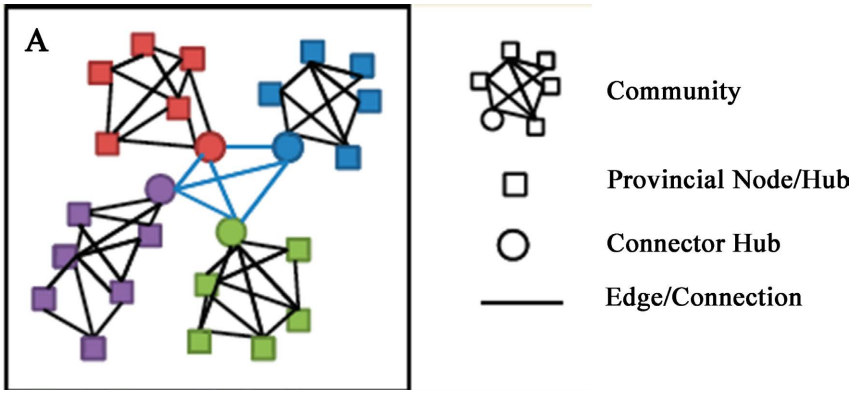
Language taxes the attention and working memory capacity of the brain. Attention is an evolutionary solution to sensory overload. The brain processes immense amounts of information per second, yet we can attend to only a miniscule fraction of the incoming data. Hence, visual and auditory attention evolved, but with these constraints. For example, multitasking is a misnomer, as we are really performing tasks in sequences. Both physiological and neuronal network science tells us that there are major constraints in so called multitasking. It is physiologically not possible to process more than a few items (range 2 - 7) of information at any one time [77]. Major bottleneck areas in the neural network for working memory exist, namely the superior parietal lobe and frontal cortex (frontopolar and dorsolateral prefrontal cortex) [78]. Experimental psychology informs us that it is difficult to engage in more than one "control demanding activity" at a time. Feng *et al.* have postulated that a trade-off exists between flexibility and efficiency, termed multiplexing as opposed to multitasking [79].

The emergency room departments, stock market exchanges and air traffic control centers are venues where multitasking and frequent interruptions are pervasive, predisposing to errors [80]. Driving a vehicle whilst talking on a cell

phone may be commonplace, but causes inattention blindness and equates to drunk driving with a blood alcohol level in the region of 0.08% [81] [82]. Furthermore, we are constrained by the milieu of our own neurotransmitters that mediate attention, arousal and learning that pending on the time of day, sleep quality or state of mind, can both stimulate us or slow us down and even cause us to make irrational judgments [83] [84]. Similarly, hormonal fluctuations may have so called neuro-economical consequences in response to cognitive and behavioral decisions attributed to testosterone and cortisol levels in traders that influence rational stock market transactions [85]. Attention is impaired in those with attention deficit disorder, lack of sleep and with various forms of brain vascular and psychiatric illness. The evolutionary answer has been to rely on a more dependable "universal senses" such as sound and smell, as a back-up, to alert us to danger or opportunity.

2) Intra-connectivity failure and avoiding hub malfunction

Brain networks interconnect with numerous other circuits, with areas of interconnectivity termed hubs. The major hubs have long range connections in comparison to other more localized, provincial hubs (**Figure 6**). The major hubs, also called rich clubs, subserve attention, working memory and executive function, the basis of the higher cognitive processes. As a consequence, these brain regions are the highest energy consuming parts of the brain. However, these hubs are the areas that are most vulnerable to energy supplies as occurs with traumatic brain injury, vascular disease and dementias as well as fatigue, migraine and work stress. These "hot spots," form the concept of the hub vulnerability hypothesis proposed by Crossley *et al.* [86]. The attention and working memory capacity has its neurobiological foundation in the expansive network circuitry that is organized according these key hub areas, termed a small world configuration by network specialists. This arrangement is not dissimilar to airline hubs. In both, these high-performance areas, are critical in the network function but are also the sites most vulnerable to damage. How to keep the rich clubs working and



With permission: Carrera E, Tononi G. Diaschisis; past, present, future. Brain 2014; 137: 2408-2422.

Figure 6. The networked brain, termed a small world model, with connector hubs (rich clubs) provincial hubs and their connected communities.

how to keep your networks at an optimum functional capacity to enable optimal communication are the most important elements that underlie super-communication.

3) Social circuitry failure

The social circuitry in our brain can be faulty or fail. We can be born or develop to be asocial, hypersocial and dys-social [87]. Examples of these include:

Asocial

Autism spectrum conditions including Asperger's syndrome that are dominated by difficulty with socializing, social cueing and avoidance of eye gaze.

Hypersocial

Williams syndrome, a congenital condition with features of being hypersocial, hypermusical and hypernarrative.

Dysocial

Frontotemporal lobe dementia and disorders that present with low empathy, poor sociability, impaired social skills and disinhibitory behavior in the context of otherwise normal cognitive functioning.

Geschwind-Gastaut syndrome including hypernarrative and hypergraphic tendencies, interpersonal viscosity syndrome, nascent philosophical interests and loquacious tendencies.

Seeking solutions by addressing the "how" and the "why" question.

1) The "how" question. Maintenance of the brain circuitry requires attention to both the internal and external circuits

a) Maintain your brain's intra-connectivity and avoid rich club failure

Maintain your attention, executive function and working memory circuits by pursuing the 5 brain fitness rules; physical exercise, cognitive exercise, brain foods, sleep hygiene, socialization, depicted in more detail in "Brain Beat" [88].

b) Maintain your interconnectivity

Optimize your social communication using your penta-sensory input and multimodal output whenever possible. This enhances and augments interpersonal communication and helps to diminish social alienation which in turn may lead to anxiety, depression and impaired performance at work with colleagues.

2) The "why" question. We are wired to chatter with all the senses: Back to the fireside chat

Human communication is no different from the other activities such as physical exercise and the acquiring critical brain foods, that are linked to our hedonic reward systems. These have become entrained to seek out activities that are crucial for our survival. When deprived, we suffer mental and physical illnesses. When we use only the literary or narrative, we miss the rich, holistic communication we evolved with, through tens of millions of years of evolutionary sculpting of our brain circuitry. By typing, texting and tweeting you communicate only part of the human message, perhaps 1/3, maybe more. The 'fragmented' message is devoid of the 'feel good' hormones and neurotransmitter effects and we lose the health protective effects of sociality and sometimes the business deal. As

Sherry Turkle has succinctly pointed out from her research, "a flight from conversation is also a flight from self-reflection, empathy and mentorship" [89].

Communication modes have their strengths and weaknesses. Narrative electronic or written instruction on how to fix a jet engine or how to get from point A to point B represents one extreme of the spectrum, no other modalities needed. The other end of the spectrum involves the many different complex human issues. Recent insightful using the "neuro messenger theory" approach, akin to deciphering the process of endophasia, may hold promise in discerning neuropsychiatric syndromes [90]. A discussion concerning an intimate, interpersonal situation, or multi-million-dollar business deal is best handled through a multisensory deployment and multichannel communication. A visually appealing locality, face to face (eye, facial body language), fireside dinner (keep the pupils bigger), background music (enhance the emotions), scented prescription (food aromas, perfumes), all culturally weighted, are likely to yield the best results. After all, the invention of fire about 1.5 mya allowed us to chat and story tell, relatively free from predator scourge, enhanced by better sleep and dreaming thanks to the tree to ground transition sleeping arrangements unique to humans (exception gorillas). The subsequent dream you may have, is the brain's double check, subconscious mechanism on the societal interaction. The dreaming brain is the arena where social challenges, analyses and solutions are sought by the brain and it is no surprise that dreaming is associated with a lowered incidence of depression. The closer we can simulate these ingredients, the better we can transmit our ideas. Although this may be a more expensive way of communicating, it will probably be worth it. We were born with the world's most powerful supercomputer, became super-cooperators, so why not maintain our super-communicator abilities? When it matters most, simulate the fireside chat as closely as possible. When we speak, we put our cognitive minds on public display and when we meet, we put our emotive minds on public display. Both matter.

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The author confirms that: He has contributed to the conception and design of the article; revised the article for important intellectual content and approved this version for publication.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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