Stories as the Tool of Knowledge Sharing: How Does it Work

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Abstract: Our minds use stories as an instrument of interaction with our external and internal world. Stories are essential communication and knowledge-sharing tools. They help to create trust and participate in the creation of communities. This paper aims to explain the neurobiological aspects of storytelling. It summarises the results of research on what happens in human bodies on the neural and neurochemical levels during storytelling. The theoretical part provides a theoretical background of the topic based on the keyword search. The application part discusses how neurobiological aspects of stories work on examples of two types of stories proposed by Steven Denning: the negative and the positive. The paper enriches the theory of storytelling by explaining the biological roots of storytelling and demonstrating how they impact the listener.

Keywords: Stories, Storytelling, Knowledge Sharing

1. Introduction

"For over 27,000 years, since the first cave paintings were discovered, telling stories has been one of our most fundamental communication methods. If we listen to a Powerpoint presentation with boring bullet points, certain parts in the brain get activated. Scientists call these Broca's area and Wernicke's area. Overall, it hits our language processing parts in the brain, where we decode words into meaning. And that's it, nothing else happens. When we are being told a story, though, things change dramatically. Not only are the language processing parts in our brain activated, but any other area in our brain that we would use when experiencing the events of the story are too" (Widrich 2012). Therefore, whether real or fictional, the rich and diverse experiences embedded in narratives are integral to how we learn about our environment and how we come to understand, process and memorise information (Bruner 1991; Gretter, Yadav and Gleason 2017). "By giving meaning and personal importance to narrative content, stories also allow the emergence of emotions essential in building a sense of belonging with others in the community" (Dal Pian, Dal Pian and Dal Pian 2019, p. 10073)

Stories are perceived as "key instruments of mind … with ability to disseminate knowledge about or ways of engaging with the world" (Herman 2013, p. 162). They provide "a society of mind, suprapersonal systems for sense-making" (Herman 2013, p. 192) and are "equipment for navigating the world and solving problems" (Armstrong 2019, p. 406).

Traditional ideas of a dualism of body and mind were challenged "by empirical facts and findings amassed in the last 15 years or so by cognitive science and neurobiology "(Aldama 2015, p. 91). These are based on "an ever more accurate knowledge of the anatomy and physiology of the brain and have empirically dissolved the so-called mind/body problem in favor of a monist (or materialist) approach. The brain is a very specialized organ of the body that reacts to stimuli from the body itself (internal stimuli) and from the outside world (external stimuli), and this material reaction, according to its specific origin and outcome, is termed emotion, thought, intention, planning, etc. " (Alama 2015, p. 91).

These findings change "understanding of the relation between language, cognition, and narrative, poised between formalist models of schemes, scripts, and preference rules inherited from structuralism and pragmatically oriented theories of narrative as embodied, intersubjective interaction. Understanding the neurobiological bases of narrative may help solve this problem by showing how the ability to tell and follow stories aligns with how the brain processes language" (Armstrong 2019, p. 396).

The researches show that "experiencing a story alters our neurochemical processes, and makes assertions about memory and mirror neurons (brain cells that fire not only when we perform an action, but when we observe someone else performing the same action), the brain activity of both storytellers and consumers starts to align thanks to mirror neurons" (Dal Pian, Dal Pian and Dal Pian 2019, p. 10080). "As we become involved with a story, fictional things come to seem real in our bodies" (Smith 2016, p. 3).

This paper aims to summarise some of the most important ideas on how this works and demonstrate them using the example of two types of stories. "The ability to tell and follow a story requires cognitive capacities that are basic to the neurobiology of mental functioning. Neuroscience cannot, of course, reveal everything we might want to know about stories, but it is also true that our species would probably not produce narratives so

prolifically if they weren't somehow good for our brains and our embodied interactions with the world "(Armstrong 2019, p. 395).

The research objective of the research discussed in the paper was to explain what happens in human bodies on the neural and neurochemical levels during storytelling. The research enriches the theory by explaining the biological roots of storytelling. We demonstrate the theoretical findings of what happens during storytelling in our bodies and how it impacts the listener on two types of stories: positive and negative.

2. Background - Stories, Storytelling

"Narrative is a huge territory that encompasses numerous phenomena "(Aldama 2015, p. 88). The story is a set of symbols, "a narrative that links a set of events in some kind of casual sequence" (Denning 2004, p. 2); “it is everything told or recounted in the form of a causally-linked set of events, account, tale, the telling of a happening or connected series of happenings, whether true or fictitious” (Denning 2013, Some definitions). It is "an account of events that are causally connected in some way" (Denning 2011, p.13), a sequence of interlinked events (Snowden 1999). "A story describes a sequence of actions and experiences done or undergone by a certain number of people, whether real or imaginary" (Ricoeur 1990, p. 150).

Humans are "homo narrans", (Fisher 1984, p.6), "essentially storytellers" (Fisher 1984, p.7). Stories are the key cognitive coping mechanism (Hevern 2008). They "give events meanings and significance" (Polkinghorne 1988, p. 18) and are "the preferred sense-making currency of human relationships" (Boje 1991, p. 106). Stories provide a virtual environment for knowledge sharing and identity development (Gibbons and Prusak 2020). "Storytelling gets inside the minds of the individuals who collectively make up the organisation and effects how they think, worry, wonder, agonize, and dream about themselves and in the process create - and re-create- their organization" (Denning 2012, p. xiv). It is natural for people to share their knowledge and experience through story "because the process of creating the story also creates the memory structure that will contain the gist of the story for the rest of our lives" (Shank 1990, p. 115).

As Armstrong (2019 p. 396) writes, "Stories help the brain negotiate the never-ending conflict between its need for pattern, synthesis, and constancy on the one hand and for flexibility, adaptability, and openness to change on the other".

"The story had created a context in which the message is inescapable or at least unarguable. This contrasts with most corporate communications, where the message is delivered at the start and then explained/justified. The fable structure prevents the problems associated with starting a communication with the message, where the audience makes up their mind early in the process and decide upfront whether they will accept the message "(Snowden 2001, p. 4).

3. Objective and Methodology

The objective of this paper is to explain the neurobiological aspects of storytelling, e.g. what happens in human brains on the neural and neurochemical levels during the storytelling. The brain response to storytelling is discussed from the perspective of the listener. We did not research the storytelling brain processes of the teller, though it is possible to conclude that the teller brain response is similar.

As for the methodology, the data used in this paper are secondary data from the literature. The theoretical background, e.g. the literature on neurobiological aspects of storytelling was collected by keyword search in WOS. In WOS we searched for words: story and physical aspects of storytelling, storytelling and brain endorphin system, storytelling and neurobiology showed that the topic is underdeveloped as the search led to the identification of only a few topic-relevant articles. The same happened when Google searched for the same keyword combinations. Still, these papers became the foundation for further snowball searches, which led to the identification of other materials. We also used literature (Merzenich, Zak, Doidge) previously known to the author.

To show how the neurobiological aspects of stories work, we demonstrate them using the example a negative and the positive story (Denning 2004). As for the methodology of this part of the paper, we analysed two types of stories (Denning 2004) from the perspective of neurobiological aspects of storytelling. We applied knowledge presented in the theoretical background to elements of negative (connectedness, strangeness, comprehensibility) and positive story (introduction of the problem, solution of the problem, I into we change,

repetitions). E.g., we combined two different pieces of explicit knowledge (explicit knowledge on neurobiological aspects of storytelling and knowledge on different types of stories) to explicit knowledge of higher quality.

In this paper, we use the words story and narrative as synonyms. We use the term story in the most general and broad way as a set of symbols, "a narrative that links a set of events in some kind of casual sequence" (Denning 2004, p. 2). From this perspective, stories are not only what is told but also various types of art, like pictures, pieces of music, etc. This approach allowed us to capture the ideas of authors from different fields. The literature shows that the human brain responds to stories performed in different forms in the same way.

4. Findings

4.1 How Does it Work – Brain and Body

One of the most exciting questions concerning stories and storytelling is "how is it possible that we learn from objects we know do not exist and how we can do this" (Aladama 2015, p. 82). We can explain this miracle by an explanation of neural circuits as action-perception circuit and by so-called neural synchronicity.

The neurons in the brain create new synapses and organise them into networks. This synaptogenesis develops new knowledge and is "experience dependent" (Merzenich 2015, p. 20). It is "the formation of synaptic connections in response to our experiences and environment" (Merzenich 2015, p. 20). Or, as Hebb (2005, p. 70) writes, "The general idea is an old one, that any two cells or systems of cells that are repeatedly active at the same time will tend to become associated: so that activity in one facilitates activity in the other".

The brain is plastic. New incentives create new connections, and connections (knowledge) that is not used are dying (Doidge 2007; Merzenich 2015). "The brain knows the world by forming and dissolving assemblies of neurons, establishing the patterns that through repeated firing become our habitual ways of interacting with the environment, even as ongoing fluctuations in these syntheses combat their tendency to rigidify and promote the possibility of new cortical connections. The brain's ceaseless balancing act between the formation and dissolution of patterns makes possible the exploratory play between past equilibria and the indeterminacies of the future that is essential for successful mental functioning and the survival of our species" (Armstrong 2019, p. 397).

"Contemporary neuroscience suggests that the biological basis of these connections is an action-perception circuit that makes action fundamental to many cognitive processes that might seem unrelated to the control of

various body parts by the motor cortex" (Armstrong 2019, p. 401). Various studies proved that reading or thinking about the action reveals the activity in the relevant part of the motor cortex, which coordinates body movements (Paul 2012; Doidge 2007). "Imagining a movement relies on the same mechanisms as actually performing it, (Jeannerod 2006, p. 28)" and that "imagined actions are indeed actions in their own right: they involve a kinematic content, they activate motor areas almost to the same extent as executed actions, they involve the autonomic system as if a real action was under way" (Jeannerod 2006, p. 39). "Learning a motor task by using motor imagery induces a pattern of dynamic changes in cortical activation similar to that occurring during physical practice" (Jeannerod 2006, p. 41). Armstrong (2019, p. 402) concludes, "If the motor cortex and even muscle tissue can be excited by mental rehearsal of an action, that should also be true of linguistic simulations of actions, and there is experimental evidence that this is so".

When we see somebody else perform the action or hear about the action in the story, "the brain activity of both storytellers and story listeners starts to align thanks to mirror neurons, brain cells that fire not only when we perform an action but when we observe someone else perform the same action" (Smith 2016, How stories unfold in our bodies). "The synchronization of brain waves across the cortex makes possible the formation of neuronal assemblies and coordinates the workings of different regions of the brain" (Armstrong 2019, p. 399).

This is called neural synchronicity. This neural process allows the other person to feel like the other one motoric sensation via his own kinaesthetic memory and knowledge (Bolens 2012). Therefore, the life experience transformed into the story works the same way.

"The story activates the neuronal connection in the brain of the listener and allows him to live the experience via his own memory and knowledge. "Different brain regions track different aspects of a story," Speer concludes, "such as a character's physical location or current goals," and "some of these regions mirror those involved when people perform, imagine, or observe similar real-world activities" (Speer et al 2009, p.990). As we become involved with a story, fictional things come to seem real in our bodies" (Smith 2016, How stories unfold in our

bodies). Through this mechanism, "the brains of the person telling a story and listening to it, can synchronize" (Widrich 2012; Stephens, Silbert and Hasson 2010, p. 14425).

"This process changes the patterns of listener reception and as such support cooperation among people therefore are a valuable source of collective knowledge and social cohesion "(Armstrong 2019, p. 406).

"Plots can play a central role in structuring our understanding of the world because action is thoroughly implicated in perception and cognition" (Armstrong 2019, p. 401).

Said differently, "readers' representations of word meaning are grounded in visual and motor representations. The brain regions involved in tracking different dimensions of a reader's situation model should correspond to regions that have a role in seeing and acting out similar activities in the real world." (Speer et al 2009, p. 2).

Forming and dissolving assemblies of neurons based on imagined actions and synchronicity represents just one of the processes related to storytelling. Storytelling is also related to changes in neurochemical processes responsible for emotions.

Zak (2015, p. 6-7) notes, "If you pay attention to the story and become emotionally engaged with the story's characters, then it is as if you have been transported into the story's ". Telling and listening to stories raises emotions, which are "the response of dedicated neurobiological systems to concrete experiences" (Hogan 2010, p. 255). Eslocker (2023) writes that our brains respond to different story elements by transmitting oxytocin, endorphins, cortisol, dopamine, and other neurotransmitters.

"The narrative with the dramatic arc caused an increase in cortisol and oxytocin" (Zak 2015, p. 4). "Oxytocin was associated with concern for the characters in the story "(Zak 2015, p. 6) as it increases trust (Zak 2017). As for cortisol, its release is stimulated by a hormone called ACTH. Zak (2015) found out that "the change in ACTH correlated with the amount of attention people paid to the story. If we do not attend to a story, it will not pull us into its narrative arc" (Zak 2015, p. 6). "Once we are attentive and emotionally engaged, our brains go into mimic mode and mirror the behaviors that the characters in the story are doing, or might do" (Zak 2015, p.9). Endorphins and dopamine are released as a result of resolving the problem in the story and happiness (Eslocker 2023).

Even more, Zak (2015) discovered that "emotionally engaging narratives inspire post-narrative actions" (Zak 2015, p.4). He writes, "The narrative is over, but the effects linger. It is as if the brain is lazy and is using a "monkey see, monkey do" approach to assess appropriate social behaviors. (Indeed, the brain seeks to conserve energy by using default pathways—a kind of "laziness)" (Zak 2015, p.6).

4.2 How Does it Work – Example of Negative and Positive Story

In this part of the paper, we would like to provide examples of how different types of stories work on the biological level. Even though all stories initiate knowledge sharing, "the purpose of telling a story might determine its form" (Denning 2004, p. 6). "Stories told in order to spur action need to make good on their promises and contain sufficient evidence of a positive outcome. But stories intended mainly to transfer knowledge must be more than true. Because their objective is to generate understanding and not action, they tend to highlight the pitfalls of ignorance; they are meant not to inspire people but to make them cautious" (Denning 2004, p. 6). We call the stories supporting the action the positive stories, the ones transferring knowledge the negative stories. The form of both types is different.

Negative stories are told in the form of the springboard story (Denning 2011). The negative story is built from three blocks: connectedness, strangeness and comprehensibility. The story starts with connectedness. Connectedness is the element of the story familiar to the listener. The protagonist has a typical role the listener understands and, therefore, can put himself into the shoes of the protagonist (Denning 2012). Feeling connected to the character leads to releasing oxytocin, the bonding hormone, which results in caring and increased empathy (Eslocker 2023). "The oxytocin response lags behind the attentional spike as the story begins. After about thirty seconds, vagal activity begins to increase as viewers get to know and then begin to empathize" (Zak 2015, p.8) with the protagonist. It is a factor that engages the listener's imagination and emotions (Denning 2012). From the biological point of view, connectedness is the factor that stimulates imagination. The imagination stimulates one's kinaesthetic memory and knowledge and activates the neuronal connections in the brain of the listener (Bolens 2012; Armstrong 2019), connections that represent his own experience, therefore, start the synchronicity.

Strangeness is the factor that interrupts the thought process of the listener and, therefore, violates this experience. There are two ways how to insert strangeness into the story: something expected does not happen, or something unexpected happens. It provides the shock of the unforeseen and raises fear or curiosity (Denning 2012). Getting information that violates one's own experience (the way how neurons fire) raises cortisol levels, which increases attention, focus and memory (Eslocker2023). It prepares the listener for the knowledge the story brings.

"As the cortisol that feeds attention mixes with the oxytocin of care, we experience a phenomenon called "transportation." Transportation happens when attention and anxiety join with our empathy. In other words, we're hooked" (Smith 2016, How stories unfold in our bodies).

Comprehensibility is the idea that should move the listener to a new level of understanding. Therefore, it is the knowledge embodied in the story (Denning 2012). In this type of story, comprehensibility usually provides the solution to the problem introduced by the strangeness. Recovery from solving the problem raises dopamine levels, resulting in pleasure, hope and increased focus (Eslocker 2023; Smith 2016).

Good stories release endorphins, which relieve stress, make people relaxed, and increase creativity.

Positive stories initiate action. They are objective-oriented and, as such, propose new objectives and visions. Their form can be explained by the specific examples of these stories, which are speeches that introduce vision statements. The purpose of such statements is to introduce the ideas and visions of the teller to the listener and motivate him to accept them. To do so, it is necessary to link the story with the listener's hopes, dreams, aspirations and values. The format of how to do it is the following.

The positive story (the speech) starts with an explanation of what is wrong. The storyteller (speaker) introduces the problem from his perspective as his problem. The stress from bad news releases cortisol, which increases the attention of the listener. The problem presented is usually some general problem that worries many people. This helps people to identify themselves with the teller, and as a result, the storyteller switches from I form to we form. The problem becomes the problem of listeners, too. Then, the teller offers the solution as his vision. He explains it in images and word pictures using traditional values and well-known examples in a positive and hopeful way, which raises levels of endorphins. The solution to the problem is to increase dopamine. He also uses repetitions. Repetitions help the audience have a common experience, increase the levels of oxytocin, and lead to trust and a feeling of human interconnectedness (Kouzes and Posner 2006; Eslocker 2023). As a masterpiece of positive stories may be mentioned two human rights-focused speeches, J. F. Kennedy's Address to the Greater Houston Ministerial Association ("I believe in America …", 12.9.1960, Houston) and M. L. King's "I Have a Dream" (28.8.1963, Lincoln memorial).

Telling the story (and listening to it) is the work with two stories. "This circuit entails an interaction between worlds the fictional worlds constructed by storytellers, and their re-creation in the imaginative worlds built by their recipients" (Armstrong 2019, p.219). The emotions of the listener reflect the emotions of the character, but "they are not the character's. They are our own. That's how empathy and identification work in fiction" (Oatley 2012, p. 29).

The storyteller and the listener have different experiences, e.g., different networks among neurons and these experiences may not match. "Following a story is a similarly paradoxical process, with both intersubjective and solipsistic dimensions, whereby my own resources for configuring the world are put to work to make sense of another, fictive, narrated world that may seem both familiar and strange and that may either reinforce or disrupt my sense of the world's patterns, since its figurations both are and are not analogous to mine "(Armstrong 2019, p. 404).

5. Discussion and Conclusion

In our paper, we intended to explain what happens in the brain of the listener when listening (reading, watching) to the story and demonstrate this mechanism through specific examples of two different types of stories. Our findings indicate that storytelling, the important tool of human communication, has deeper roots than generally perceived. These roots are biological and, as such, concern stories we tell in our personal lives or produce in the arts and the entertainment industry. The same rules also apply to stories shared in organisations, even though managers and employees may be sceptical about them (Snowden 2001).

Stories provide us with a virtual environment where we learn and share our knowledge (Zak 2015). "When we read or view a fictional narrative we know it is not real, yet we still experience it as if it were real. This stimulatory

approach is what allows to determine that fiction provides a place to experience emotions within a safe space. This can and does have an ameliorative effect: it helps us improve our mental models of others and ourselves" (Oatley 2012, p. 19) or as Aldama (2015, p. 82-83) notes, "we experience fleeting emotions and insights that leave residues that can over time change our selfhood."

The change of neurochemical processes that happens in our brains when we tell and listen to the story explains the emotions the story raises and their importance for the transfer of knowledge. "Emotion is a defining ingredient in narrative fiction. If we don't experience emotion we are less involved in the story" (Aldama 2015, p. 84).

On the other hand, the experience from practice and research shows that these mechanisms may fail. Stephens, Silbert and Hasson 2010 et al (2010, p. 14425) explain, "We used the speaker's spatiotemporal brain activity to model listeners' brain activity and found that the speaker's activity is spatially and temporally coupled with the listener's activity. This coupling vanishes when participants fail to communicate. Moreover, though on average the listener's brain activity mirrors the speaker's activity with a delay, we also find areas that exhibit predictive anticipatory responses. We connected the extent of neural coupling to a quantitative measure of story comprehension and find that the greater the anticipatory speaker–listener coupling, the greater the understanding."

The approach to storytelling adopted in this paper explains why people like stories regardless of their ethnicity and culture and why "recurrent configurations that develop" (Armstrong 2019, p. 218) in stories reflect "certain repeated characteristics of our species'. Shared experiences of birth and death, collaboration and competition, propagation and violence interact with biologically based cognitive proclivities to produce statistically discoverable regularities in cultural institutions, including the stories we circulate in our communities" (Armstrong 2019, p. 218). It also explains why stories can initiate profound behavioural changes, including costly acts of altruism (Smith 2016, How stories change behaviour).

Approaching storytelling from the biological perspective opens "new possibilities for addressing fundamental issues concerning the emotional, ethical, educative, and cognitive value of art" (Carroll and Gibson 2011, p. 2) and storytelling as such. These possibilities indicate potential research gaps.

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