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Strategy Work with Artifacts: Neurocognitive Advantages of Visual Sense-building

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Biography

Robin Gustafsson is Associate Professor of Strategic Management at the Department of Industrial Engineering and Management at Aalto University. His research focuses on strategy, organization, and policy in industry and market disruptions. His recent research explores digitalization and platform economy, specifically how industries are disrupted, sources of competitive advantage in the digital age, platform and data business models, open science and innovation, and strategy work with artifacts. Robin is an expert in flipped classroom and experience-based learning methods, a facilitator, a skilled user of the Harvard case teaching method, and an expert in the LEGO® Serious Play® facilitation method. He is the founder of PlayMyStrategy and the leader of the Visentools R2B-project.

Abstract

Artifacts are rarely used today to visualize thoughts, insights, and ideas in strategy work. Rather, textual and verbal communication dominates. This is despite artifacts and visual representations holding many advantages as tools to create and make sense of strategy in teamwork. To advance our understanding of the benefits of visual aids in strategy work, I synthesize insights from cognitive psychology, neuroscience, and management research. My analysis exposes distinct neurocognitive advantages concerning attention, emotion, learning, memory, intuition, and creativity from visual sense-building. These advantages increase when sense-building activities are playful and storytelling is used.

Keywords: Strategy work, visualization, sense-building, artifacts, neuroscience, neurocognitive advantages.

1. Introduction

Despite the restrictions of verbal and textual communication (Healey et al., 2007), strategy work predominantly happens through these modalities. Hence, strategy work in most organizations is unable to tap into human intelligence that can make sense and communicate beyond words. Current strategy work practices are therefore constrained from using human cognitive capacity to its fullest extent. Strategy work could benefit from using senses other than hearing, text reading, and "mental" sensemaking; in other words, tactile, aromatic, or nonverbal visuals are also important. Visuals are interesting because of

the untapped powerful capabilities of the brain to interpret visual information. Visual representations are superior to textual and verbal communication with respect to the human capacity for speed in processing (Biederman, 1987; Thorpe et al., 1996), noting and memorizing pictorial details (Rousselet et al., 2002), visually recalling represented information (Brady et al., 2008), and using visuals to effectively express complex ideas and thoughts to others (Ritchie et al., 2012).

Engagements with artifacts and visualizations allow individuals to explicate and communicate their views, ideas, and understandings by combining them with verbal communication. Individuals and groups can enrich verbal and textual communication though visualizations with artifacts, a practice I term sense-building. Sense-building is the activity of building meanings from (visual) information, ideas, and individual understanding with the help of visual aids, such as artifacts. Building involves organizing and synthesizing components and connections, and visual aids make this process easier. Artifacts have perceptual, physical, and motoric affordances (Chong & Proctor, 2020), which allows an individual to present information, ideas and interpretations in ways that they are perceivable and can be experienced. Affordances (Gibson, 1977), the perceivable possibilities of action that artifacts hold for sensemaking and giving, are valuable for comprehension, communication, and learning.

To advance our understanding of the benefits of visual aids in strategy work and sense-building with artifacts, I synthesize insights from cognitive psychology, neuroscience, and management research. I especially focus on the findings from neuroscience and cognitive psychology that provide ample evidence of the benefits of using artifacts and visual representations in communication and sensemaking. I use these insights to elaborate on the neurocognitive advantages of using artifacts in strategy work.

This chapter is structured as follows. I start by reviewing the restrictions of using verbal and textual communication in strategy work. I next discuss the potential of using visual artifacts in strategy work. I then present my synthesis of the research in cognitive psychology, neuroscience, and management research on the advantages of using artifacts in strategy work.

2. Restrictions of using verbal and textual communication in strategy work

Communication in strategy is dominated by textual and verbal modalities in how individuals express themselves, make sense of what others are saying and build on each other's insights. Strategy work centers on teams, or a group of people who come together to make sense and jointly create insight into strategy analysis, development, planning, and implementation. The individuals participating in strategy work meetings play a central role in directing the conversation and in staging and structuring the discussion to give room to each other.

Language is a mental model that frames activities (Welch & Welch, 2008). Language holds several constraints as a verbal and graphic representational system (Healey et al., 2007). First, the vagueness of words and their meaning make communication challenging (Russell, 1923). Verbal communication is especially restricted in representing the complex and dynamic systems that strategy work centers around. For example, we cannot easily explain with words alone the details of business relationships, the factors

impacting a strategic decision, or economic causalities in business operations. Further complicating communication is that individuals use various linguistic devices to influence the conversation, e.g. emphasizing power structures, reducing complexities by simplifying ideas, and creating credibility for particular views (Kwon et al., 2014).

Distinctively, sensemaking in strategy work is constrained by the many complexities that need to be addressed in business environments, for example, the impacts of continuously developing technologies and competitive business moves. Business environments are constantly changing, and new opportunities emerge as a result of technological advances such as AI, data pooling, and blockchains. Such changes require new conceptual models and education about the new opportunities, e.g., platform business or data monetization, to explore and understand how they can be developed and change the existing business model. Furthermore, what one person means when talking about a platform strategy, a database, or a cloud solution often becomes challenging as individuals have different expertise and tie various meanings and understanding to the concepts. Language is inexact in representing the real-world complexity. This causes differences in seeing things, differences in grouping things together, and differences in understanding strategy work. It is not easy to produce collective sensemaking in which individuals conceptualize and intend the same thing in conversation. Thus, shared meaning is challenging to create among individuals engaged in strategy work with only textual or verbal communication.

Another communication challenge in strategy work is that groups quickly develop a group-specific verbal and graphic discourse that is not easily understood by outsiders (Fay et al., 2003). Individuals who interact frequently have a “tendency to match each other in choice of words, syntax, and semantics during verbal dialogue” (Healey et al., 2007:286). Imitation as such takes place. Furthermore, the specific language used by various groups in an organization creates language-specific communities of knowing. Individuals in strategy work “use diverse expressive and interpretive mechanisms derived from their respective language systems" (Hambrick et al., 1998:198). These language-specific communities further mediate the development of personal relationships at work (Marschan-Piekkari et al., 1999). Thus, the language used in strategy work might not be easily understood by others such as another departments workers, different professional groups in an organization (e.g. marketing, legal, strategy), outside facilitators, or consultants. Furthermore, a low degree of a common language in business impairs group functioning, “hampering the exchange of information and trust" (Hambrick et al., 1998:198). Finally, reliance on verbal and textual communication in strategy work requires teams to depend on people with fluency in the language used and strong verbal and communication skills. As organizations rely on verbal and textual communication in strategy work, it empowers some individuals while disempowering others (Vaara et al., 2005).

What are the implications concerning strategy work? Reliance on textual and verbal communication makes sensemaking in strategy work time-consuming and prolongs the time and effort put into strategy planning and implementation. Let us consider in more detail what it is about verbal and textual communication that creates these challenges and their restrictions.

First, communication through language has restrictions, as it requires turn-taking and verbal dialogue, which means that strategy work is sensitive to interactional constraints (Healey et al., 2007). Turn-taking

means that individuals need to perform rapid encoding and anticipate incoming content (Levinson, 2016). However, as strategy work typically involves several people, we are not able to easily build on each other's understandings and inputs, as turn-taking requires that many of the responses to others need to be held internally; thus, continuous insights and remarks from each individual are not easily integrated into joint sensemaking. Furthermore, as there are competing motivations in communication between speakers and listeners (Piantadosi et al., 2012), communication in strategy work does not easily keep focus.

Second, language has structure and compressibility. Information compression means that we employ pragmatic heuristics "that inferentially enrich the message" in communication (Levinson, 2016:9) and sensemaking in strategy work. Compressibility brings ease of learning from each other but comes at the cost of expressivity, the ability to communicate unambiguously. It takes hence time for teams and their members to put sufficient structure into their language to ensure that communication is unambiguous in strategy work.

In summary, sensemaking in strategy work is "a subtle and intricate process in which shared views are gradually synthesized through discussion" (Kwon et al., 2014:285). There are many misunderstandings and often a lack of a holistic understanding. As verbal and textual communication is at the center of processes leading to team goals, these limited modalities can lead to much time spent on discursive struggles. It is impossible to consolidate strategic understanding quickly in groups. How we conceptualize, communicate, and make sense of strategy together is therefore limited. Despite these communication restrictions, strategy work today predominantly occurs through verbal and textual communication. Strategy planning and implementation are typically dominated by meetings where verbal and textual communication and the use of paper and pen, flip charts, power points, and post-it notes dominate. Therefore, current strategy work practices are constrained from utilizing human cognitive capacity to its fullest extent.

These limitations demonstrate a clear need to find more expressive and unambiguous ways of representing strategy and its complexities. Visual artifacts and language provide several advantages. They have the capacity to aid holistic communication of the complexities of strategy, where managers can develop expressions for complexity through visual artifacts that reveal the dynamics of strategy, business, and organization.

Visual artifacts are distinct in their ability to enhance our neurocognitive capacities, including enhancements of executive functions such as memorizing and learning (encoding, storing, and retrieving information) (Satpute & Lieberman, 2006; Tulving, 2000), sensemaking, attentional and inhibitory control (Graham & Labar, 2012; Benedek & Fink, 2019), and the comprehension of others. These capacity enhancements are possible because of the multiple advantages in particular domains of the brain that engage with and utilize visual information, together with the advantages of multimodal sensemaking such as using both verbal and visual communication (Cohn, 2016). I will next go through the distinct advantages of engaging with visual representations and artifacts, drawing upon the recent insights from neuroscience, cognitive psychology, and related work in management.

3. The potential of visual artifacts in strategy work

Humans use artifacts and tools uniquely in terms of complexity and variety of usage compared to any other living species (Heersmink, 2021). The development of tools and their usage in communication by humans in the last 5000 years has been rapid. Artifact use methodologies in human communication have developed in the recent decade. Such methods include design thinking for service design (Brown, 2008; Rowe, 1991), art-based methods (Nissley, 2010; Sutherland, 2013; Taylor & Ladkin, 2009), the use of Legos (Dykes, 2018), and various materials, such as cardboard, clay, scissors, color paper, etc., in workshops. Distinctive in all of these approaches and methods is that they enhance textual and verbal communication with visualization. These approaches support visual communication of ideas through various artifacts that act as tools for sensemaking. They also aim at advancing human creativity. Such artifacts are termed visual representations or visual artifacts. Visual artifacts are "used for acting on the world, sensing, cognizing, and feeling" (Heersmink, 2021:275). Hence, the artifacts not only represent one individual's inner thought but also significantly extend collaborative thinking and expression for communication to others.

Research has pointed out the value of visual artifacts in product and business design work (Ewenstein & Whyte, 2009), organizational work (Meyer et al., 2013), cross-disciplinary collaboration (Nicolini et al., 2012; Stigliani & Ravasi, 2012), and strategy work (Dameron et al., 2015; Eppler & Platts, 2009; Vaara & Whittington, 2012). Artifacts help us represent the external world around us. Visual communication uses spatial properties "relations, proximity and place on […] to convey literal and metaphoric elements and relations" (Tversky, 2014:8). Artifacts, as single artifacts or as groups of artifacts, can convey meaning through symbols and metaphors. As such, sets of artifacts (a group of artifacts) take form as designs that express the world around us in what Tversky (2014) terms spractions: spatial-abstraction-action interconnections. A group of artifacts enables the visual representation of spatial relations and proximity, and they can convey relationships and elements metaphorically (Tversky, 2014). Visualization on surfaces such as paper, stone, or wood and through pictures and artifacts allows inspection and reinspection by others. Artifacts contribute to understanding, inference, and insight (Tversky, 2014). They help us to illustrate, for example, alternative business and partnership strategies. Artifacts can be representations and entities belonging to a category (Barsalou, 1999). They can be metaphorical or symbolic artifacts. Artifacts can metaphorically, analogically, and symbolically represent abstract concepts such as platforms, data, AI, or value propositions. They can also express relations and dynamics between elements.

Artifacts are more flexible than words and text. Artifacts can be easily modified, and what they represent can be negotiated more quickly than words and concepts. They allow more freedom to address ideas and thoughts and provide a medium for modification (the artifacts can be modified to represent issues). They are visible for questions, wondering, and insight. Artifacts can convey ideas and phenomena. They help individuals to visibly structure ideas and phenomena in teams. Artifacts, such as Legos (Taylor & Statler, 2014), have been used as tools in strategy work. With artifacts, individuals and teams can engage in strategy work by visualizing, for example, customer value, strategic partnerships, value in data, or a full-fledged platform business model. Visualizations with a set of objects, e.g., Legos, convey suggestions and ideas open for elaboration, clarifications, and collective sensemaking in strategy work.

Beyond supporting communication, artifacts enhance human cognitive abilities by being experiential, helping us think, reflect, and perform cognitive tasks (Casati, 2017; Fasoli, 2018; Heersmink, 2021). These types of artifacts have been termed cognitive artifacts. Examples of cognitive artifacts are maps, diagrams, models, and Legos. A map helps one navigate, a diagram or a model helps structure information and relationships between elements, and Legos help us visualize ideas through physical structures. The use of artifacts relies on motor, perceptual, and cognitive techniques (Heersmink, 2021). The value of such techniques in group communication has been explained in the grounded cognition view (Barsalou, 2008, 2010). It proposes that it is not words or symbols but rather commonly shared representational schemas and, importantly, simulations, such as mental imagery activated by the sensory-motor system through situated actions and bodily states, which are core mechanisms in cognitive activities (Barsalou, 2008). As such, artifacts may be a vehicle to express things beyond language (Lakoff & Johnson, 1980), a way to extend comprehension, advance thinking, reasoning, and decision-making. To summarize, cognitive artifacts function as embodied, interactive, and perceptual techniques to support the cognitive processes of memory, problem solving, thought, and reasoning (Heersmink, 2021).

4. The neurocognitive advantages of artifacts in strategy work

Using artifacts in strategy work triggers, activates, and involves our brains in ways that text and verbal communication alone do not. The multiple unique brain activities triggered when engaging with artifacts hold advantages for strategy work. My synthesis of findings from neuroscience and cognitive psychology research suggests four distinct neurocognitive advantages from using artifacts and three practices present in collective sense-building that acts as critical neurocognitive advantage activators (see Figure 1). The neurocognitive advantages from use of artifacts in collective sense-building are: (1) increased attention; (2) emotion control; (3) learning and memory use; and (4) use of intuition. The three practices are: (1) storytelling; (2) playfulness; and (3) collective sense-building. I will go through each of them in the sections below.

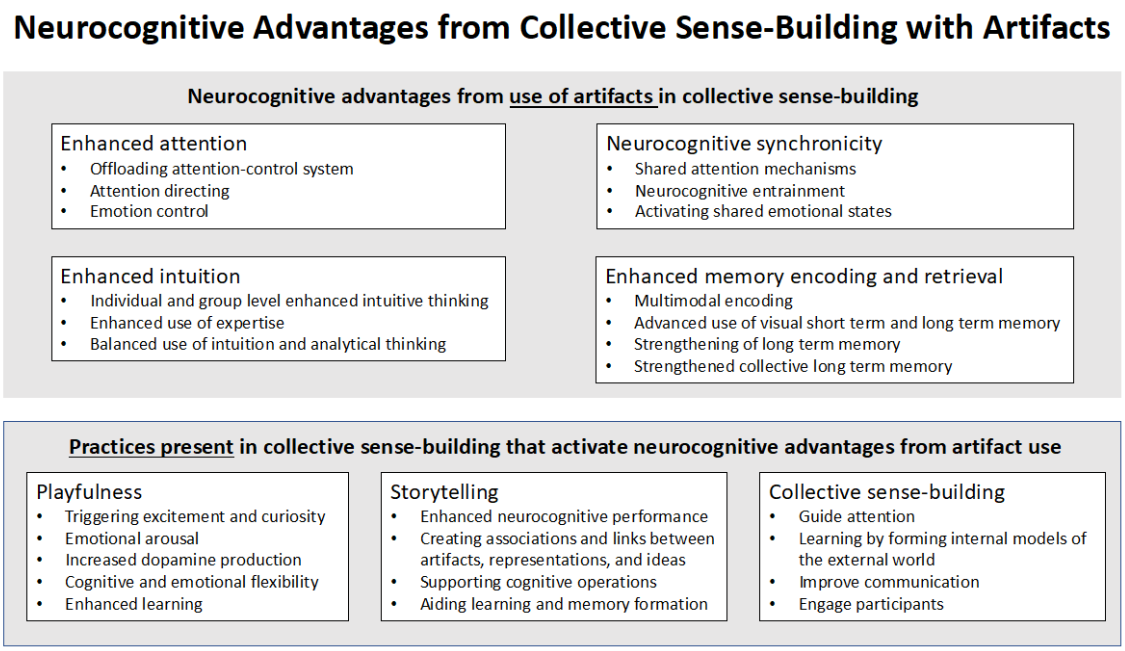

Figure 1. A synthesis of the neurocognitive advantages from collective sense-building with artifacts.

4.1. Enhanced attention with artifacts in strategy work

Attention is a central perceptual and cognitive allocating process in strategy work. Attention is both top-down, endogenously guided by the human towards a goal "with a symbolic cue that instructs where to attend" (Chun et al., 2011:79), and bottom-up, driven by external stimuli. Furthermore, one can distinguish the internal attention of humans and external attention to sensory information. Internal attention includes "the selection, modulation, and maintenance of internally generated information, such as task rules, responses, long-term memory, or working memory" (Chun et al., 2011:73). For example, the conceptual model of a business model helps a manager consider the key elements, such as resources, value proposition and costs, when elaborating a new business activity for the company. External attention refers to human selection and modulation of sensory information (Chun et al., 2011). For example, the speed at which managers respond to changes in their environment is dependent on how well they are capable of attending to the firm's external environment, e.g., competition, regulation, technology, and macroeconomic factors, and internal context, e.g., internal resources, communication, culture, and procedures (Nadkarni & Barr, 2008).

Attention is the bottleneck in strategy work due to the limited attentional resources the brain affords. It hence determines what information is further processed. To cognitively manage the complexities and dynamics of the business setting that strategy work engages with, "our attention needs to be guided to select stimuli that are relevant to our behavioral goals" (Soto & Humphreys, 2007:342). Attentional operations in strategy work can be advanced in several ways with the use of artifacts. I will next go through the advantages of using artifacts in strategy work.

Offloading the attention-control system with artifacts Working memory is the attention-controlling system that simultaneously stores and processes information (Baddeley, 1992). There is an overflow of information to attend to (Kessell & Tversky, 2011). That said, working memory has restrictions on how much it can maintain while simultaneously processing cognitive operations (Morrison et al., 2004). Furthermore, research has found that visuospatial working memory can attend simultaneously to only approximately four items of information (Jonides et al., 2008).

Attention control and working memory can however be supported by artifacts. Working memory triggers the processing of relevant sensory cortexes: in the case of artifacts, the visual cortex is affected (Harrison & Tong, 2009; Serences et al., 2009). Artifacts enable thinkers to offload cognitive work by visualizing knowledge, ideas, and visions (Wilson, 2002). Visual artifacts and displays can thus displace cognitive processes onto perceptual processes (Hegarty, 2011; Scaife & Rogers, 1996). Input channel capacity is greater when visual capabilities are used (Burkhard, 2004). Attending to visual and verbal communication is possible despite the neurological restrictions on keeping a few objects in mind simultaneously, as artifacts can be attended to on a perceptual level without entering them into working memory (Woodman et al., 2001). Hence, different cognitive subsystems, such as those holding and processing object knowledge and those holding and processing conceptual knowledge, can operate simultaneously without restricting each other. This allows individuals to simultaneously utilize multiple parts of the brain in operating, memorizing, and executing.

Another way to overcome this limitation of attentional capacity is to engage in visual-spatial chunking. It refers to the enlargement of "a representational unit of attention so that more items of information can be processed with the same working memory capacity" (Maeda, 2012:1954). By chunking, i.e., through several visual representations with artifacts and stories told about them, individuals can tie more information to artifacts through stories and draw attention to them. Individuals and groups can create an external collective working memory with artifacts by building representations of ideas using artifacts. Such spatial-abstraction-action interconnections, or spractions, describe visual representations that help offload cognition by directing attention to the most relevant aspects (Tversky, 2010).

Artifacts as attention-directing tools in strategy work Attention is selective and bounded by limited cognitive processing capabilities. Attentional operations manage the selection process of what to attend to. Attention is consciously and purposefully directed by the individual and those he or she is surrounded by. There are limits to processing information and competing options in attention (Chun et al., 2011; Lennie, 2003). There are also limits to items, concepts, ideas, and objects that can be maintained in working memory, tasks that can be executed, and responses that can be articulated (Chun et al., 2011). Therefore, to efficiently focus limited processing capacities, attention-focusing mechanisms need to "select, modulate, and sustain focus on the information most relevant" (Chun et al., 2011:73). Conversely, attentional operations suppress irrelevant information (Gazzaley et al., 2005). Artifacts can thus function as critical attention-directing tools in strategy work, pushing participants to represent the most critical and relevant ideas and observations and bring them to attention and contemplation by others.

Furthermore, with attention and cognition distributed among employees and managers in organizations (Ocasio, 1997), artifacts serve as a means to visually express individual perspectives and ideas. The

unique positioning of individuals within the organizational and external landscape, interacting with partners, customers, and authorities, leads to a distinct engagement in the organization. Each individual attends to distinct situational contexts shaped by their responsibilities, the resources they manage, and their relations with others inside and outside the organization. Individuals selectively focus external attention on the most relevant elements to them (Nadkarni & Barr, 2008). An individual's professional background and other individual related differences make them notice, encode, interpret, and focus time and effort on attending to issues distinctively. Hence, artifacts provide an excellent channel for visualizing their perspectives and observations and allow others to make sense of them and contemplate them.

In engaging with artifacts, both external and internal attention is at play. Artifacts can thus help establish a shared internal attentional structure by demanding the visualization of individuals' ideas and the visualization of concepts and frameworks they draw upon. Similarly, artifacts can help in visualizing representations of the external environment in ways that are easily comprehendible to individuals in the organization from different units. Architects, for example, use visualizations to enhance cognition and knowledge transfer (Burkhard, 2004). Artifacts, as abstract representations of the complex real world, can ease the burdens of holding attention, facilitate cognitive operations, and enhance reasoning, reflection, and projection (Lawson, 1997; Tversky, 2014). Attentional operations triggered with the use of artifacts can also "bind simultaneously presented signals across space into multisensory objects" (Chun et al., 2011:78).

Emotion and social judgment control with artifacts in strategy work In addition to the physically distinct features of the stimulus, attention is directed by emotional content and social cues. The amygdala and the anterior cingulate cortex are central in controlling emotional states and regulating impulse control and empathy. They affect attention allocation, such as through perceptual processing and memory (Roelofs et al., 2016). While emotional arousal enhances attention (Phelps et al., 2006), negatively charged communication restricts openness to others' perspectives and attention to what they say (Jones & Bodtker, 2001). Artifacts can be perceptual regulators, helping to remove potential attention-restrictive emotional triggers, such as negative judgments of individuals and negative inferences of others' mental states in strategy work. As attention is culturally (Masuda, 2017; Na & Kitayama, 2011) and socially shaped (Driver IV et al., 1999), the individuals a person is surrounded by shape their individual attention, as well as the groups' attention. Thus, those participating in strategy work can affect each other's attention through things like social cues. Artifacts can help in downplaying the distraction of those social cues and support attending to what is said rather than who is saying it.

The brain area involved in social judgment is the dorsomedial prefrontal cortex (dmPFC). It is part of the mentalizing network engaged in inferring mental states (Schulte-Rüther et al., 2007). The dmPFC is sensitive to social cues and central to forming attitudes (automatic assessment). Eye contact is central in reading other individuals' mental and emotional states. It is equally central in communicating (subconsciously or consciously) personal evaluation of an issue or a situation occurring to others (Risko et al., 2016). Internal attention is directed and guided with artifacts and object-based representations (Kahneman et al., 1992). Artifacts direct attention to the object and away from attending to facial expressions (eyes and mouth) by the one explaining and the surrounding people. In this way, the dmPFC should be less active when using artifacts for sensemaking in strategy work, permitting more attention to

be placed on what is being said, and less on judgmental reactions. Artifacts can hence act as perceptual regulators. Judgment and interpretation of an individual's idea or point and other people's mental states when that person is speaking of strategy can be redirected with artifacts. Visual communication draws attention to the artifacts rather than the person talking and the rest of the room, supporting visual perception of ideas (Phelps et al., 2006) and attention to the communicated idea or point rather than who is presenting it and how others interpret it. By directing attention toward artifacts, negative judgmental reactions to the ideas presented by an individual are reduced.

Furthermore, different brain regions activate when attention is drawn to objects and pictures instead of a person who communicates using words and writing. Distinct neuroanatomy and semantic knowledge are at play when person-related knowledge is processed versus object-related knowledge, impacting "perception and identification of socially relevant stimuli in the environment" (Mitchell et al., 2002:15242). Past neurocognitive research shows how different brain regions are activated when the individual attends to an object versus a person (Mitchell et al., 2002). Object and picture encoding activate both the left and right medial temporal lobes and the posterior and lateral temporal lobes that are engaged in storing object concept information (Martin, 2007). Object focus, however, does not activate social judgment in the medial prefrontal cortex, superior temporal cortex, intraparietal sulcus, and fusiform gyrus, whereas person-oriented focus activates judgment in these regions (Mitchell et al., 2002). This means that when the focus is on the object and picture rather than the person who talks about their ideas, social judgment areas of the brain are downplayed, and attention is rather on the artifacts and the story behind the visualization and explanation of what is represented with the artifacts.

4.2. Enhanced memory encoding and retrieval with artifacts

Memory formation and retrieval are central in strategy work. Team communication, cognitive processes for every member, and the decision-making needed in strategy work require a shared and structured understanding of the complexities and dynamics present in business and the organization. Individuals' "awareness of the broader environmental conditions and the ability to adapt their behavior to changing environmental circumstances" (Laureiro-Martínez et al., 2015:332) is central in strategy work. As past experiences and knowledge affect individuals' cognitive processes and their understanding (Volk & Köhler, 2012) in strategy work, successful encoding of strategy work-related knowledge and the ability to retrieve it is a necessary precursor.

Artifacts and their use as visual representations help in memory formation and encoding (Dansereau & Simpson, 2009; Nesbit & Adesope, 2006) in strategy work processes. Methods that guide individuals in actively making sense collectively have been shown to improve learning (Moreno & Mayer, 2007). The knowledge construction approach to learning is based on the idea of a learner as a "sense-maker who works to select, organize, and integrate new information with existing knowledge" (Moreno & Meyer, 2007:312). The individual learns by forming an internal model of the external world (Dehaene, 2020).

The hippocampus and mPFC regulate learning, memory encoding, and memory consolidation (Euston et al., 2012; Squire et al., 2015). Memory encoding occurs as these brain areas replay memories within

hours after learning, transferring specific episodes from short-term memory operated by the hippocampus to long-term memory, stored as a schematic representation in the mPFC (McClelland et al., 1995; Winocur et al., 2010; Euston et al., 2012). Visual short-term memory, also called visual working memory and long-term visual memory, operates in concert with text and verbal memory encoding, storage, and retrieval (Brady et al., 2011; Kellogg et al., 2007). Long-term visual memory is strengthened by existing category structures and the ability to form semantic associations between object knowledge and concepts (Hollingworth, 2004; Konkle et al., 2010; Martin, 2016). Memories are hierarchically structured and not item-based (Brady et al., 2011). This means that more meaningful stimuli are more easily remembered (Brady & Störmer, 2022).

Artifacts support multimodal encoding. Memory is improved by the additive effect of information and sensory experiences from various modalities (i.e., hearing, touch, vision, and smell). Research findings show that multisensory environments advance both memory encoding and retrieval (Moreno & Mayer, 2007). Artifacts boost memory formation and encoding when used as elements combined with verbal communication, or so-called mixed-modality presentations (Moreno & Mayer, 2007). The brain encodes and stores object knowledge in various locations according to sensory features, such as form, color, and perceptual properties associated with objects and their use (Martin, 2007). The linking of existing object knowledge to associations, such as high-quality service, customer loyalty, or skillful personnel, in strategy work is valuable. Color can help in grouping things and seeing relations (Heagarty, 2011). Visual representations combined with verbal explanations are more sensitive to details and articulated linkages between properties than solely verbal and textual communication (Card et al., 1999). Using multiple artifacts to construct representations of ideas and thoughts integrates reasoning, visual representations, motor codes, and haptic perception into integrated memory traces (Davachi & Wagner, 2002; Hullman & Diakopoulos, 2011). Joint understanding can hence be more easily achieved using artifacts in strategy work.

Another memory-boosting factor in artifact use is that information about artifacts stored in the brain can later be easily recalled as representations of distinct aspects, qualities, or properties of what has been visualized (Martin, 2007), e.g., the value proposition of a business model or the first step by the marketing department in the implementation of a strategy. Visualizations with artifacts in strategy work hence facilitate the formation of common understandings and shared procedural, declarative, and strategic mental models (Stout et al., 2017). When visual representations become tied to existing conceptual categories, they support memory strength and the ability to recall them later (Brady et al., 2011). Visualizing with artifacts in strategy work supports later recall of topics discussed and agreed upon. For example, representations of previous ideas can be accessed more easily when memory encoding is strong. Finally, if artifacts can be freely shaped in novel ways while tied to existing or novel categorizations, it will enhance memory. This is because the brain regions involved in object recall are sensitive to novelty, which supports encoding (Kirchhoff et al., 2000).

4.3. Enhanced intuition through sense-building with artifacts

Sense-building with artifacts can support intuitive thinking in strategy work. Intuition is one form of cognition, a process of thinking, which is distinct from conscious analytical reasoning (Salas et al., 2010).

Attention, both internally and externally directed, is a prerequisite for nonconscious processes such as intuition (Dehaene et al., 2006). Attention mechanisms can be created purposefully and consciously but also automatically. However, noteworthy is that selective attention is a conscious act by the mind, not unconscious (Dehaene & Changeux, 2011).

Individuals differ in cognitive styles regarding how much they rely on analytical versus intuitive approaches when processing information in strategy work (Hodgkinson & Clarke, 2007). Individuals can use intuition, but teams can also have collective or shared intuition (Samba et al., 2019). Intuitive and analytical processes co-occur while being executed in distinct brain areas (Dane & Pratt, 2007). Strategy work can be intuitive in many ways. Heuristics (rules of thumb) are one model of intuitive thinking that contrasts with more profound and effortful processes where analytical skills and practices are at play (Chaiken & Trope, 1999; Gilovich et al., 2002).

Using intuition can enhance the use of expertise and help express ideas that are hard to derive through verbal reasoning. Expertise-based intuition is "intuition rooted in extensive experience within a specific domain" (Salas et al., 2010:941). It is based on extensive practice and experiences acquired and stored in long-term memory (Salas et al., 2010). As strategy work relies on professionals from different domains, e.g., strategy, business, technology, marketing, and legal domains, it is valuable to consider practices that would enable the use of intuitive thinking as a way to cope with the complexities present in strategy work while at the same time using expertise in productive ways. Interacting with artifacts imparts expertise, both experience and tacit knowledge (expertise), that is made visible and available to the other group members to build upon, learn from, and enrich.

Artifacts help individuals and groups develop ideas intuitively (Ewenstein & Whyte, 2009). Artifacts enable a multisensory environment that supports creative confidence and positive team dynamics. They hence shift how groups solve organizational challenges by supporting their creativity in generating solutions (Mayer, 1999). Probing intuitive thinking can substantially reduce the need to outline all the detailed interdependent factors and complexities surrounding a business in strategy work and the formation of a collective cognitive map. Visualizations with artifacts can also help clarify the heuristics used and portray them more accurately and thoughtfully in strategy work.

A balance between intuition and analytical thinking is considered optimal for strategy work (Hodgkinson & Sadler-Smith, 2018). This balance is important, as too much reliance on intuition creates errors and biases (Salas et al., 2010). However, too much information and too many details might also be problematic in strategy work. Guided sense-building with artifacts can valuably support a balanced use of intuition and analytical thinking. Furthermore, switching between intuition and analytical thinking (Louis & Sutton, 1991) can also be valuable in strategy work. While use of intuition may hold biases, visualizations can help in making the ideas and underlying assumptions visible for others to examine, ask for clarifications and make biases explicit.

4.4. Neurocognitive synchronicity through sense-building with artifacts

One stream of recent research in neuroscience is the idea of brain-to-brain synchrony. Strategy work is critically centered on collective sensemaking in teams and workshops. There is an increasing set of

research today on neurocognitive synchronization and research that studies its role in teamwork. Research has shown how synchronizing behavior and perceptions increases prosocial behavior (Kirschner & Tomasello, 2010). Neurocognitive synchronicity in a group predicts engagement and social dynamics (Dikker et al., 2017). Furthermore, socially interactive tasks, such as collective sense-building using visual aids, induce prosociality (Hu et al., 2017). Such activities support collective and informed sensemaking (Hasson et al., 2012) and the formation of shared intentions, common goals, and collective commitment to agreed courses of action (Hu et al., 2017). Despite these many positive outcomes, notably, neurocognitive synchronization can also constrain individual thinking into group thinking.

A related stream of research is the study of mirroring and mirror neurons. Recent research into mirror neurons indicates that they are activated by perceptions of other people's actions (Rizzolatti & Sinigaglia, 2010). Relatedly, shared attention mechanisms support brain-to-brain synchronization (Dikkert et al., 2017). For example, face-to-face engagement, specifically eye contact, increases neurocognitive entrainment (Dikker et al., 2017). Mirroring also occurs on the emotional side. Emotional mirroring, attunement, or contagion (Jaffe, 2007; Tognoli et al., 2007) is a phenomenon where an individual is aroused – i.e., in "their bodily states (e.g., heart rate, breathing, perspiration, endocrine levels)" – and this bodily state is "detected unconsciously by others who begin to mirror these physiological states causing them to share the same emotion in a contagious manner" (Tobey & Manning, 2009:187). Emotional mirroring also increases through immersion, for example, through a dramatic presentation or discussion that entails the closeness of individuals (Fredrickson, 2001). Sense-building with visual aids, such as drawing and using visual metaphors, enables individuals and the group to adjust their emotional reactions to, for example, a planned organizational change, helping with "interpreting and framing their experience of organizational change" (Barner, 2008:120). The mirroring hypotheses propose that collective strategy sense-building work with visually stimulating artifacts should activate the same brain regions and emotional states.

4.5. Neurocognitive benefits of evoked playfulness with artifacts

Sense-building with artifacts is a form of play. This is valuable because artifacts enable creativity, curiosity, and playfulness. Engaging in playful work with artifacts and collective sense-building supports strategy work. It immerses participants "into a social world that has its own rules and reality" (Turner, 1974:13) and a common sense-building setting that allows playfulness. Play enables us "to act and think creatively outside existing rules and norms" (Turner, 1974:13). Playfulness has been proposed to moderate neuroplasticity (structural adaptability) and neurogenesis (the generation of new brain cells) (Brown, 2008; Lagace et al., 2007). Play characteristics include cognitive flexibility, curiosity, exploration, and a hunger for novelty (Brown, 2008).

Curiosity and playfulness easily trigger excitement, producing dopamine, a critical modulator of learning and motivation (Berke, 2018). Humans are curious about how things work. Curiosity is a state in which the brain is motivated to create solutions (reduce uncertainty). Curiosity is achieved when an individual has some idea about the answer but lacks confidence (Kang et al., 2009). Both curiosity and playfulness induce emotional arousal. Emotional arousal induces intrinsic motivational drive (Liu et al., 2016). Emotional arousal also drives up dopamine and releases chemicals that activates brain regions central to

memorizing (Kang et al., 2009). Curiosity and playfulness thus advance memory creation and learning (Dehaene, 2020; Hermans et al., 2014). Furthermore, collective sense-building with artifacts supports emotional engagement and attention to the symbolism of the artifacts. Emotional engagement also supports learning, as memory encoding is supported by emotional arousal. However, too much or too little emotional activation can harm attention and learning. Instead, optimal levels are needed (Taylor & Statler, 2014).

Play can also help in the development of cognitive and interpretive skills (Heracleous & Jacobs, 2005). Continuous play has been shown to make cognitive, emotional, and somatic functioning more flexible (Gordon, 2014). Inventing and realizing together will not happen if the state of strategy work is not permissive and supportive of play. Strategy work with artifacts and collective sense-building can as such create a playful learning space (Kolb & Kolb, 2010).

4.6. Enhanced neurocognitive performance through storytelling with artifacts

There is supportive research on the value of sense-building with artifacts and visual representations and the use of storytelling in explaining visual representations to others. Research has found that a strategy reported as a combination of text and drawing helps recall compared to a strategy that is solely described in text (Angwin et al., 2019). Similarly, past studies on the value of Lego bricks in workshops show that sense-building is enhanced by the storytelling of the constructed visual representations (Jacobs & Heracleous, 2007; Roos & Victor, 1999). A story helps create associations and links between artifacts and the elements in the story and the storyline (Morewedge & Kahneman, 2010), i.e., the business model and strategic resources, supporting the creation of associative memory and ease of recall (Dansereau & Simpson, 2009). Furthermore, the binding processes (hippocampal binding) of various forms of memory help maintain representations in short-term memory during strategy work (Dansereau & Simpson, 2009; Ranganath & D'Esposito, 2001).

The artifacts and the story the individual(s) use when explaining their ideas and visualizations support cognitive operations, such as reasoning, reflection, and projection (Ewenstein & Whyte, 2009; Lawson, 1997). Past research has shown how visual riddles and simple geometric symbols improve recall of texts and stories and create richer mental models (Blackwell, 2001). Furthermore, visual representations are more effective than spoken or written language in helping to construct new memories and enrich and refine existing memory elements (Dansereau & Simpson, 2009; Nesbit & Adesope, 2006). Artifacts act as mnemonics, aiding memory and verbal recall (Blackwell, 2001). They help retrieve and recall knowledge stored in semantic and episodic memory. Artifacts activate both hemispheres in the medial temporal lobe (MTL), in contrast to text and verbal communication, which shows greater association in the left MTL (Kirchhoff et al., 2000). In summary, sense-building and storytelling with artifacts activates more areas in the brain than solely verbal communication, improving both recall and learning in strategy work.

4.7. Neurocognitive advantages from collective sense-building with artifacts

While the previous sections have focused on specific neurocognitive advantages from using artifacts in strategy work, I end with a synthesis of the advantages from collective sense-building with artifacts.

Collective sense-building with artifacts can clearly improve the communication of insights, dialogue, and knowledge transfer between individuals (Burkhard, 2004). Artifacts help to guide attention to selective elements in the visual representation, helping others encode meaning and schematic representations in memory (Barsalou, 1999). When visual representations accompany the text, they help those observing as well as the visualizer to notice the many unobserved relationships implicit in verbal communication (Glenberg & Langston, 1992). Sense-building with artifacts helps to create a context-rich representation without overloading cognitive processing of participants (Fernandes et al., 2018). Hence, sense-building with visual representations supports participation and allows work with complexities present in strategy work.

Joint work with artifacts engages individuals to construct causal relationships together. Collective sense-building, e.g., workshops using artifacts and following the Lego Serious Play method, advances empathy for others, perspective-taking, divergent thinking, deeper learning, and psychological safety (Dykes, 2018). Sense-building with artifacts helps engage participants in strategy work and support dialogue, productive reactions, and corrections of each other's visual representations. When visual and haptic objects are used, the participants engage in exploration rather than passive listening (Helbig & Ernst, 2007). Error feedback, critical in learning (Dehaene, 2020), is also facilitated with artifacts. Observing a visual representational error enables low threshold questions about what is implied and provides clarifications and suggestions for alternative visualization of the issue, for example, a business model under discussion. Artifacts support dialogue and the ability to interactively manipulate an initial visual representation (Moreno & Mayer, 2007). It thus supports creative thinking and the intelligence of the group. Intelligence is a combination "of the ability to 'figure things out on the spot' and the ability to retain and repeat things that have been figured out in the past" (Deary et al., 2010:209).

Furthermore, artifacts as visual representations can act as "external memory as well as being sites of reasoning, reflection and projection" (Ewenstein and Whyte, 2007:82). Engaging as a group with artifacts helps collective discovery of relationships and causal structures between the artifacts and the environment (Bjorklund & Gardiner, 2011) under focus in strategy work. This kind of engagement extends the cognition of the group with the support of visual representations. Visual tools can act as technical objects describing a specific kind of customer, for example but also as representations, or boundary objects (Bowker & Star, 1999), of a property to be communicated, e.g. a strong customer engagement or trust in the company. Visual representations have, as such, the ability to increase 'human bandwidth' and the capacity to make sense (Horn, 1998) and build sense collectively in strategy work more effectively with a larger set of information than approaches relying on only textual and verbal communication.

5. Summary

Cognitive psychology, neuroscience, and management research confirm that artifacts, and visual representations, have untapped potential to advance neurocognitive processes in strategy work. The use of artifacts in strategy work allows the simultaneous use of several sensory systems, which facilitate the construction of "increasingly abstract, supramodal representations of perceptual experience that support various conceptual functions including object recognition, social cognition, [and] language" (Binder &

Desai, 2011:527). Beyond the reliance on text and words, artifacts extend cognitive functions by completing the brain's internal storage and processing system (Heersmink, 2021).

My analysis reveals that attention, emotion control, learning and memory use, intuition, and creativity can be enhanced in strategy work by using artifacts and other visual aids. These advantages are increased when sense-building activities with artifacts are playful, and storytelling is used. The many advantages of using artifacts in strategy work opens avenues for considering ways to innovate, design, and develop practices that exploit our hidden neurocognitive capacities.

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