GIVING SENSE TO *DE NOVO* MARKET CATEGORIES: ANALOGIES AND METAPHORS IN THE EARLY EMERGENCE OF QUANTUM COMPUTING

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ABSTRACT

Research on cultural entrepreneurship has explored the role of language in making and giving sense to novel ventures and market categories and in legitimating them. We analyze how an emerging de novo *market category, quantum computing, is constructed through the use of analogies and metaphors. Through a multimodal analysis of interview and newspaper data, we find that in addition to using analogies and metaphors to highlight familiarity, actors also use such tropes to expound the weirdness of the new category, thus marking it as profoundly different and novel. Such tropes have a dual function; they draw the boundaries between science and laypeople but also arouse awe and curiosity among the audiences. Our study thus casts light on the cultural work during* de novo *category emergence.*

Keywords: Market category; category emergence; quantum computing; multimodality; analogies; metaphors

INTRODUCTION

Research on cultural entrepreneurship has explored the role of language, and particularly storytelling, in making and giving sense to novel ventures and

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market categories and in legitimating them (Garud, Schildt, & Lant, 2014; Martens, Jennings, & Jennings, 2007; Santos & Eisenhardt, 2009). Beyond storytelling, studies have also shown that entrepreneurs use analogies and metaphors to create meaning around the novel venture, thereby legitimating its activities (Cornelissen & Clarke, 2010). Analogies map "knowledge from one domain into another" through bringing both resemblance of a particular aspect of otherwise different things (Gentner & Jeziorski, 1993, p. 449; Merriam-Webster, n.d.). Metaphors refer to "figurative language that represents one thing in terms of another" (Cornelissen, 2012, p. 119; Lakoff & Johnson, 1980). They both construct connections of novel, ambiguous or abstract concepts to familiar examples. By providing pre-existing meaning to a new situation, participants in nascent market categories can make use of these figures of speech to manage ambiguity (Cornelissen, 2012; Powell & Colyvas, 2008). However, research has to date paid little heed to the role of analogies and metaphors in cultural entrepreneurship although they are a pervasive and essential feature of language and contribute to the construction and interpretation of social reality (van Teeffelen, 1994).

Recently, scholars have begun to pay attention to multimodality – skilled cultural entrepreneurs use both verbal and visual discourse as a strategic tool for constructing meaning (Meyer, Höllerer, Jancsary, & Van Leeuwen, 2013). When a novel idea is difficult to align with existing meanings – as with quantum computing – visual text can support early sensemaking (Forgues & May, 2017). Thus, analogies and metaphors play a key role, especially in shedding light on the creation of meaning through both textual and visual referrals to familiar objects and phenomena.

In this study, we employ multimodal methods to explore the role of the textual and visual analogies and metaphors used in sensegiving activities in the emerging *de novo* market category of quantum computing. The emergence of this category requires broader communities of people – researchers, policy makers, industry players and even the general public – to make sense of the extremely complex science and technology. There is a fundamental disconnect between quantum phenomena and laypeople's experiences of the world. Hence the challenge lies in explaining quantum phenomena with constructs that resonate with lay perceptions. Scientists and entrepreneurs habitually mobilize analogies and metaphors in both textual and visual forms when explaining the various elements of quantum phenomena. Our study sheds light on how participants mobilize such cultural resources at the early stage of the *de novo* market category emergence when both material artifacts and boundaries are fluid and under negotiation, new players are entering and exiting the market, and policies and standards are lacking.

Our multimodal approach allows analysis of both verbal text and visual representations of meaning as it is constructed by the actors in the nascent market category. We find that scientists and entrepreneurs use naturalizing tropes to create connections to mundane experiences in order to highlight familiarity and temporal tropes to connect to other fields of science and technology that have previously revolutionized society. Counterintuitively, however, scientists in particular also use mystifying tropes to expound the weirdness of the new category, thus construing it as profoundly different and novel. Aspects of this are

negation, for example, "quantum computing is nothing like the analogy" and portrayals of quantum science as mysterious and akin to "magic." Such tropes have a dual function: drawing the boundaries between science and laypeople but also arousing awe and curiosity among such audiences. Our study thus casts light on the cultural work in which scientists and entrepreneurs engage during *de novo* category emergence.

ANALOGIES AND METAPHORS IN MARKET CATEGORY EMERGENCE

Market categories are socio-cultural meaning systems that enable the grouping of products and services based on their perceived similarity (Durand, Granqvist, & Tyllström, 2017; Glynn & Navis, 2013; Rosa, Porac, Runser-Spanjol, & Saxon, 1999). They play a crucial role in organizing markets by creating shared understandings of offerings, boundaries and collective identities (Granqvist, Grodal, & Woolley, 2013; Grodal & Suarez, 2015; Navis & Glynn, 2010). Market categories are socially constructed through interactions between various market participants over time, and studies show that language plays a major role in their constitution (Grodal & Kahl, 2017; Khaire & Wadhwani, 2010; Rosa et al., 1999, see Granqvist & Siltaoja, 2020 for a review).

Category emergence is a particularly important setting to explore how cultural entrepreneurs use language in making and providing sense in such ambiguous contexts (Garud et al., 2014; Granqvist et al., 2013; Santos & Eisenhardt, 2009). Market categories can emerge as category extensions where novel features are brought into an existing industry, leading to a new class of products (Durand & Khaire, 2016) such as light cigarettes (Hsu & Grodal, 2015) or minivans (Rosa et al., 1999). In contrast, in the emergence of *de novo* categories such pre-existing market structures and meanings do not yet exist or have only a minor presence among very specialized audiences. For instance, in the early emergence of computers (Kahl & Grodal, 2016) and nanotechnology (Granqvist et al., 2013; Kennedy, (Yu-Chieh) Lo, & Lounsbury, 2010) the early market participants engaged in producing understandings of technologies and their potential applications over decades. Producers and audiences engage in (prospective) sensegiving and sensemaking, making the new category understandable and appealing to consumers, and distinguishing it from other categories (Durand & Khaire, 2016; Navis & Glynn, 2010). In so doing, they use a wide array of linguistic resources such as discourses, frames and tropes (Granqvist & Siltaoja, 2020).

This study focuses on the role of metaphors and analogies that are particularly useful in the maintenance and creation of meaning and are thus central to the understanding of novel, complex or otherwise ambiguous categories (Granqvist & Siltaoja, 2020). These figures of speech, or tropes, are used to join two concepts from different domains, a source domain and a target domain. Drawing on cognitive psychology, we define analogy as *a relational comparison* between two domains (Etzion & Ferraro, 2010; Gentner & Jeziorski, 1993). For example, "quantum computers today are like the Wright gliders" is an analogy; it

does not mean to communicate that quantum computers exhibit attributes similar to the Wright gliders, but rather that quantum computers today are similar to the gliders that preceded commercial air jets; they were an early version of a groundbreaking technology.

Metaphor, in turn, can highlight *similarities in both relationships and attributes*, but it does so *through implicit rather than explicit comparisons* (Etzion & Ferraro, 2010). For example, the popular phrase "the brain is a quantum computer" is a metaphor – the comparison between the two objects is figurative rather than literal. Hence the difference between analogies and metaphors lies in the degree of the comparison, rather than the kind (Cornelissen, Holt, & Zundel, 2011). In other words, analogies rely on more literal comparisons between cases from the same domain of knowledge, whereas metaphors involve more extended, cross-categorical and often figurative comparisons.

Both tropes expound similarity and familiarity between concepts and can thus help in legitimating a novel category, enable innovation and legitimate strategic change (Cornelissen et al., 2011; Navis & Glynn, 2010; Seidel & O'Mahony, 2014). Studies show that institutionalization is facilitated through the use of analogies that associate novel institutions with existing ones in other domains of activity (Etzion & Ferraro, 2010; Powell & Colyvas, 2008). Further, Cornelissen and Clarke (2010) find that in the creation and justification of novel ventures entrepreneurs use analogies when they have prior experience in relevant industries – and metaphors when they lack such experience.

Moving beyond the traditional "comparison model" (Cornelissen, 2005, p. 751) of seeing analogies and metaphors as comparisons between existing features shared by the source and target concepts, scholars have begun to highlight the role of figurative language in creative thinking. In this sense, analogies and metaphors are not only comparisons between domains, but also creative tools to construct new meanings and understandings through the interaction by the two domains (Cornelissen, 2005; Etzion & Ferraro, 2010; Vaara, Tienari, & Säntti, 2003). Especially when attention is directed to dissimilarities and emergent meanings, both types of tropes can then aid innovation and bring forth novel ideas (Cornelissen, 2005; Etzion & Ferraro, 2010; Gavetti, Levinthal, & Rivkin, 2005; Oswick, Keenoy, & Grant, 2002).

In strategy research, scholars have found that analogical reasoning explains the ways in which entrepreneurs design innovative businesses and discover competitive positions in novel and complex markets (Gavetti et al., 2005; Martins, Rindova, & Greenbaum, 2015). When encountered with a novel situation, managers use analogical reasoning to map the observable characteristics of the industry to another industry based on personal or vicarious experience (Gavetti et al., 2005).

Compared with analogies, metaphors are more useful framing tools in situations of substitutive changes where existing categories of stakeholder understanding are replaced with new ones, whereas analogies are more effective in situations of additive changes (Cornelissen et al., 2011). Furthermore, metaphors are used in situations where entrepreneurs have no experience of a novel industry – in other words, they use metaphors as a way to create an understanding

for themselves and for others (Cornelissen & Clarke, 2010). In their study on organizational identity formation, Vaara et al. (2003) found that a metaphoric perspective may reveal hidden and subconscious imageries that would otherwise remain concealed. However, working within a "cognitive comfort zone" (Oswick et al., 2002, p. 299), they might also restrict idea generation, functioning as "an aid to knowledge dissemination rather than knowledge creation" (Oswick et al., 2002, p. 298). In this sense, both analogies and metaphors can also limit conception and innovation.

MULTIMODAL APPROACH TO ANALOGIES AND METAPHORS

Analogies and metaphors come in both textual and visual forms. Verbal language has particular functions – texts can argue (in the form of rhetoric), narrate, specify and abstract (facilitating typification and categorization) (Meyer, Janscary, Höllerer, & Boxenbaum, 2018). Like verbal language, images can be used to categorize, describe and communicate knowledge in a social setting. However, visual language can provide holistic and immediate information – visual text can infiltrate, spatialize, captivate and materialize (Meyer et al., 2018). Hence visual analogies and metaphors have a different way of cueing similarity and meaning (Forceville, 2008).

Based on the definition provided earlier, we contend that visual analogies are those that aim to present the object or phenomenon in a truthful manner through analogous imagery (such as depicting an atom as a ball). For example, infographics and design sketches are visual analogies, as they do not aim to convey a metaphorical meaning, but rather to present the object or phenomenon in question in a truthful manner. Visual analogies have been studied particularly within the domain of design studies, where they have been found to be helpful in problem-solving in the early stages of the design process (Casakin & Goldschmidt, 1999). In organization and management studies, visual analogies have been studied in the context of future-oriented sensemaking and organizing. Exploring the materialization of cognitive work, Stigliani and Ravasi (2012) found that the use of visual imagery facilitated the sharing of personal and unique experiences that would otherwise remain tacit. Comi and Whyte (2018, p. 1078), studying the strategizing process of an architectural firm, contend that visual artifacts such as sketches and presentations "give form to an immaterial future," thereby allowing a stable and holistic view of the uncertain future.

As in visual analogies, in visual metaphors there is a salient presence of metaphorical domains – source and target domains should be easily recognizable (Forceville, 2002). However, as opposed to visual analogies, metaphoric images present objects and scenes in a way that is not realistic – they present an anomaly that violates the natural order of things (Kennedy, 2008). Cornelissen, Oswick, Christensen, and Phillips (2008) call for a multimodal perspective on metaphor; they contend that metaphors are likely to be represented in multiple modes simultaneously. Despite this call, fairly little work has been published on

visual or multimodal metaphors within the realm of organization and management studies. A notable exception is the work of Heracleous and Jacobs (2008) on embodied metaphors. Studying organization development workshops, the authors found that the analysis of embodied (or multimodal) metaphors reveals qualities and dimensions of organizations that are not accessible through other, more traditional interpretive methods. Like verbal metaphors, embodied or multimodal metaphors may thus elicit subconscious views that would otherwise be hard to uncover.

A multimodal approach to analogies and metaphors is well warranted as the process of emergence requires managing both familiarity and novelty for which these tropes prove excellent means (Hargadon & Douglas, 2001; Martins et al., 2015). Building on the phenomenological tradition and social semiotics, a focus on visuals highlights the performativity of discourse (Meyer et al., 2013). A multimodal approach, incorporating analysis of visual and verbal analogies and metaphors, will thus provide an enhanced understanding of sensemaking around a novel technology. Indeed, for skilled cultural entrepreneurs, visual rhetoric and visual framing are central strategic tools of meaning construction (Meyer et al., 2013). Nevertheless, we do not yet understand how analogies and metaphors are used in the construction of a *de novo* market category where meaning systems and market structures are almost completely lacking. We explore this conundrum in the context of quantum computing – an emerging market category based on science and technology that very few people can comprehend. The use of both textual and visual analogies and metaphors to make and give sense to this nascent market category is rife in this setting.

METHODOLOGY

Research Context: The Emergence of a Market Category Around Quantum Computing

Our study is set in the context of the emerging quantum computing market category. Powered by the "second quantum revolution," the aim is to build a universal quantum computer. While estimates of when this goal will be reached vary greatly, most experts reckon on 10–20 years. The current stage of development can be described as "lab to fab," meaning that quantum computing is moving from laboratory research to fabrication of what are called noisy intermediate scale quantum devices. As is common for the early market emergence, although a wide variety of technological solutions are being developed, a prototypical design has yet to emerge. The novel category is characterized by extreme ambiguity and uncertainty; there is ambiguity around the meaning of the technology (e.g. what constitutes a quantum computer) and its operating principles (how a quantum computer works, and uncertainty regarding its possible uses (what quantum computing could do) and the timeline of its emergence (when the first universal quantum computer will be built). This equivocality is accentuated by the fact that quantum computing is an extremely complex domain of science and technology that very few people can comprehend. Hence the use of analogies and metaphors

for trying to communicate some key aspects and functionalities of quantum computers to broader audiences are widespread in this domain.

Data Collection

This study draws on data that are part of a larger research project that follows the emergence of the novel quantum computing market category in real-time. As part of this project, we have collected a large qualitative data set consisting of semi-structured interviews, observations at field configuring events (Garud, 2008; Lampel & Meyer, 2008) and archival material, such as newspaper and magazine articles and blog posts. The data that we draw on are presented in Table 1.

Our initial analyses of 74 interviews and 760 newspaper and magazine articles highlighted the role of language and visuals in early narratives about quantum computers. This finding was supported by our observations and field notes on events, where analogical and metaphorical language and imagery were often used to explain the intricacies of the novel technology. Following these early findings, we decided to focus our analysis on the verbal and visual analogies and metaphors of quantum computing. For a more focused coding, we decided to focus our attention on news media, as they can be understood as a public arena for sensemaking and sensegiving efforts by actors in the field, and contains visual data such as photographs, illustrations and infographics (Höllerer, Jancsary, & Grafström, 2018).

We selected articles published between 2010 and 2020 in three outlets: *The Financial Times*, *New York Times* and *Scientific American*. These three outlets

Table 1. Data and Materials.

Data	Amount	Country	Additional Information
Interviews	74	Multiple	Our informants represent a number of universities, research institutes and companies. Semi-structured interviews have been conducted between 2019 and 2021
Observations and field notes	120 hours	Multiple	Observation and participation in field configuring events between 2019 and 2021
Magazine and news articles	760	N/A	Archival data collected included media articles, governmental reports and consultancy reports from 1985 to 2020

provide a holistic view of the communication around the emerging market category as they span general news, business news and popular science. For the analysis, we concentrated on articles that focused on quantum computing and quantum computers and left out all articles that mentioned quantum computing only in passing. With these restrictions, we analyzed 107 articles, which included altogether 124 images.

Data Analysis

Our analysis of textual and visual data proceeded as follows. Through a careful reading of each article and interview transcript, we coded all passages of text that included analogies and metaphors, in other words implicit or explicit comparisons between the two domains. We then analyzed these passages in more detail, following the domains-interaction model outlined by Cornelissen (2005) to recognize the source and target domains and the underlying meaning behind the use of the analogy or metaphor. First, we developed a generic structure of the analogy or metaphor by inferring the source and target domains and the feature being mapped between the two domains. Second, we elaborated on the meaning of the analogy or metaphor by rewriting the sentence in more conceptual terms. Third, we analyzed the emergent meanings brought about by the use of the trope in question. There is an example of our analysis in Table 2.

In a similar manner, we carefully analyzed each image in the context of the article in which they were published to determine whether they convey a literal, analogical or metaphorical meaning to the reader. Our analysis was guided by the principles of multimodality – we did not analyze the images separately, but as part of the article and when applicable, together with its title. Literal images (including multimodal compositions of text and image) do not entail any analogies or metaphors – they present objects and events in a literal and truthful manner. If the image or composition did not fit this definition, we asked three questions as outlined by Forceville (2008, p. 464): (1) What are the two domains presented in the analogy or metaphor? (2) What is the target domain, and what is the source domain? (3) Which feature must be mapped from source to target to understand the meaning? By answering these questions, we aimed to recover the analogical or metaphorical meaning of the visual/multimodal image. These analyses led us to identify three main categories of analogies and metaphors: naturalizing, temporal and mystifying types.

ANALOGIES AND METAPHORS IN THE CONSTRUCTION OF THE QUANTUM COMPUTING MARKET CATEGORY

Our initial analyses of archival and interview data, combined with detailed analyses of the key media outlets, enabled us to uncover some central aspects of quantum computing. First of all, our data show that quantum computing is incomprehensible to nearly everybody who engages with it. Nevertheless, the actors who are involved in its development need to be able to communicate it to

Table 2. Example of Textual Data Analysis.

Data Source	Date	Verbatim	Generic Structure				Elaborated Meaning	Emergent Meaning
			Type	Source Domain	Target Domain	Mapped Feature		
Financial Times	March 19, 2017	Mr Byrnes is working to develop new technologies that will ultimately, he hopes, help deliver the holy grail of the sector – a quantum computer	Metaphor	Holy grail	Quantum computer	Elusiveness and power	Likening the quantum computer to the holy grail hints at the elusiveness of the object and its great power	The metaphor constructs quantum computer as a desired object with an unclear existence. The quantum computer, if one can be "found," in this case built, will have exceptional powers
Financial Times	March 6, 2017	The current state of quantum technology is still equivalent only to the level that digital computing had reached in the 1940s, said Mr Crowder	Analogy	Digital computing	Quantum computing	Nascent state	Current quantum computers are in a very early stage of development	As quantum computers are likened to classical computers, they are constructed as a future transformative technology. This meaning is expounded by the reference to the 1940s, when the very first digital computers were built. The analogy constructs a future in which quantum computing will continue to develop and will ultimately transform society
New York Times	January 20, 2011	Our mecca is to build a quantum computer that could have thousands of qubits; here we have only a few	Metaphor	Mecca	Quantum computer with thousands of qubits	Pilgrimage	Mecca refers to the end goal, which in the case of quantum computing is to build a device with thousands of qubits	The journey of building a universal quantum computing is a pilgrimage – a slow process with a reward waiting at the end

wide audiences in order to gain support for their activities and they use analogies and metaphors in this communication. We next discuss the incomprehensible nature of quantum computing and the way in which scientists strive to make it meaningful through the use of tropes.

The Unintelligible Quantum Computing

What makes quantum computing, and quantum technologies in general, interesting, is the complexity of the science behind the technology. Even names such as Einstein and Schrödinger have been famously quoted pondering about the difficulty to understand quantum phenomena. Quantum scientific facts are incomprehensible and counterintuitive to the way we think about the world. Our experience of the world is classical rather than quantum (e.g. an object is found only in one rather than several places at a time). The abstract language of mathematics is not available or helpful when explaining quantum phenomena to lay people – the same applies to nearly all scientists who are not trained in quantum physics. Therefore, to disseminate the knowledge about quantum computing and the novel market category, mainly scientists but also other actors such as industry analysts and business professionals need to make a wealth of difficult concepts somewhat understandable to a wide audience. As our informant explains, while these phenomena cannot be correctly explained using tropes, they are helpful in explaining the basic functioning principles in an understandable manner.

> Quantum technologies, quantum physics, has this problem that the intuition of these phenomena is really lacking …. The only correct way to explain you this would be through math, using equations, and this is really a language that we don't share. So I have to use some sort of approximate descriptions of something, it's much easier to describe, a ball that I can throw, because we have experience of it, while we do not have experience in our life [of how] quantum objects behave. And this makes it difficult. (Karen, Scientist)

In our analyses, we identified three main categories of analogies and metaphors: naturalizing, temporal, and mystifying types. In what follows, we show how familiarity and novelty but also weirdness are simultaneously constructed through the multimodal use of such analogies and metaphors. The use of naturalizing tropes makes quantum computing made understandable, within limits, while temporal tropes construct quantum computing as a legitimate and high-potential market category. The use of mystifying tropes arouses awe among audiences, but also draws boundaries between experts and laypeople.

Approximating Quantum Phenomena Through Naturalizing Analogies

As a common, accurate language is lacking between quantum physicists and their audiences, analogies and metaphors, in both textual and visual forms, provide tools for approximation and communication of meaning. We found that some analogies present quantum computers and quantum computing in a *naturalizing* manner. The source domains for these analogies are found in everyday life; bank accounts, needles in a haystack, phone books, and billiard are used in describing quantum computing and the quantum mechanical principles it employs.

These analogies were often used by knowledgeable experts including scientists and people working in the quantum computing field to explain the operating principles of a quantum computer. In fact, the word "computing" is an analogy as many of our informants stated that the only similarity between classical computing and quantum computing is the word computing; computing as we know it has nothing to do with the quantum "computing" science and technology.

To explain quantum computing to non-expert audiences scientists regularly turn to familiar, yet simpler objects as approximations of quantum phenomena, such as the coin in this case:

> If you are working with non-tech people then I think the best approach is working with examples. For instance, you have a coin. You flip it and if you look at it and if it's a definite head or a definite tail but as long as you don't look at it, it can be either. These examples may not be entirely true or may not be fundamentally true but they do give an idea of what is happening. They do give a picture of the things that happen within quantum computers. (Kevin, Research Scientist)

The analogy of a coin flip is used here to explain the phenomenon of superposition that allows a qubit to be in two different states simultaneously. An analogy of searching for a needle in a haystack is used to explain the different operating principles in quantum computing. This analogy explains the quantum phenomenon of superposition that enables quantum computers to compute multiple answers simultaneously without the need to process computations one after the other as in classical computing.

> The analogy we like to use is that of a needle in a haystack. A machine can be specially made to look for a needle in a haystack, but it still has to look under every piece of hay. Quantum computing means, I'm going to look under every piece of hay simultaneously and find the needle immediately. (*Financial Times*, May 25, 2017)

Through the use of this analogy, the operating principle is at once made both familiar (looking for a needle in a haystack) and novel (being able to look under every piece of hay simultaneously). This analogy of "search" is prevalent in the quantum computing discourse. In addition to a needle in a haystack, other source domains used include, for example, a phone book and a combination lock (see Table 3).

Infographics – multimodal compositions of text and visuals – are a commonly used visual analogy to explain the operating principles of a quantum computer. For example, the phenomenon of decoherence, through which qubits lose their quantum properties when interacting with the environment, is visualized with an image of a traditional desktop computer. Inside the computer there are particles depicted as gray balls with zeros and ones on them, with the zeros and ones presenting quantum information inside the system. Outside there are particles depicted as red balls with no numbers on them. When the gray balls interact with the red ones, the system information carried by the gray balls is displaced, effectively spoiling quantum computations. These visuals were particularly prominent in the popular science outlet (*Scientific American*). As with verbal analogies, infographics aim to make the novel phenomenon more understandable by portraying complex information in a mode that can be processed more rapidly than plain verbal text.

Table 3. Examples of Naturalizing Analogies.

Target Domain	Source Domain	Example	Data Source
Entanglement	Phone book	[L]et's say you want to find the name corresponding to a phone number in a phone book. Classically, you have to read through the whole phone book. Quantumly, you don't	Interview
	Colored balls	This is where a mysterious property known as quantum entanglement comes in. Imagine a box containing a red ball and a blue ball. You can reach in without looking, take one ball and put it in your pocket, then travel across town. You then take the ball out of your pocket and discover that it is red. That immediately tells you that the ball back in the box is blue. That is entanglement. This effect, translated to a quantum realm, can transmit information instantaneously and across vast distances	*Scientific American*, May 15, 2018
	Combination lock	I often show this (...) lock for the bicycles. Where you have a number combination, you know, four or six digits. And at the end a quantum computer would try out all the combinations, at the same time. Whereas a conventional computer would do it one after the other. And this clearly gives an advantage	Interview
Uncertainty	Bank account	[N]ot knowing which abstraction in the computer corresponds to which object is a little bit like having a bank account and the bank telling you, "Oh, your balance is some number." Unless you know what number it is, you haven't really expressed the whole of the physical situation of you and your bank account	*Financial Times*, May 28, 2014
	Billiard	Dr Vinokur likened the challenge to sending a speeding billiard ball back to where it started. Seems easy: Just hit it with a cue stick. But if it's a quantum ball, the uncertainty principle kicks in: You can know how hard to hit the ball, or in which direction to hit it, but not both	*New York Times*, August 25, 2018

Temporal Analogies and Metaphors

In addition to pertaining to similarities and familiarity, analogies and metaphors are also deployed to communicate the future potential of the technology. Temporal analogies liken the present stage of development to that of another technology decades ago that has since had a revolutionary impact on the society. A common source domain is classical computing:

> This is the very early days of quantum computing, probably like it was in 1955 at IBM …. It is far different from any computer that you and I have ever known before. (*Financial Times*, January 24, 2017)

The use of these analogies evokes ideas of familiar and now successful technologies, projecting quantum computing as a successful future technology that is still in the early stages of development. What is notable is that these analogies and metaphors were most frequently used by field actors and investors in the business outlet (*Financial Times*). The novelty of the technology is emphasized by notions of it being in its infancy and describing the efforts of quantum computing hardware developers as "showing the machines in PowerPoint slides" (*Financial Times*, October 2, 2017) and considering the current state of the devices through a metaphorical reference to an "era of toy systems" (*Financial Times*, January 28, 2018). Examples of the use of temporal tropes are presented in Table 4.

In terms of visual and multimodal presentation, we find that the nascent state of the market category is portrayed through literal rather than metaphoric images. These images, tied to the present gradual and incremental development of the hardware, depict quantum devices in the laboratory, often with scientists working on them. Such images portray devices as still under construction and convey the notion that quantum computing is in the making. As the visuals present the current state of the devices in a truthful manner, no metaphors or analogies are needed. Fig. 1 presents an example of such an image, featured in an article with the following image caption "A scientist at D-Wave, the quantum computing company, works on one of its systems" (*Financial Times*, April 26, 2016).

In a similar manner, potential applications of quantum computing are described through an analogy of an earlier industry-transforming technology. Notably, these analogies portray a strong belief in a bright future for the novel technology – it will follow the paths of prior transformative technologies: "If you went back to the 1950s, could you imagine the internet? The same is going to

Table 4. Examples of Temporal Analogies and Metaphors.

Target Domain	Source Domain	Example	Data Source
Quantum computing	Semiconductors	"We are moving out of the science discovery stage and into the engineering phase," says Vijay Pande, a partner at venture capital firm Andreessen Horowitz, one of the backers of Rigetti. Like the early days of semiconductors, he adds, the challenge now lies in finding ways to "scale up" a technology that has, in most cases, been demonstrated to work	*Financial Times*, October 2, 2017
Quantum computers	Classical computers	If you compare the current status of quantum computers with that of the classical computer then I think you have to go back to the 1960s or the 1950s for similar state-of-the-art classical computers and the current state-of-the-art quantum computers	Interview
Quantum computers	Nature (rising sun)	Together with similar steps at IBM, Alibaba's move adds grist to the belief that the first practical quantum machines, capable of outperforming today's most powerful supercomputers, are on the horizon	*Financial Times*, September 19, 2018

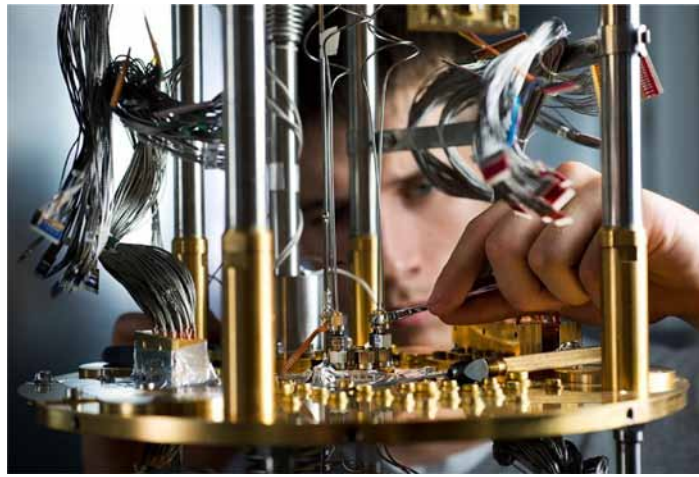

Fig. 1. A Scientist Working on a Quantum Processor. *Financial Times*. Copyright D-Wave Systems Inc..

happen with quantum computing" (*Financial Times*, September 2, 2020). Several informants state that it is not the hardware that creates the revolution in the end, but a wealth of applications – and that they are beyond comprehension in the early stage of development. One of the key scientists in the field, John Preskill, stated in *Scientific American* (July 10, 2018): "We know from history that we just don't have the imagination to anticipate where new information technologies can carry us." The future is also clearly portrayed through visuals of quantum computing. An image from the *New York Times* (Fig. 2) portrays a business executive in front of the elusive device in a dark room, creating a space-like environment. His back is turned toward the viewer to suggest that by moving away from the present, the image can be understood as the metaphor "quantum computing is the future." This interpretation is supported by the title of the article: "Quantum Computing Is Coming, Bit by Qubit."

Mystification of Quantum Through Analogies and Metaphors

The above-described categories of analogies and metaphors seek to make quantum phenomena and quantum computing more comprehensible by using familiar concepts to explain it in both a naturalizing and a temporalizing sense. However, we also found that analogies and metaphors expounded the weirdness by portraying the fundamental differences between classical and quantum phenomena and by constructing quantum computing as mysterious and magical. Quantum phenomena are described in supernatural terms and a variety of tropes are used to make distinctions between quantum computing and classical computing. Examples of mystifying analogies and metaphors found in our data are presented in Table 5.

Fig. 2. Quantum Computing as the Future. *New York Times*. MISHA FRIEDMAN/MVphotos.

Table 5. Mystifying Analogies and Metaphors.

Target Domain	Source Domain	Example	Data Source
Quantum entanglement	Magic	Quantum computing exploits the fact that the laws of conventional physics break down at the smallest scales. Subatomic particles can be in different physical states at the same time, and pairs of particles can be mysteriously linked or "entangled." Exploiting these weird characteristics makes it possible, in theory, to carry out vast numbers of calculations simultaneously	*Financial Times*, February 1, 2014
Quantum computing	Magic	Struggling to shoehorn that mathematics into newspaper-friendly metaphors, most popular writers describe a quantum computer as a magic machine that could process every possible answer in parallel, rather than trying them one at a time	*New York Times*, December 5, 2011
Quantum physics	Magic	Even more outlandish? It's the prospect of a quantum computer. Drawing on the seemingly magical properties of quantum physics, such a machine would be exponentially more powerful than computers of today. Think of it this way: A quantum computer could instantly crack the encryption that protects the world's most private data	*New York Times*, November 13, 2017

In terms of analogies, we found counterintuitive uses that seemingly undermined the power of figurative language through negation. The scientists often present an analogy, only to add that reality is of course much more complex and does not work at all in the manner suggested by the analogy. An example of this was presented in an interview. In the image presented in Fig. 3, electron spin, a fundamental phenomenon harnessed in quantum computing, is explained in terms of the classical world. A "pure" analogy in this case would be the use of a rotating ball as an example of electron spin. However, in this image, a laconic verbal comment weakens the visual analogy and casts serious doubt on it. In this multimodal construction, the visual and verbal modes are inseparable; without the explanatory verbal text it would be impossible to understand that the ball is not actually a ball and that it is not actually spinning.

Such analogies of negation seem to alienate the audience members at the outset. Based on our analyses, one of their functions is to draw boundaries between the quantum physicists and the audiences by pointing out that the science is inaccessible to the latter. In the quote below, a ball is actually a wave and the operations required to control the wave are too complex for nature to perform – hinting at the counterintuitiveness of quantum phenomena (the ball is a wave) and the ability of quantum scientists to manipulate the way the world works (a task too complex for nature).

> Dr. Vinokur likened the challenge to sending a speeding billiard ball back to where it started. Seems easy: Just hit it with a cue stick. (…) However, in quantum mechanics, the ball is actually a wave. Once its location is known, it spreads like ripples on a pond and evolves. Making it go backward takes more than a nudge with a cue stick. It requires reversing the phases of the waves, turning crests into troughs, and so forth, an operation too complex for nature to accomplish on its own. (*New York Times*, August 25, 2018)

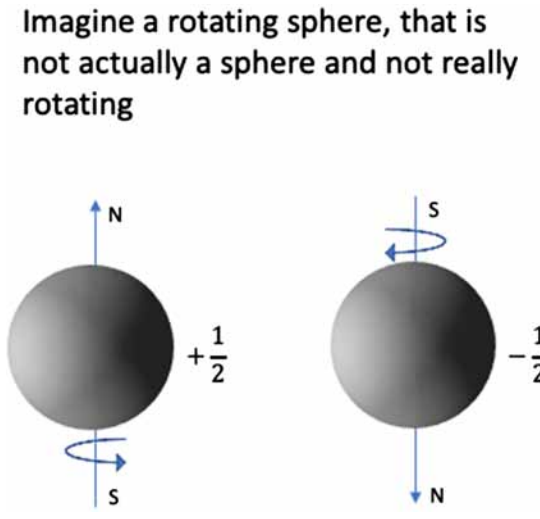

Fig. 3. Explaining Spin to Those Who Do Not Understand It. Adapted from a popular meme on reddit.com/r/chemistrymemes.

Another common type of tropes in the emerging market category focuses on the weirdness and complexity of the quantum world. In the quote below, quantum computing is likened to magic. In this metaphor, the phenomenon of quantum coherence is the magic spell that allows for the magician, that is, the quantum scientist, to perform measurements, "a magician's tricks," on the device.

> The processing of quantum information involves "magic tricks" that are only possible through careful control of a quantum system. Finding a system that maintains quantum coherence, the magic spell, over relatively long periods of time – long enough to use the magician's tricks – is a challenge. (*Nature*, July 9, 2009)

As in the analogies followed by negation, these types of tropes also have a particular function. Metaphors of magic arouse awe, wonder and also curiosity among the audiences. Also, as audiences cannot fathom quantum physics such metaphors suggest that anything is possible. Hence such tropes support the constructions of endless future possibilities and can also support hypes around quantum phenomena:

> No wonder quantum computing has become the subject of such hype. Machines that harness the weirdness of quantum mechanics are so alien – and promise such massive theoretical leaps in performance – that it is easy to believe nothing will be the same again. (*Financial Times*, May 17, 2018)

Mystifying visual metaphors were mostly found in the popular science media. These images contained futuristic imagery and references to space, such as a dark background a blue or purple color scheme, and imageries referring to wormholes (hinting at time travel and teleportation). A prime example of a mystifying visual metaphor is shown in Fig. 4. The image is inspired by the famous Flammarion engraving, a metaphorical illustration of the human quest for knowledge from the late nineteenth century in which a man peeps through the border of the earth, reaching toward the cosmos. Building on the original metaphorical meaning of the engraving and interpreted as a multimodal composition together with the heading of the article ("Beyond the Quantum Horizon"), the image can be interpreted as a metaphor for a leap in scientific understanding, where the boundaries of the classical world no longer limit human activity. In the image, a person can be seen floating in space, detached from the "real" world. The facial expression suggests awe and astonishment, and the act of floating upside down can be interpreted as a metaphor for a new understanding or point of view, or a lack of control in the face of the new science.

Through a multimodal analysis of textual and visual data, we have investigated the ways in which analogies and metaphors are used in constructing the *de novo* market category of quantum computing. We found that on the one hand, the familiarity of the technology is highlighted through metaphors and analogies of everyday objects and events such as coins and libraries. On the other hand, figurative language is used to enhance the weirdness and other-worldliness of quantum phenomena, thereby painting a picture of an elusive black box to which only a handful of individuals have access. Next, we discuss these findings and the contributions of our study.

Fig. 4. Illustration for the Article *Beyond the Quantum Horizon*. *Scientific American*. Copyright © 2013 SCIENTIFIC AMERICAN, a Division of Nature America, Inc. All rights reserved.

DISCUSSION AND CONCLUSION

The main tenet of the cultural entrepreneurship literature is that culture is a set of resources that skilled actors can use to gain legitimacy for their ventures (Lounsbury, Gehman, & Glynn, 2019). Research on cultural entrepreneurship has quite extensively explored the role of language in making and giving sense to novel ventures and market categories and then legitimating them (Garud et al., 2014; Granqvist et al., 2013; Martens et al., 2007; Santos & Eisenhardt, 2009). Scholars have theorized how through analogical and metaphoric reasoning entrepreneurs can build a shared understanding and gain legitimacy and support for novel ventures, but also overcome cognitive constraints that may hinder innovation (Cornelissen & Clarke, 2010; Martins et al., 2015). Our study further deepens such an understanding through a multimodal analysis (Meyer et al., 2013) of verbal and visual analogies and metaphors in the *de novo* category of quantum computing. We show how through the use of figurative language and images cultural entrepreneurs are able to simultaneously construct the category as familiar yet novel through naturalizing, temporal and mystifying tropes.

As previous studies have shown, figurative language is a powerful tool in the creation of new categories. Analogies and metaphors connecting a new

technology to an earlier technology or another familiar object enhance legitimization of the new technology by promoting both familiarity and similarity (Hargadon & Douglas, 2001; Kaplan & Tripsas, 2008; Powell & Colyvas, 2008). This study further specifies such understanding by uncovering the different functions of tropes in *de novo* market categories. First, we find that scientists, in particular, use naturalizing tropes to create comparisons with mundane aspects of everyday life. These analogies, which likened aspects of quantum computing to everyday objects, such as coins and phone books, were often used by scientists to explain the unfamiliar concepts of quantum computing to audiences outside of their own field. Naturalizing visual analogies in the form of infographics were prevalent in the popular science outlet. As multimodal compositions, infographics extend and clarify verbal analogies by presenting complex information in a way that can be processed more rapidly (Höllerer et al., 2018). The function of naturalizing analogies was to highlight familiarity and act as explanatory devices to create early traction among a wider audience. Naturalizing analogies thus act as cognitive simplifications of complex technology by using everyday objects as cultural resources in sensemaking.

Second, while research on cultural entrepreneurship has paid attention to the role of temporality through expectations in entrepreneurial storytelling (Garud et al., 2014), there is a void of research on exploring the temporal qualities and functions of tropes. We present temporal tropes as tools that cultural entrepreneurs use in building rapport for a *de novo* category. We show how metaphors and analogies provide a future-oriented understanding of a novel market category. As the quantum computer does not yet exist in the form of products or markets, and their future prospects are difficult to understand, industry actors used temporal analogies and metaphors to emphasize the nascent state of the market category and to highlight the future promise of the technology. Hence the key function of temporal tropes is to foster belief in market development and often in a revolutionary technological development. For example, a popular analogy likens quantum computing to classical computing or the Internet, while claiming that the new technology will have a similar revolutionary and unpredictable impact on the society, and that this will also take a long time, as it did in conventional computing. In this way, the actors use these kinds of tropes to craft a tentative yet ambiguous timeline for the emergence of quantum computers. This was also visible in metaphoric images in which quantum computers were portrayed in a futuristic manner or as a "work in progress." The use of temporal analogies and metaphors was especially prominent in the business outlets, which again points to the use of these analogies and metaphors specifically in the context of resource acquisition (i.e. convincing potential investors and industry partners) and legitimacy building.

Taken together, these two uses of figurative language construct quantum computing as a somehow familiar, high-potential market category, particularly highlighting the future promise and possibilities of the technology. However, we also observed some counterintuitive uses of tropes to mystify the market category. Scientists, in particular, used an analogy only to immediately negate it – "quantum computing is in fact nothing like the analogy". They also used tropes to portray

quantum computing as mysterious and magical. Previous research has shown that such mystifying language connects with reinforcing and creating certain subject positions, particularly positions of authority, where those who use this type of language exert "pastoral power" (Foucault, 1982) over audiences (Mantere & Vaara, 2008). The function of such language is to protect the existing hierarchies, thereby strengthening the power position of the actors in charge and promoting acceptance without questioning (Mantere & Vaara, 2008)– by subjugating but also making it difficult to form and ask the right questions. Also in our study, the mystifying use of tropes had the function of maintaining the boundaries between the scientific community, particularly when used by quantum physicists themselves, and lay audiences by highlighting that while some of these phenomena can be expressed through the tropes, they are still fundamentally beyond ordinary comprehension. But going beyond this, our data indicate that mystifying tropes also engage people with the new market category. They appeal to emotions and arouse curiosity, wonder, and also fear. Hence they also play an important role in increasing the appeal or resonance of the novel category. Furthermore, mystifying tropes may have an impact on the participation and contributions to this domain of science and technology, aiding innovation.

As a whole, our findings show how cultural entrepreneurs in the *de novo* quantum computer market category use different types of analogies and metaphors to build a shared, albeit simplified understanding of the technology to gain legitimacy and secure resource acquisition, but also to protect existing industry hierarchies and engage audiences with mystifying tropes. While other studies have looked at tropes in category emergence, they have focused on the ways in which they reduce ambiguity and uncertainty in a novel market, also paying attention to how tropes evolve as understandings change, and how through institutionalization, their use is less prevalent as the meanings become shared and taken-for-granted (e.g. Etzion & Ferraro, 2010; Navis & Glynn, 2010; Powell & Colyvas, 2008). Our findings broaden this understanding by showing how, specifically in the case of *de novo* emergence, tropes not only reduce ambiguity and uncertainty, but also create a horizon for future developments and an aura of mysticity, which both induce innovation and participation in the novel category. Our study shows that analogies and metaphors play a key role in *de novo* categories, in particular, because in these setting general understandings as well as conceptions of the potential and applications are completely lacking among most audiences. The analogies to paradigm shifting technologies produce a frame of reference for potential, and mystical metaphors expounds the fundamental difference. Taken together, the three types of tropes: naturalizing, temporal and mystifying mark the category as familiar yet profoundly different and novel.

We extend the literature on cultural entrepreneurship by explicating the various functions of analogies and metaphors used by cultural entrepreneurs. By including visual tropes in our analyses we also introduce and develop multimodal analyses in this literature. Future research could explore the role of analogies and metaphors further by exploring such mystifying tropes in meaning making in a variety of settings. Our study focuses on two types of tropes, analogies and metaphors, but future studies could also look at how other types of tropes, especially

hyperbole, are used in early market emergence. Studies using vast longitudinal data sets could also make use of longitudinal multimodal analyses to investigate how verbal and visual text evolve and change along with the market category development and an increasing understanding of the novel technology. Our study provides an early contribution to such analyses in the context of *de novo* market categories.

REFERENCES

Casakin, H., & Goldschmidt, G. (1999). Expertise and the use of analogy and visual displays: Implications for design education. *Design Studies*, *20*(2), 153–175.

Comi, A., & Whyte, J. (2018). Future making and visual artefacts: An ethnographic study of a design project. *Organization Studies*, *39*(8), 1055–1083.

Cornelissen, J., & Clarke, J. (2010). Imagining and rationalizing opportunities: Inductive reasoning and the creation and justification of new ventures. *Academy of Management Review*, *35*(4), 539–557.

Cornelissen, J. P. (2005). Beyond compare: Metaphor in organization theory. *Academy of Management Review*, *30*(4), 751–764.

Cornelissen, J. P. (2012). Sensemaking under pressure: The influence of professional roles and social accountability on the creation of sense. *Organization Science*, *23*(1), 118–137.

Cornelissen, J. P., Holt, R., & Zundel, M. (2011). The role of analogy and metaphor in the framing and legitimization of strategic change. *Organization Studies*, *32*(12), 1701–1716.

Cornelissen, J. P., Oswick, C., Christensen, L. T., & Phillips, N. (2008). Metaphor in organizational research: Context, modalities and implications for research – Introduction. *Organization Studies*, *29*(1), 7–22.

Durand, R., Granqvist, N., & Tyllström, A. (2017). From categories to categorization: A social perspective on market categorization. *Research in the Sociology of Organizations*, *51*, 3–30.

Durand, R., & Khaire, M. (2016). Where do market categories come from and how? Distinguishing category creation from category emergence. *Journal of Management*, *43*(1), 87–110.

Etzion, D., & Ferraro, F. (2010). The role of analogy in the institutionalization of sustainability reporting. *Organization Science*, *21*(5), 1092–1107.

Forceville, C. (2002). The identification of target and source in pictorial metaphors. *Journal of Pragmatics*, *34*(1), 1–14.

Forceville, C. (2008). Metaphor in pictures and multimodal representations. In R. W. Gibbs (Ed.), *The Cambridge handbook of metaphor and thought* (pp. 462–482). Cambridge: Cambridge University Press.

Forgues, B., & May, T. (2017). Message in a bottle: Multiple modes and multiple media in market identity claims. *Research in the Sociology of Organizations*, *54*(B), 179–202.

Foucault, M. (1982). The subject and power. In H. L. Dreyfus & P. Rabinow (Eds.), *Michel Foucault: Beyond structuralism and hermeneutics* (pp. 208–226). Chicago, IL: The University of Chicago Press.

Garud, R. (2008). Conferences as venues for the configuration of emerging organizational fields: The case of cochlear implants. *Journal of Management Studies*, *45*(6), 1061–1088.

Garud, R., Schildt, H. A., & Lant, T. K. (2014). Entrepreneurial storytelling, future expectations, and the paradox of legitimacy. *Organization Science*, *25*(5), 1479–1492.

Gavetti, G., Levinthal, D. A., & Rivkin, J. W. (2005). Strategy making in novel and complex worlds: The power of analogy. *Strategic Management Journal*, *26*(8), 691–712.

Gentner, D., & Jeziorski, M. (1993). The shift from metaphor to analogy in Western science. In A. Ortony (Ed.), *Metaphor and thought* (pp. 447–480). Cambridge: Cambridge University Press.

Glynn, M. A., & Navis, C. (2013). Categories, identities, and cultural classification: Moving beyond a model of categorical constraint. *Journal of Management Studies*, *50*(6), 1124–1137.

Granqvist, N., Grodal, S., & Woolley, J. L. (2013). Hedging your bets: Explaining executives' market labeling strategies in nanotechnology. *Organization Science*, *24*(2), 395–413.

Granqvist, N., & Siltaoja, M. (2020). Constructions, claims, resonance, reflexivity: Language and market categorization. *Organization Theory*, *1*, 1–32.

Grodal, S., & Kahl, S. J. (2017). The discursive perspective of market categorization: Interaction, power, and context. *Research in the Sociology of Organizations*, *51*, 151–184.

Grodal, S., & Suarez, F. F. (2015). The coevolution of technologies and categories during industry emergence. *Academy of Management Review*, *40*(3), 423–445.

Hargadon, A. B., & Douglas, Y. (2001). When innovations meet institutions: Edison and the design of the electric light. *Administrative Science Quarterly*, *46*(3), 476–501.

Heracleous, L., & Jacobs, C. D. (2008). Understanding organizations through embodied metaphors. *Organization Studies*, *29*(1), 45–78.

Höllerer, M. A., Jancsary, D., & Grafström, M. (2018). 'A picture is worth a thousand words': Multimodal sensemaking of the global financial crisis. *Organization Studies*, *39*(5–6), 617–644.

Hsu, G., & Grodal, S. (2015). Category taken-for-grantedness as a strategic opportunity: The case of light cigarettes, 1964 to 1993. *American Sociological Review*, *80*(1), 28–62.

Kahl, S. J., & Grodal, S. (2016). Discursive strategies and radical technological change: Multilevel discourse analysis of the early computer. *Strategic Management Journal*, *37*(1), 149–166.

Kaplan, S., & Tripsas, M. (2008). Thinking about technology: Applying a cognitive lens to technical change. *Research Policy*, *37*, 790–805.

Kennedy, J. M. (2008). Metaphor and art. In R. W. Gibbs (Ed.), *The Cambridge handbook of metaphor and thought* (pp. 447–461). Cambridge: Cambridge University Press.

Kennedy, M. T., (Yu-Chieh) Lo, J., & Lounsbury, M. (2010). Category currency: The changing value of conformity as a function of ongoing meaning construction. *Research in the Sociology of Organizations*, *31*, 369–397.

Khaire, M., & Wadhwani, R. D. (2010). Changing landscapes: The construction of meaning and value in a new market category – Modern Indian art. *Academy of Management Journal*, *53*(6), 1281–1304.

Lakoff, G., & Johnson, M. (1980). *Metaphors we live by*. Chicago, IL: University of Chicago Press.

Lampel, J., & Meyer, A. D. (2008). Guest editors' introduction: Field-configuring events as structuring mechanisms: How conferences, ceremonies, and trade shows constitute new technologies, industries, and markets. *Journal of Management Studies*, *45*(6), 1026–1035.

Lounsbury, M., Gehman, J., & Glynn, M. A. (2019). Beyond homo entrepreneurus: Judgment and the theory of cultural entrepreneurship. *Journal of Management Studies*, *56*(6), 1214–1236.

Mantere, S., & Vaara, E. (2008). On the problem of participation in strategy: A critical discursive perspective. *Organization Science*, *19*(2), 341–358.

Martens, M. L., Jennings, J. E., & Jennings, P. D. (2007). Do the stories they tell get them the money they need? The role of entrepreneurial narratives in resource acquisition. *Academy of Management Journal*, *50*(5), 1107–1132.

Martins, L. L., Rindova, V. P., & Greenbaum, B. E. (2015). Unlocking the hidden value of concepts: A cognitive approach to business model innovation. *Strategic Entrepreneurship Journal*, *9*, 99–117.

Merriam-Webster. (n.d.). Analogy. In *Merriam-Webster.com dictionary*. Retrieved from https://www.merriam-webster.com/dictionary/analogy. Accessed on December 3, 2021.

Meyer, R. E., Höllerer, M. A., Jancsary, D., & Van Leeuwen, T. (2013). The visual dimension in organizing, organization, and organization research. *The Academy of Management Annals*, *7*(1), 487–553.

Meyer, R. E., Janscary, D., Höllerer, M. A., & Boxenbaum, E. (2018). The role of verbal and visual text in the process of institutionalization. *Academy of Management Review*, *43*(3), 392–418.

Navis, C., & Glynn, M. A. (2010). How new market categories emerge: Temporal dynamics of legitimacy, identity, and entrepreneurship in satellite radio, 1990-2005. *Administrative Science Quarterly*, *55*, 439–471.

Oswick, C., Keenoy, T., & Grant, D. (2002). Metaphor and analogical reasoning in organization theory: Beyond orthodoxy. *Academy of Management Review*, *27*(2), 294–303.

Powell, W. W., & Colyvas, J. A. (2008). Microfoundations of institutional theory. In R. Greenwood, C. Oliver, K. Sahlin, & R. Suddaby (Eds.), *The SAGE handbook of organizational institutionalism* (pp. 276–298). London: SAGE Publications Ltd.

Rosa, J. A., Porac, J. F., Runser-Spanjol, J., & Saxon, M. S. (1999). Sociocognitive dynamics in a product market. *Journal of Marketing*, *63*, 64–77.

Santos, F. M., & Eisenhardt, K. M. (2009). Constructing markets and shaping boundaries: Entrepreneurial power in nascent fields. *Academy of Management Journal*, *52*(4), 643–671.

Seidel, V. P., & O'Mahony, S. (2014). Managing the repertoire: Stories, metaphors, prototypes, and concept coherence in product innovation. *Organization Science*, *25*(3), 691–712.

Stigliani, I., & Ravasi, D. (2012). Organizing thoughts and connecting brains: Material practices and collective sensemaking. *Academy of Management Journal*, *55*(5), 1232–1259.

Vaara, E., Tienari, J., & Säntti, R. (2003). The international match: Metaphors as vehicles of social identity-building in cross-border mergers. *Human Relations*, *56*(4), 419–451.

van Teeffelen, T. (1994). Racism and metaphor: The Palestinian–Israeli conflict in popular literature. *Discourse & Society*, *5*(3), 381–405.