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Ideas rise from chaos: Information structure and creativity



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ABSTRACT

Is structure good or bad for creativity? When it comes to organizing information, management scholars have long advocated for a hierarchical information structure (information organized around higher-order categories as opposed to a flat information structure where there is no higher-order category) to reduce complexity of information processing and increase efficiency of work. However, a hierarchical information structure can be a double-edged sword that may reduce creativity, defined as novel and useful combination of existing information. This is because a hierarchical information structure might obstruct combining information from distal conceptual categories. Thus, the current research investigates whether information structure influences creativity. We theorize that a hierarchical information structure, compared to a flat information structure, will reduce creativity because it reduces cognitive flexibility. Three experiments using a sentence construction task and a LEGO task supported our prediction.

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1. Introduction

Organizations are complex systems with hierarchical structures, consisting of distinct subsystems that are subordinated by higher-level systems. Such structures arise because the existence of stable intermediary units (subsystems) is a superior form in the evolution of systems (Simon, 1962). In the Herbert Simon's (1962) example of watchmaking, suppose a watch contains 1000 components, a watchmaker could either piece all of them together at once, or assemble relatively stable subparts first and then integrate the subparts. Further assuming that the watchmaking process is frequently interrupted by external forces (e.g., phone calls) and every time that happens the watchmaker has to start from the beginning, the former flat system is hugely inefficient compared to the latter hierarchical system because the cost of interruption is much higher.

Hierarchical structures underlie many organizational activities.¹ For example, production management systems, such as the lean manufacturing system, categorize all components into clearly defined categories so that workers can easily and rapidly distinguish and use necessary components in manufacturing lines (Krafcik,

1988). The importance of structure on production efficiency is best illustrated in the fast-food industry, where ingredients and raw materials are neatly categorized in separate containers and can be quickly assembled on demand rather than making everything from scratch. Similarly, organizational information is highly structured as well. Since employees are clustered around jobs and roles, both explicit (e.g., job manual) and implicit information (e.g., embedded information) are categorized by job function. Generally speaking, it is advantageous for companies to organize information or materials by higher order categories due to the gain on efficiency in learning and production.

Without disputing the benefits of having such hierarchical structure, the current research asks whether structure might come with the cost of reduced creativity. In the example of watchmaking, suppose the goal is not to make a watch as quickly as possible but to create a novel watch, is the final product likely to be more or less creative if the components are organized into distinct categories as opposed to when there is no structure? Thus, in this paper we investigate the effects of hierarchical structure on creativity. We do so by focusing on the simplest form of hierarchical structure – the presence of high-order category that is just one level up.

Creativity is one of the defining features that separate humans from other species (Csikszentmihalyi, 1997; Nijstad, De Dreu, Rietzschel, & Baas, 2010). In the current research, creativity refers to novel and useful combinations of information (Koestler, 1964; Ward, 1994). We use the term information broadly, consistent with the concept of declarative information, which refers to “chunks,” including objects, symbols, or facts that possess distin-

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¹ By hierarchy we do not imply authority-ranking relationships but it simply refers to the presence of subsystems and higher order categories or systems following Simon (1962). In the watchmaking example the process that involve subparts is a hierarchical system as contrasting to a “flat” system where everything is assembled at once.

guishable attributes² (Anderson, 1996, 2013). For example, a chair typically contains at least three pieces of declarative information including *seat, legs, and back*, each of which refers to a specific object with unique attributes that are distinguishable from other objects. In this sense, both components in the watchmaking example and raw materials in the production example can be considered declarative information.

We expect that a hierarchical structure of declarative information may be a double-edged sword. On the one hand, it clearly increases efficiency; on the other hand, it may reduce the generation of creative ideas because the presence of higher-order categories reduces distal associations. For example, to design a wheelchair one needs to connect two distal pieces of declarative information: *wheel*, which typically belongs to the vehicle category, and *chair*, which is subordinate to furniture (Goldenberg & Mazursky, 2002). We argue that this association is less likely to take place if the set of declarative information is structured by higher order categories. In what follows, we define two types of information structures and explain why structures of declarative information (hereafter information structures) influence creativity via cognitive flexibility.

1.1. Information structure and creativity

Information structure, which refers to the way in which units of information are associated with one another within a set of information, can be hierarchical or flat. In a hierarchical information structure, a set of information is organized by higher-order categories, where units of information within a category have strong conceptual relationships but those between categories have weak conceptual relationships. In a flat information structure, a set of information is presented without higher-order categories and units of information have weak conceptual relationships with each other. For instance, a set of information that includes “cat”, “dog”, “cow”, “mouse”, and “tiger” is hierarchically organized under the higher-order category of “animal”. On the other hand, a set of information such as “pudding”, “Ukraine”, “check”, “mouse”, and “symphony” has a flat information structure because they do not have an obvious and coherent higher-order category.

We suggest that a flat information structure will lead to higher levels of creativity compared to a hierarchical information structure mainly due to cognitive flexibility. Cognitive flexibility refers to the extent to which individuals can easily switch their focus between different categories or perspectives, making it more likely to integrate distal information in unique ways (George, 2007; Guilford, 1967; Mednick, 1962, 1968; Shalley, Zhou, & Oldham, 2004; Ward, 1994). Many previous studies have found a positive relationship between cognitive flexibility and creativity (De Dreu, Baas, & Nijstad, 2008; De Dreu, Nijstad, Baas, Wolsink, & Roskes, 2012; Mehta & Zhu, 2015; Miron-Spektor & Beenen, 2015; Miron-Spektor, Gino, & Argote, 2011). For example, De Dreu et al. (2008) showed that an increased level of cognitive flexibility induced by positive mood enhanced creativity, which was measured by both fluency and originality. Similarly, Miron-Spektor and Beenen (2015) found that simultaneous inducement of learning and performance goals increased creativity via cognitive flexibility.

² Anderson also defined procedural information as abstract rules of using and combining declarative information. There are some studies that compared absence and existence of procedural information in predicting creativity, showing that having procedural information has an inconsistent but generally positive effect on creativity. Since our research is primarily interested in structure in declarative information in terms of its hierarchical form or flatness, the relationship between procedural information and creativity is not relevant for our paper. We included an appendix that summarizes the role of procedural information on creativity (see Appendix A).

A flat information structure, compared to a hierarchical information structure, increases cognitive flexibility for two reasons. First, the presence of higher-order categories in a hierarchical information structure anchors sense making because individuals interpret the focal information in relation to adjacent information. According to the Adaptive Character of Thought theory, a focal declarative information can belong to many higher-order categories and the interpretations of the information depend on which categories are activated (Anderson, 1996). Category activation is determined by both base-level activation and contextual-priming. Base-level activation refers to individual differences in how people categorize declarative information. For instance, an individual may frequently associate the word “star” with celebrity rather than a celestial body compared with others. Contextual-priming refers to the activation of higher-order categories induced by the conceptual associations between the focal information and adjacent information. The stronger the conceptual overlap, the stronger the influence of contextual-priming on the categorization of the focal information. For example, if “star” is presented along with words like “galaxy”, “rocket”, “meteor”, “satellite”, an individual is likely to interpret the word “star” as a celestial body because the contiguous information activates a higher-order category, “cosmic.”

Asch (1946) showed that conceptual overlap between the focal and contiguous information could change the interpretation of the focal information. He presented one of two sets of information to participants and observed whether the meaning of the focal word (e.g., calm) changed in relation to adjacent words. In one condition, the information set consisted of “kind-wise-honest-calm-strong” while the other consisted of “cruel-shrewd-unscrupulous-calm-strong.” Participants were then asked to come up with synonyms of the word “calm”. In the first condition, participants generated neutral or positive word such as “serene”, “poised”, and “reserved.” However, in the latter condition, the frequently reported synonyms were “cold”, “frigid”, and “icy”. Thus, the interpretation of the focal concept changed as a function of its relations to adjacent concepts through conceptual priming.

We thus argue that a hierarchical information structure might reduce cognitive flexibility through contextual-priming. In a hierarchical information structure, the presence of a higher-order category primes the interpretation of the information in that category, reducing the possibility for alternative uses of the information. In a flat information structure, the absence of higher-order category allows individuals to discover alternative interpretations of the information and increases cognitive flexibility.

Second, a flat information structure may increase cognitive flexibility because it introduces higher probabilities of making distal connections among concepts. By definition, the flat information structure has a flat associative hierarchy, meaning that each unit of information has approximately equal probabilities of being next to any other units of information in the set (Eysenck, 1993; Mednick, 1962; Simonton, 2003). Compared to those in the hierarchical information structure condition, individuals presented with a flat information structure may be more likely to discover serendipitous associations between distal information. Scholars in the creativity literature have long argued that variations in the idea generations can be due to serendipity (Campbell, 1960; Simonton, 1999a, 1999b, 2003). Given that human conscious imagination is bounded and our ability to associate distal categories (i.e., cognitive flexibility) is limited (Ward, 1994), serendipity can refresh habitual thinking and opens up new possible associations. History provides numerous instances where serendipitous discoveries, such as the Archimedes principle or the X-ray, have enriched our lives. Thus, a flat information structure, relative to a hierarchical information structure, may increase serendipitous, flexible uses of information because a flat information structure is more likely to

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