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Knowledge creation and systems research: implications from memory science

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ABSTRACT

If systems research is to enhance the creation and use of knowledge in organizations and society, it must be clearly defined what knowledge is and how it is created. In this position paper, we hope to lay the theoretic foundation explaining individual knowledge creation based on current findings from memory psychology. On the individual level, we link the four stages of the SECI-model to configurations of the multi modal memory theory. We conclude with outlining implications for system development, such as a stronger focus on conceptual knowledge.

Keywords: multi-modal memory model, individual knowledge, SECI model, conceptual knowledge, structural knowledge

1. INTRODUCTION

The spiral of knowledge creation or SECI model [1, p74] has influenced thinking on knowledge creation and its support for more than a decade. The spiral of knowledge creation described in the SECI model roots in processes of individual knowledge creation because "knowledge is only created by individuals" [2, p11], "new knowledge begins with the individual" [2, p32] and "(the spiral) moves up the ontological levels from individual to group to organizational" [3, p465]. If knowledge creation starts on the individual level, processes of individual knowledge creation and use must be understood and enhanced in order to get the SECI-spiral moving. Since individual knowledge is stored in the human brain, findings from memory science and psychology are beneficial to the explanation of individual knowledge creation and can thus enhance the development of systems supporting knowledge creation.

One memory model, the multimodal memory theory [4; 5], is especially useful for this purpose as it can be used to link the concepts of tacit knowledge, implicit knowledge and explicit knowledge from KM to memory research. The benefit of linking the concepts from KM to the memory model lies in a deeper understanding of how knowledge creation and conversion processes work, how they can fuel the spiral of organizational knowledge creation, and how they can be supported. In this way, the application of concepts from psychology can help to facilitate the knowledge creation process. In the following sections, we will introduce the multi-modal memory model, link it to different stages of the SECI-spiral and conclude with implications for systems design and research.

2. THE MULTIMODAL MEMORY MODEL

Based on decades of empiric research and on the established concept of semantic networks [6], the multimodal memory model assumes a conceptual system storing memory contents (and thus knowledge) in the form of semantically networked concepts. Concepts can be seen as abstract data structures in which experiences representing circumstances and expected coherences from a certain realm of reality are generalized [7]. These representations contain constants and vacancies that store probabilities for schemata that can be inserted. In this way, a schema is an instantiable class of a situation. The multi-modal memory model further assumes several systems that are linked to the conceptual system: The nonverbal visual input system for perception, the nonverbal output system for enactment, a verbal input system for hearing and reading and a verbal output system for speaking and writing (compare figure 1 on the following page).

3. INDIVIDUAL KNOWLEDGE CREATION IN THE MULTI-MODAL MEMORY MODEL

On an individual level, the processes of knowledge transformation and creation described in the SECI-model can be explained with the multi-modal memory model. In this section, we link the four stages of Nonaka's SECI-model to the corrsponding memory processes.
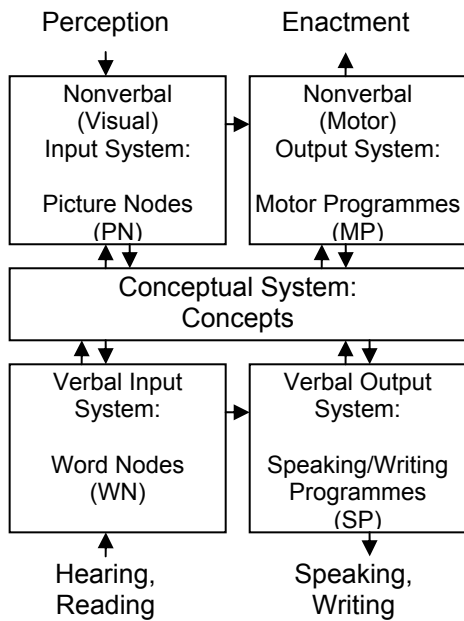
Figure 1: The multimodal memory model [4, p36]

3. 1. Socialization

During socialization, individuals imitate tasks performed by others. The perception of these self-performed tasks (SPT) passes through the non-verbal input system and creates new conceptual knowledge in the conceptual system. This new knowledge is, through performing the task during knowledge acquisition, directly linked to the non-verbal motor output system and thus enables enactment of the newly acquired skill (compare figure 2).
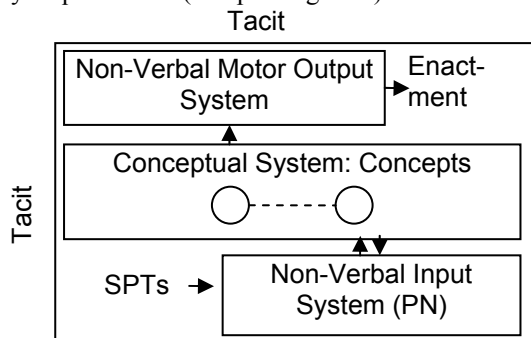

Figure 2: Individual knowledge creation in the socialization phase

3. 2. Externalization

During externalization, conceptual knowledge that only had connections to the non-verbal system for output (through action), is linked to the verbal output system. This implies that that the difference between tacit and exdplicit knowledge is mainly based on different output

systems (either verbal or motor) that are connected to conceplual knowledge. This is in line with Markowitsch [8, p25] who states that explicit and tacit knowledge are basically two different kinds of knowledge retreival (conscious and unconscious) .

The process of creating new links from conceptual knowledge to the verbal output system is facilitated through metaphors and analpgoies [1; 2] and is given in figure 3.
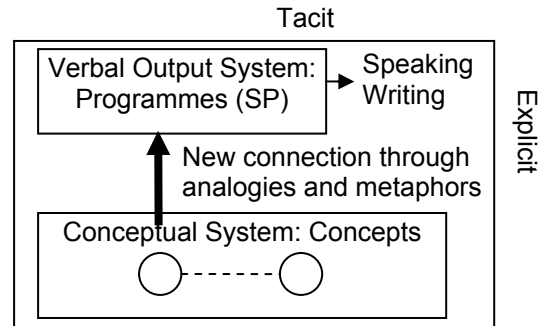

Figure 3: Linkage of individual conceptual knowledge to the verbal output system through metaphors and analogies in the externalization phase

In this way, the model can also explain implicit knowledge, which is non-explicit knowledge that can be formalized through metaphors and analogies: Conceptual knowledge without links to the verbal output system is linked to different but similar conceptual knowledge that does possess such links.

3.3. Combination

During combination, codified information in terms of language is percieved by the verbal input systems in terms of reading and writing. The word nodes in the verbal input system are connected to the conceptual system where they create new concepts. These concepts are linked to the verbal output stem and can be produced through speaking and writing (compare figure 4). This configuration represents explicit knowledge.
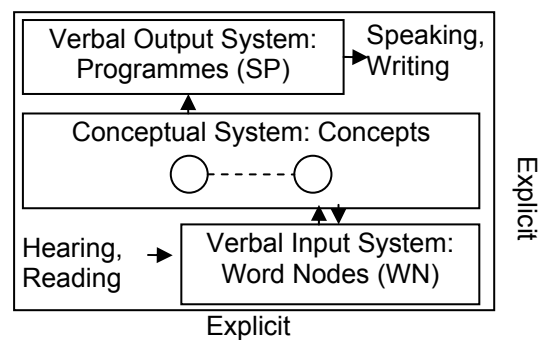

Figure 4: Individual knowledge creation in the combination phase

3.4. Internalization

In the internalization phase, verbal input and the perception of self-performed tasks (compare 3.1.) take place at the same time, e.g. during learnin by doing. In this way, both verbal input and non-verbal input lead to the creation of conceptual knowledge linked to the non-verbal motor output system (compare figure 5).
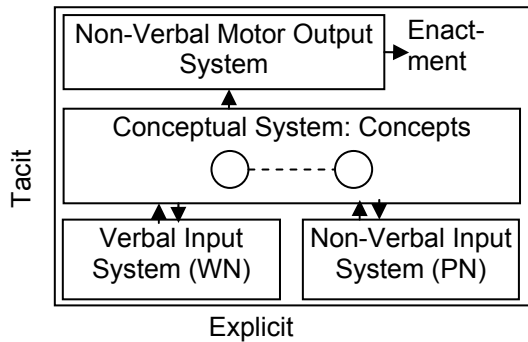

Figure 5: Individual knowledge creation in the socialization phase

3.5. Conclusion

The central issue of these statements is that all processes of individual knowledge creation lead to the creation of conceptual knowledge. Memory research backs this by stating that the conceptual system is "of mayor meaning in processing" [4, p36]. Conceptual knowledge has also been referred to as structural knowledge [9]. Today, there are many possibilities for elicitating structural knowledge [9] and the role of structural knowledge in non-explicit knowledge appears to be vital [10].

4. IMPLICATIONS FOR SYSTEMS RESEARCH

The implication for systems research supporting knowledge creation is outlined as follows: Systems designed to aid knowledge creation on individual and/or group level should especially target the support of structural knowledge. One way of doing so is the visualisation of interconnectedness between knowledge elements, regardless of whether these elements are documents, people, organizational units or whatsoever [11]. In terms of data mining from texts, semantic network construction and graph visualization, systems research has a lot to offer to this domain. If these technologies take findings from knowledge research as the above into account, they can be used as powerful tools for knowledge creation purposes.

REFERENCES

[1] Nonaka, I., & Takeuchi, H. (1995). The knowledge--creating company : how Japanese companies create the dynamics of innovation. New York [u.a.]: Oxford Univ. Press.

[2] Takeuchi, H., Nonaka, I., & Hitotsubashi-Daigaku. (2004). Hitotsubashi on knowledge management. Singapore: Wiley.

[3] Umemoto, K. (2002). Managing Existing Knowledge is Not Enough: Knowledge Management Theory and Practice in Japan. In C. W. Choo & N. Bontis (Eds.), Strategic Management of Intellectual Capital & Organizational Knowledge (pp. 463-476). New York, Oxford: Oxford University Press.

[4] Engelkamp, J. (1998). Memory for actions. Hove: Psychology Press.

[5] Engelkamp, J., & Zimmer, H. D. (1994). Human memory: a multimodal approach. Seattle: Hogrefe & Huber.

[6] Quillian, M. R. (1968). Semantic Memory. In M. Minsky (Ed.), Semantic Information Processing (pp. 216-270). Cambridge: MIT Press.

[7] Schnotz, W. (1994). Aufbau von Wissensstrukturen : Untersuchungen zur Kohärenzbildung beim Wissenserwerb mit Texten (in German). Weinheim: Beltz.

[8] Markowitsch, H.-J. (1999). Gedächtnisstörungen (in German). Stuttgart: Kohlhammer.

[9] Jonassen, D. H., Beissner, K., & Yacci, M. (1993). Structural knowledge: techniques for representing, conveying, and acquiring structural knowledge. Hillsdale, NJ: Lawrence Erlbaum Associates.

[10] Meyer, B., & Sugiyama, K. (submitted). The concept of knowledge in KM: a dimensional model. Submitted to the Journal of Knowledge Management.

[11] Meyer, B., Spiekermann, S., & Hertlein, M. (2005). skillMap: identification of unrecognized parallel developments and of Communities of Practice in distributed organizations. Paper presented at IFSR2005 The First World Congress of the International Federation for Systems Research, Nov 14-17, Kobe, Japan.