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REVIEW ARTICLES

A Discussion on Representing Organizations and Teams as Cognitive Systems

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Abstract

Viewing organizations/work-groups/teams as cognitive systems that process information is either a prevalent perspective or a tacit assumption in many management studies with a long history (Hayek, 1949; Simon, 1945). In this research, first, ontology of cognitive system (or cognition) will be discussed in the context of organizations and organizational behavior. It will be exhibited in the light of the literature that different approaches on this subject affect research methods, findings and interpretations of these findings in management sciences, especially in the organizational behavior literature. The two main distinctions in this regard are as follows. 1- Cognition as information processing and symbol manipulation and organization is the information processor. In other words, the mental representation of the world is based on symbols (representationalist perspective). 2- The anti-representationalist: the external world is not a collection of given facts independent from the individual minds of agents or collective mind of groups, but merely a construction by our given or emerging knowledge structures, the environment and the action are situational/contingent. Accordingly, there is a conflict between the notion of tacit knowledge and the representationalist symbol-processing cognitivist view (Tsoukas, 2005). Another distinction emerges when we analyze the activities of teams/work-groups as information processing and knowledge production activities, below the organizational level of analysis, at the group level. As a consequence of the assumption, considering team cognition as *information content*, a product/output, and investigating as such, is a specific ontological attitude. However, grounding the team cognition as an emergent phenomenon, of collection of processes and actions during collaboration is an alternative approach and research paradigm, which considers the cognition as the *process* of collaborative interaction (Cooke et.al 2012). At the organizational level of analysis, this second approach is consistent with focusing on "organizational knowing" rather than organizational knowledge (Cook & Brown, 1999; Orlikowski, 2002).

Keyword

Team cognition, Collective Intelligence, Organizational cognition, Organizational knowledge, Cognitive science

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1. INTRODUCTION

The "cognitive revolution" that heralded the birth of cognitive science as an interdisciplinary field is retrospectively traceable as early as mid-20th century. This development is also contemporaneous with the start of the organizational theory and behavior literature on information processing, and/or the literature on cognitive characteristics of organizations and their subsystems. This overlap is no accident, and it was not however, just a result of influx of cognitivism to peripheral scientific fields. Rather, intellectual scientific and technological developments of the first half of the 20th century caused both cognitive revolution in general, and notion of organizations, societies, economies as information processing systems. After defining/discussing the "cognition" and what is "cognitive" in organizations, this overlap will be explained further.

What are "cognition", the adjective "cognitive" and the term "cognitive system"? All three will be defined in a unified terminological discussion. "Cognition" is the set of mental activities related to knowledge and knowing. Etymologically, co-, meaning "with" in Latin and gnosis "knowing" from Ancient Greek, 'gignoskein', to know, the process of acquiring knowledge (Gomez-Marin & Mainen, 2016); underlies the notion as an act of knowing. However, as a noun, it refers to the perception, sensation, idea, or intuition resulting from the process of cognition; so to the knowledge content itself (Lexico, 2022). As a contribution to terminological discussion in Turkish scientific literature, cognition might had corresponded to "idrak", "derk etmek" in classical Ottoman Turkish, if it had introduced to Turkish scholarship before the language reforms of the republic. Currently the generic translation as "biliş" (cognitive, bilişsel) in modern Turkish is gaining its specific sense and connotation, as the academic audience using the term is creating this technical sense as a terminological convention.

A more technical, cognitive scientific, or cognitive psychological definition of cognition on the other hand, further specifies the mental activities that yields this "knowing": Perception, manipulation/processing of sensory input and memory content in order to recognizing and remembering, decision making, problem solving, planning, any kind of adaptive, *knowledge using behavior*, for individual adaptation or social adaptation and survival. Processing is usually transformation of one modality of input into another. For example, visual sensory input to conceptual when looking at a scene and labelling the scene as for example, 'a tree and apples in the branches' by means of recalling the concepts of tree and apple from the long term memory. Or, phonological input to verbal or lexical and then conceptual (heard sounds to words and then concepts, then meanings). Another case is from mental to visual imagery, thinking about something and the visually representing it in the mind, imagining etc. Another type of processing is inference, using the knowledge available to the mind (the cognitive system), establishing relationships between prepositional statements and concluding a new one, namely, starting from known truths and on the basis of logical operations, attainment of previously unknown (new) truths about reality, by just using mental power, in contrast with learning by observation/experience.

Both of these two types of processing, namely, transformation and inference, requires dealing with the notion of "mental representation": internal, symbolic knowledge structures. So cognition as a process, actually is, to operate on representations and create new symbolic knowledge structures out of the former. This centrality of notion of representation is called as 'representationalist view'. Mental representations are internal pictures, reflections in the mind, of external reality, of entities of outside world, not only in the form of images but symbols or concepts. This is also the way that we can imagine and reason about things that are not only physical, three dimensional or visual. The analogy is that you can represent an image of an apple in a computer's memory in terms of strings of zeros and ones, as well as you can represent a melody, or a music file. Similarly; in addition to visual ones, human mind can represent some entities in terms of language-like or descriptive representations. (Block, 1983). Mental imagery is only partially visual.

"Mental states" are derived from the above mentioned representationalist view of mind: when mind is actively operating on a certain configuration of mental representations, this is a mental state, when this operation processes and/or transforms this representation to a new one, now, the mind is in a new mental

state, or when the previous one is completed or quitted, and a totally new task is at the center of focused attention, this is also a new mental state. Mental activity is depicted as a continuous transition from one to another mental state. During a single cognitive task of problem solving that entails several mental steps, before discovering or reaching to a solution, different representations of the problem as phases, are examples of mental states.

Another significant point on the term 'cognitive' is its demarcation or distinction from the 'affective'. Affective domain of human mental activity entails emotional, attitudinal, motivational and empathy related dimensions (Baker, 2012). As a side note, most of the "cognitive" studies in organizational context, regardless of their being in the individual, group or organizational/societal level of analysis, struggle to confine their research paradigm to the cognitive domain when they want to particularly focus on knowledge related processes. The struggle is of course about controlling affective domain related variables, and they concede the exclusion of constructs from affective domain as a limitation or as being outside the "scope of the research problem".

2. COGNITIVE REVOLUTION AND ORGANIZATIONAL SCIENCES

Notions of cognitive process, mental representation and states are foundations of the representationalist view of mind and relates to the computational theory or mind, which in addition, depicts all transitions from a mental state to another, as computations. Unsurprisingly all these notions and views of mind are reminding us computers; a central processing unit operating on internal symbols, recalling data from and writing onto a long term memory module and actively using a working memory (i.e. RAM) containing the current computational state. This computer metaphor and view of mental activities as series of computations is the core of cognitive revolution which focused on the information processing to understand human psychology. This novel paradigm challenged and replaced the dominant behaviorist and psychoanalytic schools around the end of second world war in United States and Europe. Behaviorism was extremely positivist and relying only on observable behavior and environmental conditions, deeming mental activities and mental phenomena (being inaccessible to third person) as scientifically irrelevant. On the other hand, cognitive revolution started a new research paradigm that launches an expedition in the human mind:

"The cognitive revolution'' in psychology, which was really more of a counterrevolution against the revolution of behaviorism, was stimulated by the introduction of the high-speed computer. With input devices analogous to sensory and perceptual mechanisms, memory structures for storing information, control processes for passing information among them, transforming it along the way, and output devices analogous to behavior, the computer provided a tangible model for human thought. Perceiving, learning, remembering, and thinking were reconstrued in terms of ''human information processing,'' performed by the software of the mind on the hardware of the brain. Artificial intelligence, simulated by the computer, became both a model and a challenge for human intelligence." (Kihlstrom & Park, 2002)

3. EARLY POLYMATHS OF COGNITION IN THE SOCIAL: H. SIMON AND F. HAYEK

The above mentioned analogies about workings of human mind and psyche went beyond psychology and permeated into administrative, organizational sciences and economics. For example, Herbert Simon in his early 1945 work *Administrative Behavior: A Study of Decision Making Processes in Administrative Organizations*, envisions these organizations as decision making systems. In his analysis of the psychology of administrative decisions, he refers to the formal decision theory of von Neumann (founder of game theoretic economics and modern computer architecture) and Morgenstern, and adopts their notions of representing possible future as the nodes of a "decision three", applies notions of tree data structure or tree search algorithm to human organizational decision making. Another notion derived from von Neumann and

Morgenstern was the min-max calculations of optimal choice with the best outcome at minimum cost (p.120-121).

In addition to adoption of information science to study organization, in his seminal paper "The Architecture of Complexity", Simon brings about another novel perspective on the notion of "hierarchy" in organizations. Rather than a stratified structure of power relations, Simon pictures hierarchy as a feature of complex systems, relation between parts and the whole, higher level systems and subsystems, "to refer to all complex systems analyzable into subsystems" (Simon, 1962). Social/organizational hierarchy is only a version of this systemic feature which is also universal for biological, physical and artificial systems. All systems are organized into hierarchical layers of parts, parts of these parts and so on. Any (sub) system at some specific layer in a hierarchy are not only interdependent but can be decomposed into (which means easily understood, explained in terms of, or reduced into) the nearest, one level down or horizontally neighboring, simpler subsystems. The most intense interactions and information exchange occurs among these neighboring subsystems and we can see this systemic feature in the divsionalization of organizations, and in division of knowledge related tasks, (similar to the notion of division of labor). This systemic feature is characterized as "division of labor, and can be considered a problem solving activity where the recursive division of problems into sub-problems is a property of both organizations and computer programs" (Egidi & Marengo, 2004). Simon's notion of this close relation to, and interaction with closer subsystems is called "near decomposable architecture" or "near decomposability".

Friedrich Hayek, articulated similar but alternative ideas when he tried to explain the reasons of the economic institutions, in his book The Sensory Order (1952). His understanding of cognition is different from the computationalist/symbol processing/representationalist view based on computer metaphor. What Hayek thinks that human sensory experience and thinking happens through the network of connections among the similarly structured nerve cells of the brain. As we can empirically verify, there is no central processing unit, or a biologically different long term memory module or working memory cells in human brain, what we see is a sea of seemingly identical neurons which are connected to each other via synapses that carry electrical current from one to another neuron. Human cognitive system cultivates and is structured as a result of interaction of this network with sensory information pouring from external world, action-perception couplings and adaptive behavior selects and reinforces the best configuration of the synapses and patterns of flow of signals among the neurons. All of the mental systems of processing and storage (of information) must be implemented on this biologically uniform structure by means of different configurations of synaptic connections and specific flow of electrical impulses among the neurons (neural networks). This perspective is called "connectionism" and is a reaction against the computationalist/representational view, which was criticized to be counterproductively reliant on the computer metaphor to understand human cognition. Connectionist view of a cognitive system is bottom up, networked, adaptive, emergent and relational. The connectionist movement was named and gained traction in 70's and 80's but Hayek's view that all aspects of human mental activities can be explained by a system of connections of specific groups or patterns of nerve-excitations (in 1940's terminology of psychology and brain anatomy), captures the whole idea and predates the connectionist movement itself. What is interesting about his approach on human mind is that this connectionist conception is applied to the field of economics and societal level to explain market process. Neurons are replaced by simple individuals with trivial market information:

But, while the latter has been one of the main subjects of investigation ever since the beginning of our science, the former has been as completely neglected, although it seems to me to be the really central problem of economics as a social science. The problem which we pretend to solve is how the spontaneous interaction of a number of people, each possessing only bits of knowledge, brings about a state of affairs in which prices correspond to costs, etc., and which could be brought about by deliberate direction only by

somebody who possessed the combined knowledge of all those individuals. Experience shows us that something of this sort does happen, since the empirical observation that prices do tend to correspond to costs was the beginning of our science. But in our analysis, instead of showing what bits of information the 'different persons must possess in order to bring about that result, we fall in effect back on the assumption that everybody knows everything and so evade any real solution of the problem (p. 50-51)

Here, Hayek characterizes the price system as a mechanism for information flow. Similar to the mind, as also in the market system, surprisingly only a very little explicit (conscious) knowledge is required by the agents in order for them to respond the signals in the market and to the changes in his circumstances. In the mind as in the market, the most essential information is passed on in the form of simplified 'signals' (as contextually situated nerve impulses or prices, respectively). (Smith and Barry, 1997) Network of individuals are receiving and passing simple market signals to each other without any central control and design, and this connectionist system decides upon a prices that enables the functioning of the price system.

Both Simon and Hayek relies on their own view of human cognition (computationalist vs connectionist) to analyze organizational and economic institutions, but their distinct positions create a theoretically complementary system. Hayek considers the market as the exceptional institution that can coordinate the actions of atomic individuals with very limited, local information, Simon on the other hand adds elements of division of knowledge (in reference to division of labor) and specific institutions of coordination as complementary mechanisms explain evolution of organizations in addition to markets (Egidi and Marengo, 2004). A witty side note is that,, due to his genius, Hayek created such an early connectionist view which was contemporary with computationalist view of the cognitive revolution, but this did not chronologically match the succession of computationalism by connectionism as two schools of cognitive science. The practitioners of cognitive science had never been aware of Hayek's relevant works of whom known merely as an economist (Feser, 2006).

4. ORGANIZATIONS AS COGNITIVE SYSTEMS IN THE THEORY OF ORGANIZATIONAL KNOWLEDGE

Simon and Hayek were early polymaths and generalists who applied their novel perspectives into broad areas of scientific disciplines from economics to administrative sciences and computer science. In this section, in a more focused way, the notion of 'organizations as information processors', hence as 'cognitive systems' in the specific discipline of *organizational theory and behaviour* will be illustrated. The main theme of classification of varieties of employing this notion is the representationalist/computationalist vs. connectionist duality. Secondly, this section will elaborate on how this duality influenced the construction of theories and how different theoretical approaches preferred one side of this duality.

Simon envisioned organizations as decision-making systems and proposed organizational level complementary mechanisms to overcome limitations of bounded cognition of its individual members working under conditions of uncertainty and limited information. Similarly, the studies on organizational knowledge envisioned organizations as knowledge possessing and processing entities and as higher-level cognitive agents, beyond and above its indivual members, as these members possess individual information and knowledge. This ontology of 'knowledge as possession' (Cook & Brown, 1999) is compatible with the definition of cognition as a representation and an information content, which also entails assumptions about how knowledge is the outcome of logical rule based operations where both the rules and the outcome are stored in the mind as entities. This approach extends into the organizational level of analysis, and to the theories on knowledge production, on knowledge transfer within and between organizations. These theories are constructed on rule based procedural knowledge handling organizational processes. According to this representationalist view, organizational knowledge represents a pre-given world, is universal and objective,

knowledge results from information processing, is transferable, and enables problem solving (von Krogh and Roos, 1996).

However, the discussion on the nature of knowledge, tacit vs explicit knowledge, and on the duality of "knowledge used in the action" and "knowing as part of action" causes the questioning of depicting organizations as representationalist/computationalist cognitive systems. Previously existing, planned, explicit rules, procedures cannot explain the existence of tacit knowledge and can't produce it, cannot account for its activation in the relevant context. In his 2005 book "Complex Knowledge: Studies in Organizational Epistemology", H. Tsoukas characterizes this representationalist/computationalist view:

"in terms of propositional knowledge and logical if-then operations on them: "is the formulation of conditional 'if, then' statements relating a set of empirical conditions ('If X __' - the factual predicate) to a set of consequences that follow when the conditions specified in the factual predicate obtain (' . . . then Y'—the consequent)" (p. 71).

This side of information processing view works best for to handle patterns and regularities, squeezes them into simple, general observational statements and a limited set of rules to activate when they are observed, this process is called "codification" but also unsurprisingly termed as 'algorithmic compressibility' by Tsoukas and organizational knowledge literature preceding his work. This is a rule based algorithmic, hierarchical (in Simon's sense), top down cognitive system, compatible with the computer metaphor.

On the other hand, the problems of tacit knowledge are categorized along with 'narrative knowledge'. In contrast with propositional knowledge, narrative knowledge is anecdotal, context, practice/action dependent, dynamically constructed and provides adaptation to unforeseeable conditions. Both tacit knowledge and narrative knowledge create the problem of codification, namely putting organizational knowledge into generalizable, context independent propositional statements and both are irreducible to simple coding schemes. For example, basic steps of decision making for routine tasks with and pre-determined number and types of actions can be codified into expert systems. However in the case of codifying a "repair" task for any system, the final stage (system repaired, problem source discovered and treated) cannot be achieved by guessing previous steps (backtracking), instead there is a constant use of previous experience coupled by trial and error to extract new transitional, information required for the intermediate mental states of the agent. Therefore, the knowledge that really works and practically used is context and action dependent, dependent on the continuous change of the state of the problem, environment requires specific knowledge and action at each step and instance of repair (Cowan, 2001). This example is illuminating for an organizational analysis about how it can provide and present knowledge in such non-deterministic contingent problems, and how organizations are able to handle and create this kind of knowledge. The quest for explanation requires the changing the paradigm of cognitive system that is used to characterize organizations, and recourse to view of an organization as connectionist cognitive system, previously described as bottom up networked, emergent, relational (Biggiero, 2008). When an explicit propositional formula for action cannot be created, the necessary knowledge and expertise is created by action reaction cycles that trains the cognitive systems of the members of the organization and the organization itself. Therefore, only recollections of past experiences are implicitly imprinted on the individual and organizational memory in the forms of heuristics, instincts or intuition, i.e. tacit knowledge. Tacit knowledge is both acquired by practice/action, and activated-realized during practice/action. This distinction of knowledge from knowing: a perspective on knowing in practice which highlights the essential role of human action in knowing, i.e. knowing as part of action, how to get things done in complex organizational work (Orlikowski 2002). Where knowledge as a static content residing in the heads of cognitive agents, is compatible with representationalist computationalist view;

"knowing as a part of action" is only possible in this second connectionist interactionist view of organizations as cognitive systems.

After the illustration of the duality of connectionism vs. computationalism for organizations, the following question is still unanswered. How can an organization, as being a mere collectivity of agents, or sometimes just an abstract entity, be construed as a cognitive system i.e. a knowing agent itself? Where does the ontological justification come from? What is the solution to the problem of elevating cognitive agency to the collectivity? This question will be discussed in the following section of team cognition and group minds.

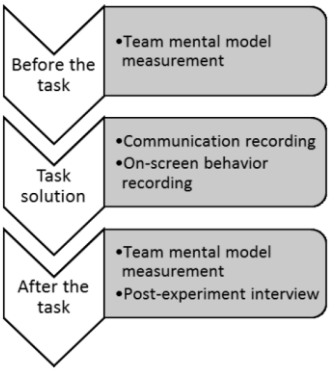
5. TEAM COGNITION

When activities of teams/work-groups are studied with some attention on an ongoing actions of information processing and/or knowledge production, there are two discernible pillars of the research paradigm, first is the level of analysis: it is at the group level, below organizational level of analysis, and above the individual level. Second pillar is that the group's or its members' *cognitions of* tasks, environment, members, procedures, experience, roles and any other kind of knowledge or information that the group deals with, is conceptualized as *group cognition* or *team cognition* depending on the terminological choice. As a result of this second pillar of research paradigm, any of group related object of inquiry in the cognitive realm, is rendered to information or knowledge *content*. So team cognition is the knowledge content that teams knows, produces and uses to make sense of the world and solve problems.

The first pillar is easily justifiable, studying how individual inputs are translated into group outputs, or how individual information inputs are combined into group knowledge, how group judgments can be predicted from individual preferences (McGrath et al., 2000) requires a group level of analysis of knowledge, judgement, and performance. Moreover, when teams are studied, it can be realized that the totality of the team knowledge and performance cannot be reduced into the aggregation of individual knowledge and skills. Human collectivities manage tasks in such level of complexity that no member can have a clear, all-encompassing and detailed ownership or understanding of the teams' actions and knowledgebase. All these aspects places the group performance, judgements and knowledge as the object of inquiry.

Second pillar has significant consequences in research design in team cognition related studies. The result is an input output (I/O) research paradigm where cognitive activity is perceived in terms of its product or precedent, as knowledge content, and the studies are carried out by making initial measurements of these content and team related constructs. Then hypotheses are tested by means of post experimental measurement. In the following figure of the research model, basic elements of team cognition are team mental models (i.e. the information structures, knowledge that the members have about the task and the task environment). They are measured at the individual level and then overlap, complementarity or inconsistencies on individual mental models among the members are used to make group level characterizations of a collective mental model, named as team mental model. To underline the assumptions again, while studying the group activity of collaborative problem solving all of the measurements are made for the inputs and outputs.

Fig. 1 An example for I/O research paradigm: Team mental models (Geszten et al. 2017)



The change in the individual mental models in terms of consistency or overlap is considered to be the dependent variable. Usually performance is also measured, and correlated with efficient team collaboration, in other words collective intelligence. The problem here and the focus of criticism from alternative paradigms, is that the middle part, where the actual collective efforts had taken place is left unattended as a black-box. What kind of knowledge processing and producing activities and interactions happened, as a result of overlap or inconsistencies of members' mental models? How these actions, interactions and events contributed to the chance of individual mental models therefore team mental models, what kind of different team mental states realized during all the tasks were carried out? Similar questions and their answers are not central in this I/O paradigm of research. The critics point out the notion of "cognition as knowledge content" as the source of this neglect of internal workings of the *black-box of team cognition* and viewing the system only in terms of inputs and outputs.

Interactive Team Cognition (ITC) theory criticizes and diverges from existing I/O paradigms (Cooke et.al 2012, 2009, 2004) and considers team cognition is an activity, not a property or a product; proposes that team cognition should be measured and studied at the team level and team cognition is inextricably tied to context. Teams engage in cognitive activity as a single cognitive agent/unit, and this activity extends beyond the knowledge and skills that each team member carries within his or her head. As a cognitive function, team cognition is located in the interactions among team members rather than the static properties of their shared knowledge structure. Team member interaction, is typically in the form of explicit communication (e.g., e-mail, phone, talking face-to-face), is team cognition. The research paradigm of ITC focuses on interaction analysis and uses specific patterns of interaction to explain its conjectures about dependent variables.

This recurring duality (or dichotomy) of diverging conceptions of cognition in organization sciences once again presented. I/O research paradigm focuses on cognition as knowledge (internal representations or reality), and ignores the action in the black box of cognition. ITC on the other hand, establishes cognition of the team around the semi-structured, context dependent and dynamic interactions of the agents under minimal central control of previously calculated, long-term general instructions. We observe this same duality in the Hayek's dynamic information flow between interacting players of the market (connectionism) and the Simon's administrative organizations as decision-making agents, while performing rule based information processing (representationalism). Similar duality was also portrayed in the theories of organizational knowledge.

6. ONTOLOGY OF TEAMS AS COGNITIVE SYSTEMS AND GROUP MIND

An important dimension of examining cognitive dimensions of organizations and organizational units like teams, is the assumptions about ontology of a cognitive system where agent is not an individual person or

animal. In the cases of individual agents, we have an autonomous sentient individual with some level of recognizable intelligence, which actually is the stereotypical base of the notion of cognition. How can we attribute cognition and the functions/features of cognitive systems (i.e. being a knowing agent) to a collection of individuals, to a group which might be considered an abstract entity resulting from and aggregation of individuals? Where does ontological justification come from? What is the solution to the problem of elevating cognitive agency to the collectivity?

One of the ontological approaches to solve this problem is compartmentalization of mental features of sentient/autonomous entities and demarcating cognition from unrelated mental functions. Features like consciousness of external entities, self-consciousness, free will, emotions and affection are not necessarily to be attributed to organizations or teams. But the act of knowing/knowledge related features like judgements, information processing, memory and collective attitudes may be attributed to collectivities. An administrative organization can make decisions but this does not require attribution of a "self" to an organization. So here, attributing cognition to collectivities (organizations or teams) entails propagation, processing and possession of information (or knowledge) by the collectivity above the individual level, but does not entail construing the collectivity as a person with a self, consciousness or sentience. For example, a decision making committee may exhibit its unique and idiosyncratic qualities and behavioral outcomes (decisions) as a result of the unique arrangement of its member, structure, specific rules and task constraints that the committee exposed to in a certain context. When analyzing or observing a decision making task the level of analysis can't be individual cognitive agent, event their collectivity is short of explaining what is going on. Amalgamation of each members' mental models into team mental models, organizational constraints at that unique time point, and combination of contingent personal contributions to collective activity creates a contingent and time and context dependent outcome. All these parameters cannot be implemented or realized in any of the members or even in the totality of the members, this collective attitude of the group is unique and sometimes idiosyncratic combination of the views, skills and knowledge about the task and the context, and can be realized only through their collective action and interaction, when the collective action and the existence of the collectivity, the group ceases, the attitudes and the knowledge base attributed to the group vanishes into oblivion.

In the context of modern business world, (technological or organizational) systems become more and more complex, and they scale to larger and larger systems, so that an individual will no longer have complete control over it, rather, it requires multiple individuals to collaborate in order to accomplish a goal, Therefore when the focus of analysis is propagation of a representational state (dissemination of knowledge) through the system, the cognitive system cannot be construed at the individual level. In his theory of 'distributed cognition', Hutchins expemplifies by means of decks of ships or cockpits of modern planes as such systems, pilots, captains, navigators, engineers, co-pilots, instruments like maps or flight control computers all together forms the cognitive system that navigates these vessels. And a very limited and simplified portion of ongoing information processing is realized in the actual minds of members, (even in the minds of leaders, captains or coordinators); it's distributed across the individuals and the organizational technical systems and realized during collaborative actions. When the interactions cease only a very partial and imperfect traces of information and procedures remains in the individual memories. The above discussions and examples from the literature concludes the argument that there is an ontological ground for cognition by collectives on the condition that cognition must be stripped and isolated from general mental functions and features, and should be attributed to groups and organizations as an isolated feature. Group mind in this sense, is a limited, one dimensional mind without self and soul.

One problem of boundary conditions for attributing cognition to other than sentient individuals is about the definition cognition as 'the source adaptive behavior in the face of environmental stimulus and constraints'. This is a lower boundary. If any adaptive behavior that entails some mechanism for reacting a stimulus is considered to be a result of cognition or information process, then bacteria and plants may be considered to be equipped with a cognitive system but not with a mind (Allen, 2017), like we assume for groups. To overcome this fallacy, the following definition and assumption must be taken in consideration all the time:

Cognition entails internal representations of external reality by means of symbol systems, inside the cognitive system and behaviors as outcomes of operations on, or processing of these internal representations can be outcomes of cognitive activity. So this requirement of internal representations is the explanation of why computational-representational understanding of mind is such indispensable in every theoretical standpoint even it is under continuous attack from more interaction and process focused views of cognition.

7. CONCLUSION

In this study, recurring duality of computational-representational (CR) view of cognition vs. connectionist, interactionist, process based (CIP) view is observed at societal (Hayek, 2005), organizational (Simon, 1945), (Tsoukas, 2005) and team level (Cooke et.al 2013) analysis human collective action in the context of cognitive tasks. As illustrated in the previous sections, adoption of CR view involves an organizational or team cognition view of collective creation and sharing of structured knowledge content and focuses on the analysis, observation and measurement of these knowledge content or knowledge structures. Adoption of CIP on the other hand urges a focus on the processes and interactions and the making of these knowledge contents and ontologically grounds collective cognition on these processes and interactions. As another result of this study, which is a discussion of a very narrow scope and a very selective review of the literature, CR / CIP demarcation corresponds to and overlaps with the 'cognition as content' vs. 'cognition as process' duality.

Then what is the significance of this dualities and overlap of these two dualities? The awareness of the duality may guide researchers and the audience of the research in organizational cognition field about the issues of conceptualization of their object of inquiry as cognitive system. If the organization as cognitive system is conceived as a location for information content then CR view will be expected to guide the research about detecting rule based, computational structures, or (sometimes metaphorical) algorithms for processing this information. Similarly, as a consequence of CR, the most possible oversight is the neglect of the actual processes and interactions where these computations, rules of processing were at work. These processes are also the opportunities for illuminating how rules were generated for the first time or evolved from an earlier version, or how they actually fit the external reality of the organization. Same awareness of the duality may help to guide CIP based research to be able to detect internal representations of the collectivity, where the way these representations are structured may constrain and even determine the patterns of interaction and process of collaboration.

In conclusion, this duality not being a dichotomy, may serve as complementary paradigms to have multi-dimensional picture of the instances of organizational cognition.

One for the limitations of the study is, the problematic of metaphorical use of cognition related vocabulary. This is not addressed in the discussion of ontology and the history of cognitive view in organizational sciences. To articulate their theoretical arguments researchers, may recourse to metaphorical and analogical use of cognition related terminology, characterizing organizations, teams and groups as intelligent, learning, innovative, creative, etc. without making or being aware of any ontological assumptions. This may create ambiguity for the audience and sometimes confusion for the researcher themselves in the research design. Nonetheless, use of cognitive system or intelligence as a metaphor in the organizational behavior and theory was out of the scopes of this study and beyond the intellectual resources of the author.

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